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PRACTICAL GEOGRAPHY AND XXI CENTURY CHALLENGES

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RESPONSE OF MOUNTAIN ECOSYSTEMS TO CLIMATE CHANGE

CLIMATE CHANGE IMPACTS ON BIOCLIMATIC CONDITIONS AND TERRESTRIAL ECOSYSTEMS IN CENTRAL ASIA

Robert Zomer[1,2], Xu Jianchu[1,2], Wang Mincheng[1]

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Understanding and planning for adaptation and mitigation of climate and environmental change is crucial to implementation of sustainable development efforts and effective environmental and biological conservation in Central Asia. Climate change is and has been on-going, and is already evident and widely observed across the region. Meteorological data series for central Asia have shown a steady increase of annual and winter temperatures since the beginning of the 20th century. We summarize the current and future projected status of a set of bioclimatic indicators and the expected impacts of climate change on bioclimatic conditions in Central Asia. Projected climate change impacts were modeled for the four Representative Concentration Pathways (RCP) spanning the range of potential emission scenarios for the year 2050, based upon an ensemble of 13 Earth System Models produced by the Coupled Model Intercomparison Project - Phase 5 (CMIP5) of the World Climate Research Programme (WCRP). Under all scenarios, our spatial analysis indicates quick and drastic change in bioclimatic conditions in the near to medium term, and predicts significant and increasing biophysical and biological perturbation for biodiversity, ecosystems and ecosystem services, and agricultural and pastoral production systems. Potential impacts include both northward shifts in mean latitude and upward shifts in mean elevation of bioclimatic zones, expansion of the warmer ecoregions into higher elevations, decreases in area of the highest elevation biomes and ecoregions, and the disappearance of habits with highly specific sets of bioclimatic conditions impacting on biodiversity and other conservation efforts. We conclude that there is now an overriding necessity to recognize the now central role of a rapidly changing climate and

environment across Central Asia, and highlight the need to plan for adaptation within almost all aspects of sustainable development and conservation planning, efforts and policy.

Keywords: climate change, hydrology, geospatial modeling, environmental stratification, terrestrial ecosystems, agro-ecosytems, biodiversity conservation.

BACK

EPILITHIC LICHEN COMMUNITIES IN ALPINE LIFE ZONE UNDER CLIMATE CHANGE

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The alpine life zone is a unique terrestrial biogeographic unit because of its global distribution (Körner et al. 2011). Epilithic lichen communities inhabit rocky environment over tree line around the globe. They have been studied along altitudinal gradient within alpine life zone in conjunction with different environmental characteristics in different parts of the world, including Alps, Scandinavian Mountains, Central Negev Highlands, Canadian Rockies, Tibetan Plateau, Himalaya. The importance of altitude in explaining trends in species richness was superior to other factors because climatic factors are changing along altitudinal gradient. However, estimate of epilithic lichens biodiversity by means of random sampling and analysis of the environmental features controlling the community pattern was not carried out in Altai-Sayan ecoregion yet. Rate of surface air temperature increase in the region is 0.58 ^{0}C/decade over 30 years starting late 1970s. Such the rate appears sufficient in view of 0.26 ^{0}C/decade global warming given by the Intergovernmental Panel on Climate Change (2014) for the same period. We applied random sampling for epilithic lichens study in Katun Biosphere Reserve, Altai Mountains (South Siberia, Russia). The Reserve is protected area almost without anthropogenic disturbances located at heights between 1,300 and 3,280 m a.s.l. The rock surfaces are often flat, the structural complexity of the micro-environment is reduced there. Climatic factors are changing along altitudinal gradient, so plots spread from1500 to 2600 m ASL in the alpine life zone. Lichen species diversity showed hump-shaped relationships with elevation with highest richness observed between 1600–1800 m ASL. We revealed group of species confined to high mountain belt over 2570 m ASL. Under climate warming, species range in mountains move upward, and this group of species is likely at risk of extinction in the Reserve if global warming continues.

BACK

PEATBOGS OF THE RUSSIAN ALTAI: INDICATION OF CLIMATE CHANGE AND LANDSCAPE REFERENCE

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Peat bogs are important indicators of climate change and anthropogenic impact especially in the intracontinental mountains, where peat accumulation is constrained due to increased drainage of the territory, lack of heat or moisture. Firstly, it is possible to restore the past climatic change and landscape evolution using the botanical and spore-pollen analysis in combination with radiocarbon dating of a peat deposit taking into account its location. Secondly, the wetlands respond to the current climate change and environmental loads.

Considering the distribution of peat bogs within the landscapes of the Russian Altai physical-geographical provinces (Chernykh, Samoylova, 2011), they can be divided into three groups:

1. Automorphic landscapes with sporadic development of bogs: Pre-Altai (1707 km^2 that is 9% of the province area and 10% of the total area of this group of landscapes in the Russian Altai), North-Western Altai (1107 km^2, 8%, 7%), Northern Altai (650 km^2, 5%, 4%), North-Eastern Altai (1847 km^2, 10%, 11%), Central Altai (5157 km^2, 13%, 31%), Eastern Altai (4278 km^2, 26%, 26%), and South-Eastern Altai (2033 km^2, 16%, 12%).

2. Semihydromorphic and hydromorphic landscapes with limited development of bogs: Central Altai (675 km^2, 2%, 38%), Eastern Altai (520 km^2, 3 %, 29%), and South-Eastern Altai (593 km^2, 5%, 33%).

3. Hydromorphic and semihydromorphic landscapes with maximum development of peat bogs: North-Eastern Altai (559 km^2, 3%, 60%) and Central Altai (372 km^2, 1%, 40%).

By location, the bog landscapes of the Russian Altai can be divided into the following groups:

1. Depression-valley: a) floodplain; b) terrace; c) intra-moraine; d) dammed (moraine-dammed, etc.).

2. Watershed-slope: a) saddle; b) pedestal and step-like slope; c) exaration (kar, etc.); d) catchment basin (funnel); e) land subsidence (thermokarst, karst, suffusion, etc.).

Landscapes with maximum development of peat bogs are the most promising for their study in terms of paleoreconstruction and indication of modern changes. For climate paleoreconstruction, it is advisable to use bogs of more conservative relief elements (terrace, saddle), and to study the evolution of landscapes and current climate change – more dynamic ones (floodplain, catchment basin, land subsidence).

The work was supported by the RFBR grant no. 18-05-00007-a.

Keywords: peat bogs, landscape structure, the Russian Altai, indication of climate change and anthropogenic impact.

BACK

CURRENT DYNAMICS OF LOW-MOUNTAIN LANDSCAPES IN THE RUSSIAN ALTAI UNDER CLIMATE CHANGE AND ANTHROPOGENIC IMPACT (THE MAIMA RIVER BASIN AS A CASE STUDY)

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The Maima river basin (776.5 km^2) is a key model territory for low-mountain landscapes, which occupy more than 90% of its area. The basin is located in the Northern (69.6%) and North-Eastern Altai (30.4%) physical-geographical provinces (Chernykh, Samoylova, 2011) and includes the largest agglomeration in the Russian Altai (Gorno-Altaisk town, Maima and Kyzyl-Ozek villages). In the basin, there are a hydrometeorological station Kyzyl-Ozek (average annual precipitation – 799.7 mm, evaporation – 533.5 mm) and a gauge station Maima.

According to the modern landscapes map (scale 1:100 000), transformed landscapes occupy 6.8% of the basin: mono-species tree plantings – 1.5%; arable lands – 1.2%, buildings – 4.1%.

The dynamics of a land cover was studied using the Landsat images for 3 time slices (1976, 2001, 2016) and 4 types of land cover, i.e. water body, arable lands and settlements, forests and natural herbal community. Over the past 40 years, forests area has decreased by 13.6% (105.4 km^2). In the Northern Altai, forests area in the expositional forest-steppe was reduced by 22.4% (15.7 km^2), in subtaiga and mountain taiga – by 16.6% (77.8 km^2), in the North-Eastern Altai chern and mountain taiga – by 5.5% (11.9 km^2). Most forests have turned into natural herbal communities. The area of water bodies has slightly decreased, while that of settlements and arable lands has increased.

To analyze the atmospheric humidification, the drought index Si (Ped, 1975) was used. In 1940/41–1976/77, 8 years (22%) were humidified: 7 “excessively humidified” (Si$\leq$ -2.0) and 1 “humidified” (Si$\leq$ -1.5). The "drought" (Si$\geq$ 2.0) was only in 1961/62. In 1977/78–2013/2014,

there were 10 (27%) "dry" years: "drought" – 7 and “droughty” (Si≥ 1.5) – 3. “Excessively humidified” year was only in 1984/85. In 1940/41–1976/77, the average annual water flow made up $\bar{Q}$=8.8 m³/s, and in 1977/78–2013/14 – $\bar{Q}$=8,1 m³/s. In 1940/41–1976/77, there were 3 extremely high-water (10% flow probability**,** 1946/47, 1957/58, 1968/69) and 3 extremely low-water (90% flow probability, 1962/63, 1963/64, 1967/68) years. In 1977/78–2013/14, there were 4 extremely high-water (1983/84, 1992/93, 1994/95, 2013/14) and 4 extremely low-water (1997/98, 2006/07, 2007/08, 2011/12) years.

The work was supported by the RFBR grant no. 18-05-00007-a.

Keywords: Russian Altai, low mountains, landscape dynamics, land cover, drought index, flow probability, climate change, anthropogenic impact.

BACK

TRENDS IN ECOSYSTEM SERVICES OF NORTHERN ALTAI

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The given article reviews the level of realization and stability degree of utilization of ecosystem services. Application of expert evaluation method allowed evaluating quite objectively the quality of services performed by ecosystems of Northern Altay. Application of Leopold matrix provided the evaluation of regional differentiation of ecosystem services in the investigated territory. The performed research allowed identifying the intensity and direction of change process of quality of main types of ecosystem services. The results received during this stage made a basis for the development of indicators system for the dynamics of ecosystem services.

Keywords: ecosystem services, dynamics, quality, regional-time differentiation.

Introduction

Examination of the benefits which the humanity receives from ecosystems becomes more topical nowadays [1-5]. The research “Natures services: societal dependence on natural ecosystems” edited by a well-known American economist-ecologist G. Daily [1] gives the following examples of ecosystem: purification of water and atmosphere air, regulation of precipitation and drought, waste assimilation and detoxication, shaping and preserving of soil, pest and plant diseases control, conservation of biodiversity for agriculture, protection from UV radiation, stabilization of climate and many other things. The following key types of ecosystem services are identified according to the international classification [5]: providing (supplying): food, water, wood, raw materials; cultural: recreational resources, esthetic and religious values of nature; regulating: impact on climate, flood and natural disasters control, quality of water resources, etc.; supporting: soil formation, photosynthesis, nitrogen cycle and others.

It is known nowadays that two thirds of ecosystem services considered while examination either degrades or are used unstably. This conclusion has serious consequences for

the whole world and it will impact seriously business community and production [2].

Data and methods

We analyzed the connection between the quality of ecosystem services and changeable conditions of environment. There was revealed by expertise the character and change trends in the natural complexes under the influence of both anthropogenous factors and climatic changes and as a consequence there was revealed quality change of the provided ecosystem services. Leopold matrix was used to systematize the received data. As a result there was received a matrix table which described the effects of change environment conditions influencing the quality of ecosystem provided by geocomplex.

Results and discussion

We have carried out the identification of ecosystem services of Northern Altay. This territory has a wide diversity of natural and climatic conditions due to high landscape inhomogeneity. Its landscape structure is covered by 61 % of forest, forest-steppe and steppe low-hill terrains, 36 % – by forest and forest-steppe medium altitude landscapes, 1,2 % – by high mountains and 1,8 % – by river valleys. Besides the above mentioned Northern Altay has a high recreational and agricultural potential.

The study region is represented by the following mountain chains Seminsky, Cherginsky, Anuisky and Baschelaksky. The mountain chains spread out like a fan from the south and descend gradually to the north changing into low-hill terrains and foothills. The highest chains reach up to 2500 m but the divide line of chains never goes up higher than the forest boundary.

The climate of Northern Altay is characterized by a warm and humid summer and relatively mild and snow winters. Average yearly temperature is 2-3 °C, average January temperature is -12-(-16) °C, average July temperature is 17-20 °C. Cumulative temperatures of period with average daily temperature above 10°C vary from 1600 to 2100 °C.

Picturesque natural landscapes, presence of archeological monuments and ethnocultural traditions contribute to the active development of recreational field. The most popular tourism types are automobile, water, horse and pot-holing. Appearance of archeological and ethnograthic tours has a particular importance. The network of “green houses” (rural tourism) becomes wider.

Agriculture remains the main life-supporting field and is mainly represented by dairy and meat cattle breeding. The population of marals (Siberian red deer) grows nowadays. Challenging landscape prevents the development of crop farming.

The study area is the most industrially developed region compared with the rest regions of Altay. However, the industry is represented by small enterprises of wood-based, building and food industries.

In spite of quite favorable ecological condition of geocomplexes of Northern Altay there is a range of real menaces influencing the quality of the services provided by ecosystems.

Climate change and human economic activities were determined as the main menaces for ecosystem services. Regional display of climate change was revealed by us on the analysis basis of meteorological data base for the period since 1963 to 2013 years. (Maximum observation period in Altay). As a result there was revealed the following: increase of seasonal and yearly temperatures of surface air; extension of extreme temperatures range; decrease of precipitation in winter period; increase of intensity of summer precipitation; decrease of the amount of days with stable snow cover; increase of frequency of late and early ground frosts; increase of aridness. Impact of anthropogenic factor mainly reveals in the pollution of air and water basins, soils degradation and reduction of biodiversity.

The objective of our research was to evaluate the trend and change intensity of eco services of the region. The complexity of the above mentioned is that up to date there are no definitions of methods which allowed to evaluate quantitatively ongoing changes and thus currently it is most rationally to use only quality data. In this case alongside with the method of expert evaluation the application of Leopold matrix showed good results. Actually this is a check list which includes quality data about interconnection “cause-consequence” and at the same time it is the information source about the results. Leopold matrix applies “weights” and “impact intensity” for the indication of relative importance of processes and alongside there are no exact criteria to put these weights into numerical values. We have modified the matrix according to a particular objective to evaluate quality change of eco services provided by each exact geocomplex affected by synergetic influence of climatic and anthropogenic components. The received results are included into maps.

As a result it has been discovered that the regulating eco services show stable condition (Fig. 1,2) in the most part of the study region (56 %). The exception makes the ecosystems of western and eastern parts of the region where insignificant deterioration of regulating eco services is noted. At the same time there is a range of small areas peripherally in the Northern Altay where insignificant improvement of defined eco services is noted (Fig.1).

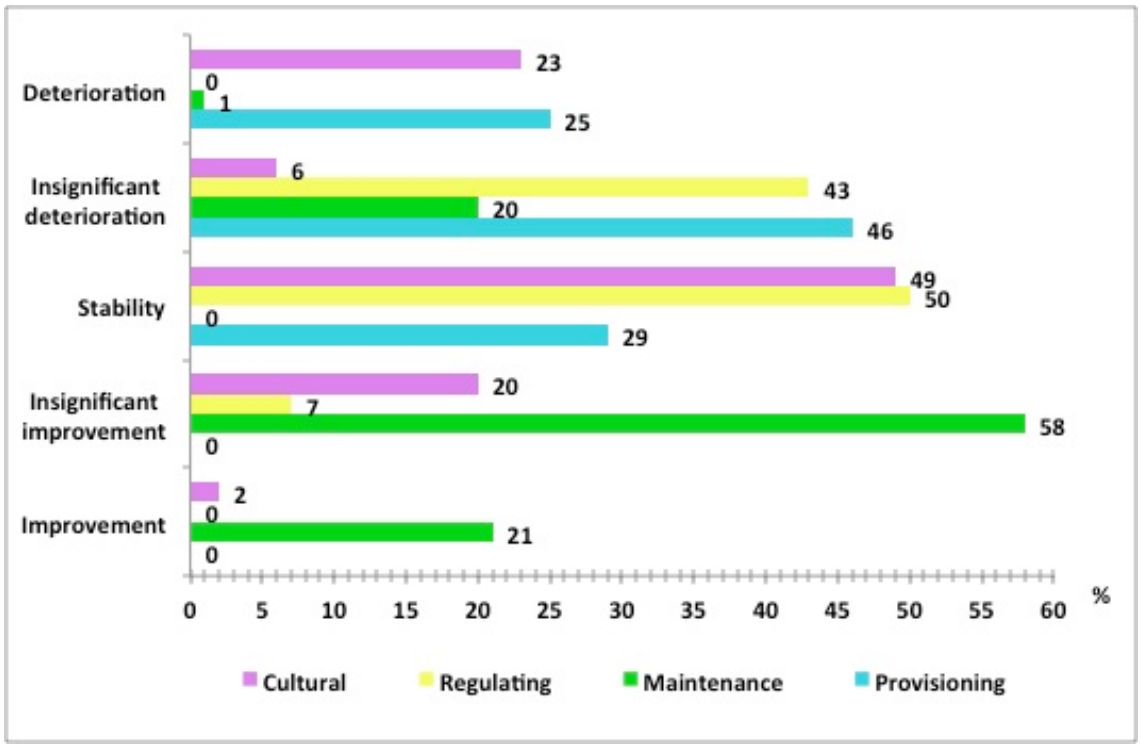

Fig. 1. Dynamics of Northern Altay ecosystem services condition

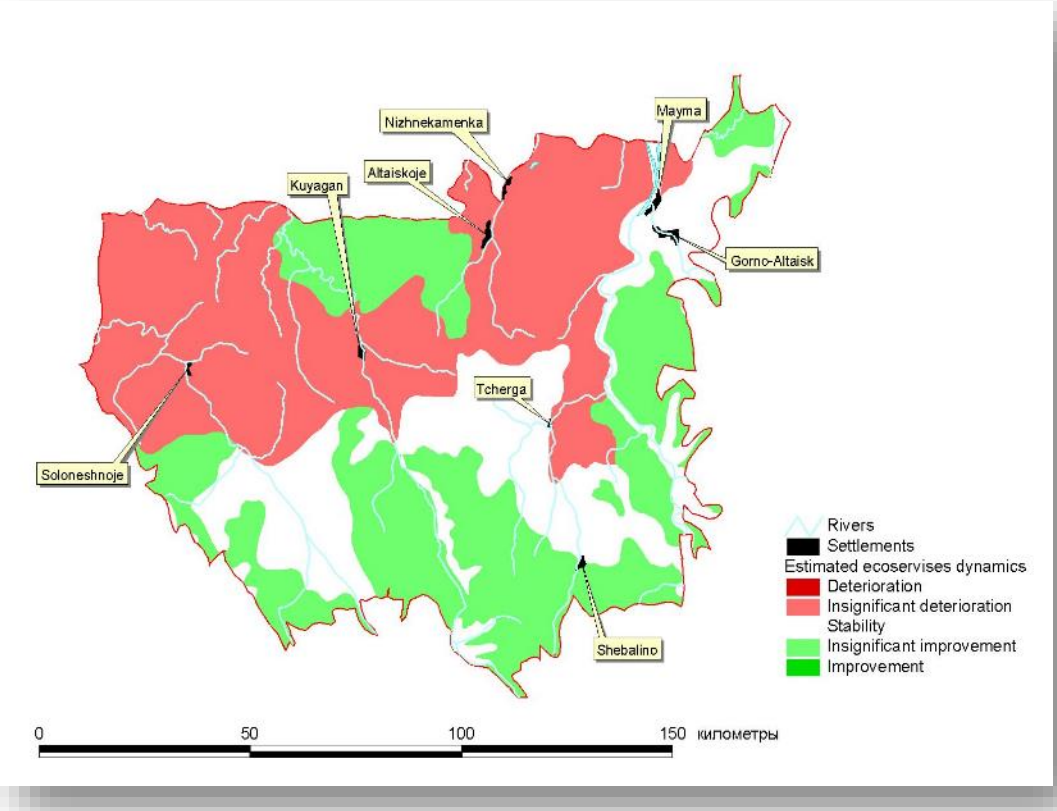

Fig. 2. Expected dynamics of quality of regulating eco services in the territory of Northern Altay

The most concern is caused by the providing eco services as their quality is at stake in the most part of the territory (Fig. 3). The situation is characterized by deterioration in the north-west and north-east, the central part shows insignificant deterioration of the given type of eco services. These are the most densely populated territories or banks of the rivers where tourism-recreational field develops actively. The rest of the territory is marked by a stable condition of ecosystem services which quality is predicted to be permanent.

The most optimistic situation reveals while evaluating the trends of conditions of supporting eco services (Fig. 4). Practically three fourths of the territory is characterized by insignificant improvement and improvement of ecosystem services quality. Only in the central districts of the province and in small sections in the south and south-west of the territory the situation is evaluated as insignificant deterioration and deterioration.

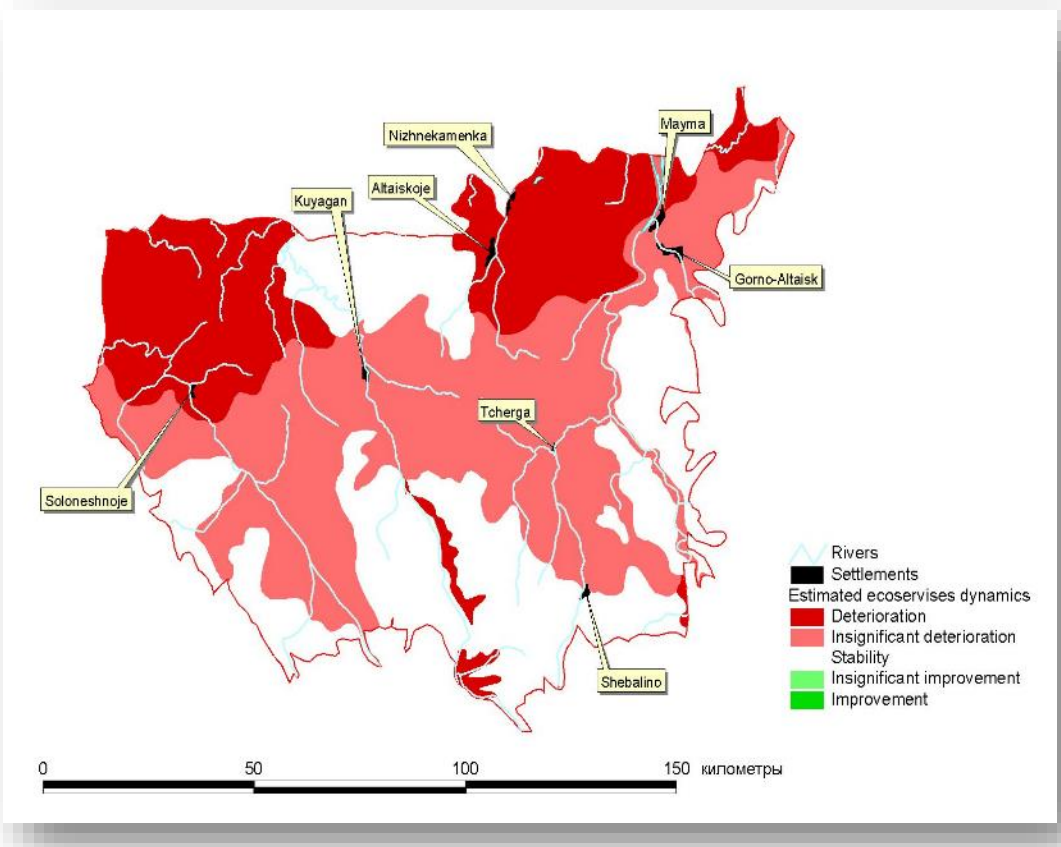

Fig. 3. Expected dynamics of quality of providing eco services in the territory of Northern Altay

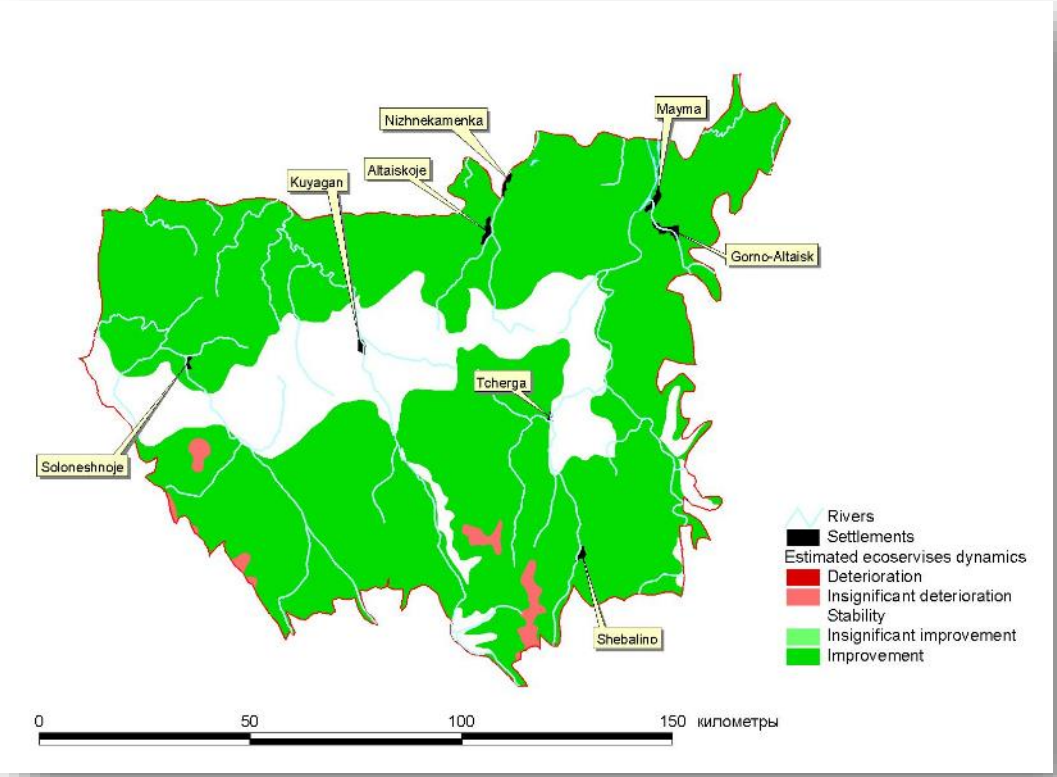

Fig. 4. Expected dynamics of quality of supporting eco services in the territory of Northern Altay

The quality of cultural ecosystem services suffers changes as well. (Drawing 5). North-western and north-eastern districts undergo deterioration. However, there is observed a stable condition or insignificant improvement in the most part of the territory and the valley of the Katun river is characterized by improvement of eco services.

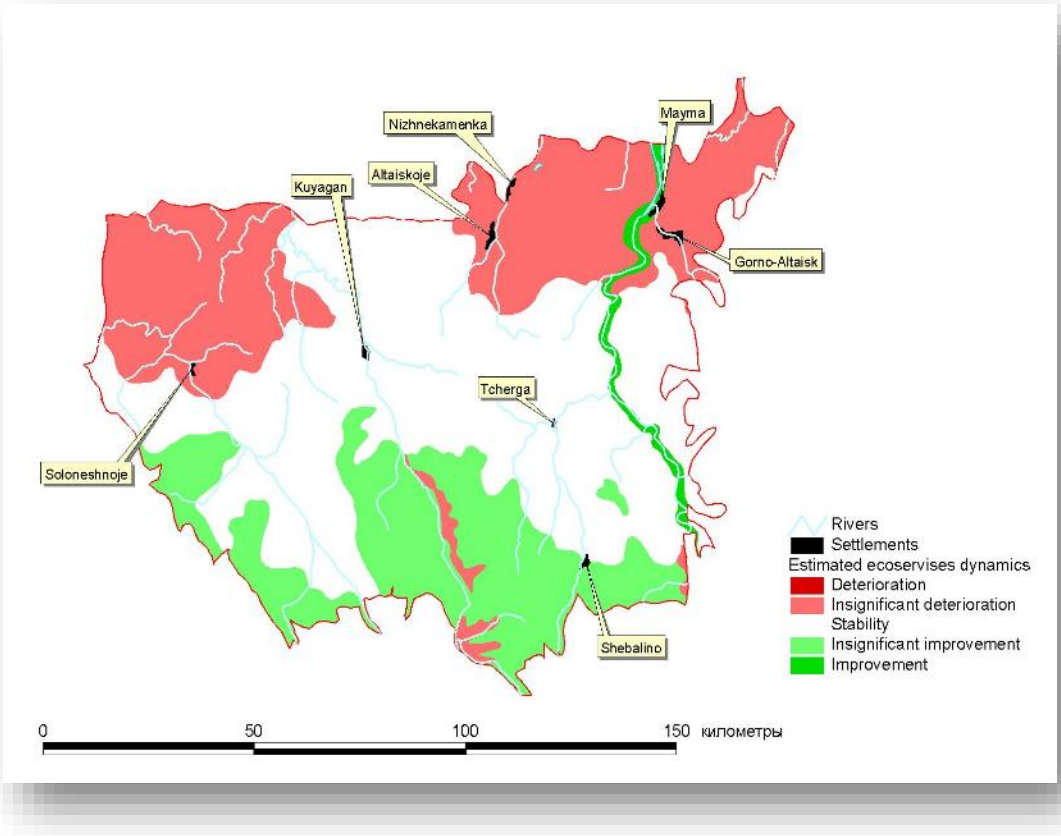

Fig. 5. Expected dynamics of quality of cultural eco services in the territory of Northern Altay

There has been made an attempt to evaluate ecosystem services of the Altay Republic from the economical point of view. Based on the technique offered by some people (S. Bobylev, V. Zakharov, A. Rosenberg) [3,4] there has been calculated the cost of “full package” of ecosystem services for the Altay Republic which equals to $5.94 bln. [6].

Whilst it is important to note that the income of Altay Republic budget for example in 2010 equaled to 8,4 bln. [$264 million] and 6,8 bln. out of 8,4 bln. were dotations from the federal budget.

Conclusions

1. As a result we can state a fact that the dynamics of condition of ecosystem services of Northern Altay is multidirectional. There are observed either insignificant positive or negative trends (registered deterioration and insignificant improvement). Supportive eco services have the highest amount of improvement and insignificant improvement, providing eco services deteriorate insignificantly or have a stable condition.

Cultural and regulating eco services are characterized by the most stability while the first mentioned are accompanied with quite high deterioration and the second ones are

accompanied with insignificant deterioration.

2. For a more correct economic evaluation there is a need for a unified system of indicators for mountainous territories which allow to state unmistakably the direction of processes and accordingly the quality change of ecosystem services.

3. Therefore there is a necessity for further monitoring the situation to identify the direction and speed of transformation processes of mountainous territories environment as a composition and quality of ecosystem services have a direct dependence on influence by external factors.

The work was done within the framework of the state task of the Ministry of Education and Science of the Russian Federation 5.5702.2017/8.9, and also with the support of RFBR grants 16-45-040266 r a, 16-45-040158 r a.

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BACK

ANALYSIS OF TEMPORAL AND SPATIAL DISTRIBUTION OF GRASSLAND FIRE IN MONGOLIAN PLATEAU

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Wildfire plays a key role in the past, present and future of Earth system as one of the major factors in this system. Monitoring and assessing the temporal and spatial pattern of wildfire have significance in understanding the ecological processes and the human impacts on ecosystem.

The Mongolian Plateau, which is an important part of the global ecosystem and one of the most important ecological barriers in Northeast Asia, is important for the ecological security of the Mongolian Plateau and its surrounding areas. Therefore, in this study, the temporal and spatial distribution of wildfire was analyzed by using MCD64A fire slash production in the Mongolian Plateau from 2000 to 2017. It was found that the grassland fire was mainly distributed in the eastern Mongolia where is the border of China and Mongolia, with the great difference near the borderline. Therefore, taking the buffer zone with 100km from the borderline as the main study area (core area), the frequency and spatiotemporal characteristics of grassland fire was analyzed, and the temporal and spatial pattern of grassland fire on both sides of the borderline was compared. The results showed that 248500 km^2 were burned with in the study area from 2000 to 2017and 119700km^2 of them were in the core area, which represented the 48.17 percent of the total burned areas. The temporal distribution of burned areas were declined firstly, then increased in the core area from 2000 to 2017, which the fire more than 10000 km^2 occurred in 2002, 2003, 2005, 2010, 2011 and 2015. In the daily dynamics of the number of wildfire, the frequency is high in the spring, mainly from March 29th to July 11th, from August 22th to October 26th in autumn. In the spatial distribution, the 96.45%

percent of total burned areas were in the Mongolia, which is 113300 km^2, 6400 km^2 were in the Inner Mongolia. The high frequency area was mainly distributed in the borderline where the frequency had a significant difference. The borderline between China and Mongolia is not a natural geographic boundary where the natural environment on both sides of the borderline is exactly same, but a line delineated by human. However, why did the fire distribution on the side of the borderline have such a difference? The occurrence of wildfire is closely related to climate and human activities. The general trend in a region is likely to be climate-related, whereas the great difference of wildfire in the sides of borderline may be related to human activities. The border area of China and Mongolia is also an ideal research area to study the impact of human activities on wildfires. It has important characteristics of climate change and human activities. Research from climate change and human activity is also the main content of future study.

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C6.05 Cold and High Altitude Regions (IGU CHAR)

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C16.05 Cold and High Altitude Regions (IGU CHAR) – Cold & High Altitude Regions challenges and solutions for achieving sustainability

BIRD NESTING COMMUNITIES AS INDICATORS OF HYPOARCTIC BIOGEOGRAPHYCAL BELT

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The latitudinal distribution of biota complexes on the Earth and the system of natural zoning are one of the basic postulates of biogeography. Especially clearly natural zones manifest themselves on vast plains, for example, such as the West Siberian. In a number of cases, the effect of geoecotons makes it necessary to differentiate and supplement the generally accepted scheme of natural zones. So the Russian biogeographers identified the Hypoarctic Biogeographical Belt in addition to the tundra and taiga natural zones. The purpose of our work is to determine the role of nesting birds as indicators of the Hypoarctic in the north of the West Siberian Plain.

In 1966 the Leningrad botanist B.A. Yurtsev substantiated the existence of a specific geographical phenomenon - the Hypoarctic Botanicogeographical Belt (1966), which includes the northern taiga forests, forest-tundra, shrub tundra and the southern part of the moss-lichen tundra. Eligibility for the allocation of such a latent category is a single biogeochemical and biogeocenotic formation confirmed by V.O. Targulian(1967) as pedologist.

Further study of birds and mammals distribution gave A.A. Kischinskii base (1980) to extend this concept to Hypoarctic Biogeographical Belt (HBB) disposed between tundra and boreal zones with a set of specific ecosystem in each of them. Yu.I. Chernov and N.V. Matveeva (1986) also find it acceptable to use the concept of "Gypoarctic" as "latitude" but outzonal biogeographic category ", and their arguments supported by analysis of animal groups such as arthropods, amphibians, birds and mammals, and much more extensive than that of B.A. Yurtsev, an overview of the distribution of plants. It should be noted that the existence of the HBB does not at all deny the legitimacy of the allocation of natural zones - tundra and taiga, and the existence of the northern boundary of the forest as the limit of the spread of many

species of animals and plants. However, the need to recognize such latitudinal extra-zonal biogeographical categories as the HBB is a reminder of the gradual, unsteady and conventional boundaries that we identify and the dialectical unity of the unbreakable and discreteness in a geographical environment.

At the same time, the search and determination of indicators of the Hypoarctic biota, at least for the animal population, often occurs on a qualitative basis, without quantitative criteria, so the quantitative assessment of a number of parameters of animal communities is so relevant.

In general, we are convinced of the fruitfulness of the integrated synthetic approach to the qualitative and quantitative characteristics of individual species or their groups on the one hand and ornithocomplexes in general on the total indicators on the other. N.P.Vtorov and N.P.Drozdov (1978) convincingly showed that in the near future in zoogeographical studies the interrelation of classical qualitative assessments and analysis of quantitative data on the structure of the animal population will prevail and develop. The advantages of such a synthetic approach are shown in a number of works (Vtorov, 1965, 1971; Drozdov, 1965, 1968; Chernov, 1966, 1971, 1978; Puzachenko, 1967; Gladkov, 1969; Vtorov, Drozdov , 1969, Ravkin, 1973, 1978, Ravkin, Lukyanova, 1976, Kuleshova, 1968, 1972, Buteev, 1977, E. Ravkin, 1980, Shenbroth, 1985, Schwartz, 1987).

Thus, the northern taiga rare-earth forests are part of the forest zone, its northern margin and at the same time the southern region of the HBB. Assigning them to one or another geographical category is determined by the feasibility of a different approach. Thus, in the typology of the ranges of animals or plants, it is possible and appropriate to interpret these forests as a component of the HBB. In this connection, following BA Yurtsev (1966), in his early works we take into account not only the range of the species, but, above all, the optimum of its habitat both on the scale of zonal categories (zone, subzone) and on a landscape scale. In the latter case, we are primarily interested in the relation of the species to the habitats of the zonal type.

At the same time, when clarifying the main features of the bird population, including its summary indicators and seasonal dynamics, we considered the northern taiga forests as a separate band of the subzone of the northern taiga of the taiga zone and tried to elucidate its originality by the example of the bird population in this capacity.

The area of work refers to the subzonal belt of sparse forests located in the northern subzone of the northern taiga of the West Siberian Plain. Excess moisture, permafrost and a decrease in heat availability near the northern boundary of the forest zone are reflected in the reduction of bonitet and closeness of the tree layer, reduction in the edificative role of trees and

the productivity of phytocenoses . Due to the progressing bogging, zonal rare-earth forests are not only structurally simplistic, but also fragmented. At the same time, on high floodplains and near-river areas of even small rivers throughout the Ob-Yenisei interfluve, the zonal forests are replaced by a high-quality dark coniferous taiga. The strip of northern taiga rare-earth forests, like the entire forest zone of Western Siberia, is characterized by waterlogging, the location of large bog massifs on placers and the shift of zonal types of vegetation to river terraces. However, the bogs are characterized by a number of zonal specific features. On the northern outskirts of the taiga zone, hummocky swamps are widespread, where oligotrophic frozen knolls are combined with eutrophic and mesotrophic hollows, the total intensity of peat accumulation is slowed and the average thickness of peat is lower than in more southern areas. The marked specific features of the northern marshes and forests provide lesser differences between them in the productivity of phytocoenoses than in the more southern parts of the forest zone. At the same time, the mosaic of plant groups to the north is increasing.

It should be noted the geological youth of the entire West Siberian Plain, and its northern part in particular. Therefore, the dynamics of landscape-forming processes is particularly intense here. The processes of formation of the biotic components of the landscape, in particular avifauna, are also in the stage of intensive formation. This process is aggravated by the fact that, with its exceptional flatness, the action of the glacier in Western Siberia was particularly wide and devastating, in the refugia are strongly remote from its territory (Formozov, 1964).

The above-mentioned specific features of the nature of the West Siberian Plain are fully manifested in the animal world, in particular the avifauna, which makes this region very attractive for ornithogeographic research.

Our research was conducted in the summer periods of 1976-82. (excluding 1979) in four key sections forming a sublate-shaped incision of about 900 km in length at 65o30 'north latitude along the subzone band of sparse forests located in the northern subarea of the northern taiga of the West Siberian Plain. The first key site was located in the Ob valley, where surveyed floodplain and terraces above the floodplain, the second, third and fourth respectively in the middle part of the river basins of Poluy, Nadym, and Taz. That is, when choosing a location for key areas, we used a non-random stratified or stratified sample according to the mesorelief levels: the valley of a large river (Ob), dividing into a floodplain and terraces; valleys of small rivers; interfluves.

The landscape tract was the main accounting element of the territory: in each of them, every 2 weeks, morning counts of birds were carried out on five-kilometer specific but not strictly fixed routes. In total, bird counting was carried out in 46 different habitats in the range

of 1200 km of landscape tract. Each key observation site began on June 1 and ended on August 31.

A more detailed description of the method of recording birds is given in the literature (Ravkin, Dobrokhotov, 1963, Ravkin, 1967), so we do not give a detailed description of it.

Advantages of the method consist in the uniform registration of birds with varying detection distance at different periods of the seasonal cycle and in the unnecessary pre-marking of the territory. The main attention was paid to the quantitative characteristics of the number of background species in various habitats, which served as the basis for defining biotopic complexes of species on the one hand and for defining zonal-landscape optimums of ranges from the other. When distinguishing the complexes of hypoarctic and boreal-hypoarctic species, the principles of the typological (zonal) approach are applied.. The data for the rest of the taiga zone are borrowed mainly from the monographs of Yu.S. Savkin and L.Vartapetov (1984), and the unity of our and the above-mentioned studies in the main methods has ensured complete comparability of the materials. The monographs of N.N. Danilov with co-authors (1983) and E.V.Rogacheva (1988) provided us with basic materials for comparison with forest-tundra and tundra zone.

Strict confinement to a particular biotope is demonstrated by a relatively small number of species. This is a characteristic feature of the northern communities. The increase in the latitude of the distribution of species from south to north along the taiga zone is indicated for birds by L.Vartapetov (1979) and for spiders by K.Yu.Eskov (1936).

We are primarily interested in species with hypoarctic and boreal-hypoarctic distribution as possible edificators of the HBB. They include 30 and out of 49 species examined by us, 15 species belong to hypoarctic and 15 to boreal-hypoarctic species. When trying to define the species with the maximum number in the places of our work - the northern taiga rare-earth forests, it turned out that there are 9 of them, 4 of them prefer to nest in the marsh landscapes: Whimbrel (*Numenius phaeopus*), Spotted Redshank (*Tringa erythropus*), Jack Snipe (*Lymnocryptes minimus*). and Eastern Yellow wagtail *(Budytes tschutschensis)* , 4 - in river dark coniferous forests (Arctic Warbler (*Phylloscopus borealis*), Yellow-browed Warbler (*Phylloscopus inornatus)* , Siberian Tit (*Parus cinctus*), Pintail Snipe (*Gallinago stenura*), and only Brambling (*Fringilla montifringilla),* and not everywhere, prefers zonal rare-growth forests

Little Bunting (*Emberiza pusilla*) has the optimum of its nesting range in the forest-tundra and at the same time prefers rare and willow floodplain forests.

Another 14 of the hypoarctic and boreal-hypoarctic species inhabiting the extreme northern taiga have optimum ranges in the forest-tundra. Moreover, their overwhelming majority prefer hummocky swamps. The Bluethroat (*Cyanosylvia svecica*) most eagerly nests in the riverine dark coniferous forests, the Willow Warbler (*Phylloscopus trochilus)* - in sparse forests, and tapping does not give preference to either one or the other.

Two more species have the highest nest numbers in the typical northern taiga, situated at the more southern places. Of these, Eurasian Three-toed Woodpecker (*Dryobates tridactyla*) in the places of our work prefers riverine dark coniferous, and Pine Grosbeak (*Pinicola enucleator*) - placer rare woods.

Siberian Jay (*Perisoreus infaustus*) and the Nothern Hawk Owl (*Surnia ulula*) have an extensive optimum range throughout the northern taiga, and in the extreme prefer zonal habitats.

For two other boreal-hypoarctic species – Two-barred Crossbill (*Loxia leucoptera)* and the Bohemian Waxworm (*Bombicilla garrulous*), as mentioned above, it is difficult to specify the range optima. On the northern edge of the forest zone, they mostly adhere to the placer rare-wood forests, but not everywhere.

So, first of all, a rather strange situation attracts attention: despite the fact that a relatively large number of species find the most optimal conditions for the existence of a relatively large number of species in the north-taiga sparse forests and in the adjacent forest tundra and typical northern taiga, almost all of them prefer non-zonal rare-growth forests or light forests, and riverine dark coniferous taiga, floodplain willow forests or hilly swamps.

From the zonal forests are preferred sites with the most closed and full stand. Even from 9 species, strictly preferring this subzone band, only one is adherent to the placental forests, and that is not everywhere. Thus, the population of the nesting birds of the zone rare forest has practically no "face" of its own, while the northern taiga rare forest as a subzonal strip as a whole has a whole range of specific species. Spatial changes in the population when moving from riverine forests and hilly mires to rare forests of the zonal type occur according to the principle of non-replacement, as is most often the case in bird communities, but impoverishment, which is less characteristic of them. A similar situation for the distribution of hypoarctic spider species is noted by KY Yesskov (1986).

It should be thought that adaptation of hypoarctic and boreal-hypoarctic species is aimed at the fullest possible use of all the advantages of the ephemeral climatic well-being of the HBB in the nesting period. VZ Zimin (1988) believes that many specific features of the biology of northern birds are explained by "round-the-clock illumination and a short period of night

dormancy in the spring-summer season" (p. 162). In the opinion of this author, the positive energy balance, determined by the excess of energy inflows from food per day, over its expenditure during the night rest, gives northern birds certain advantages. Such advantages include the combination of such intensive phases of the annual cycle, as nesting and molting. Their simultaneity is shown for a number of hypoarctic species, for example, oatmeal-crumbs and varacus (Ryzhanovsky, 1986, 1988). The possibility of round-the-clock production of feed makes polycyclic reproduction possible, and in the north, repeated nesting is not strictly disaggregated in time with the main one, both in the southern and middle latitudes, and often coincides (Zimin, 1988). Absence of tension in the energy balance causes the phenomenon of polygyny. Thus, S.V. Shutov (1986) showed that bigamy is widely distributed among Warblers in the Polar Urals. It is natural that birds prefer the most productive riverine forests, with a complex structure, somewhat similar to the southern taiga. In turn, the southern taiga species of birds can not "take advantage" of these habitats because of their limited area and distance from the optimum ranges, and also because of the lack of adaptations to the instability of the climatic conditions of the northern taiga.

The bird population of hummocky swamps is a fairly specific group, not similar to the forest population of birds in a number of parameters. First of all, Arctic elements take part in its formation, but a number of species are most characteristic precisely for this latitudinal band of bogs. Marshes in Western Siberia are only fomally being intrazonal landscapes, form their own zonality system (Romanova, 1973), which reflects the biotic elements of the landscape, including the bird population. The existence of two latitudinal complexes of bird species in the extreme northern taiga: bog and forest, confirm the idea of I.A. Gvozdenky and N.I. Mikhailov (1978) that in Western Siberia there are "two independent systems of latitudinal zoning: zonality of the drained sections and zoning of undrained interfluves "(p.180).

In a more general view, Yu.I. Chernov (1978) showed a significant role of intrazonal landscapes in general in the formation of the animal population of the northern regions. In addition, B.A Yurtsev (1966) and Yu.I. Chernov (1978), as one of the sources of hypoarctic forms, is called intrazonal communities of more southern zones.

K.Yu.Eskov (1986) believes that in the hypoarctic zone landscapes provide not so severe requirements and are not as passive as in the tundra zone. In other words, they do not require animals and plants to have highly specialized adaptations and are populated with species from intrazonal biotopes, which is not observed in typical and arctic tundra.

Further, we note that about half of all hypoarctic and boreal-hypoarctic species noted in the area of our works can be named, based on the optimums of their ranges, forest-tundra. This

confirms the assumption of AA Kishchinskii (1980) on the forest-tundra as a core region in the HBB.

In our opinion, the typical northern taiga also belongs to the HBB when considering the nesting population of birds, despite the fact that a significant number of species are restricted in their distribution to the south of the extreme northern taiga and species with optimum ranges in the typical northern taiga are much less than in the forest-tundra and in the extreme northern taiga. However, the most significant decrease in the abundance of numerous hypoarctic and boreal-hypoarctic birds occurs not from the extreme northern taiga to the typical, but during the transition from the typical northern taiga to the middle taiga. This can explain the absence of an independent bird population, and its poverty in the middle taiga, noted by many authors (Ravkin, 1978, Vartapetov, 1979; Anzigitova et al., 1979). It is, as it were, a "neutral stripe" between the hypoarctic and boreal biogeographical belts.

Keywords: Hypoartic biogeographycal belt (HBB), bird communities, zonality.

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BACK

IGU-CHAR COMMISSION ROLE IN INTERNATIONAL SCIENCE COUNCIL AND INTERNATIONAL SCIENTIFIC COOPERATION IN THE ARCTIC

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The Cold and High Altitude Regions Commission was created as a successor of Cold Region Environment Commission, and the former Periglacial Commission. A final decision on the continuation of the work of Cold Regions Environments commission (CRE) was taken at IGC 2016 in Beijing, in consultation with the IGU Executive, and included in the proposal to the IGU General Assembly in Beijing. A proposal to change the name of the Cold Region Environment Commission to “Cold and High Altitude Regions” (IGU-CHAR) was accepted and a new chair T.K.Vlasova from the Institute of Geography of Russian Academy of Sciences was nominated.

It has been stated that the new IGU-CHAR Commission will contribute to the realization of the goals of the International Geographical Union by:

1) enhancing, supporting and encouraging inter- and trans-disciplinarity in the study of cold social-ecological systems through geographical research in Arctic, Antarctic and High Altitude regions.

2) producing and disseminating new knowledge, and developing new frameworks for analysis, synthesis and innovation at cross-cutting scales from local to global; and

3) contributing to international cooperation, governance and adaptation for greater sustainability by developing more effective and creative scenarios for the future, in response to emerging threats such as climate change affecting sustainability (Vlasova 2018).

The IGU-CHAR Commission being one of IGU commissions is fully engaged in all IGU activities and events. One of the most important events which the commission can not pass by is firstly the creation of the *International Science Council (ISC)*, by merging ICSU (International Council of Scientific Unions) and ISSC (International Social Science Council).

As the president of IGU Yukio Himiyama underlined, creating this new body, we are demolishing the walls between natural and social sciences (Himiyama 2018). It is important to remember that IGU is a long-standing member of both ICSU and ISSC, and their merger is therefore is of considerable importance to IGU, as the IGU has been deeply involved in the merger, partly because of the interdisciplinary nature of geography, and partly because of its traditionally deep involvement in the initiatives of ICSU and/or ISSC, such as IGBP, IHDP, IYGU, and Future Earth. It is desirable that the nominee(s) have deep understanding of the need for cooperation in scientific research and education; geographers are strongly supportive of this, as Yukio Himiyama stressed. Moreover geographers could really help the ISC unite in tackling global/regional problems that often require interdisciplinary approaches.

Considering the importance of geography in tackling pan-arctic socio-ecological problems such as global warming, sea ice melting, water problems, pollution problems, land and forests degradation, etc., ISC without arctic geographers is unthinkable. All these multidisciplinary issues are of primary importance to IGU-CHAR commission members. IGU and its commissions are tightly connected to the GeoUnions group that adheres to ISSC as well as to ICSU, should be ready to work closely with the other members of the GeoUnions such as: International Cartographical Association (ICA); International Union for Quaternary Research (INQUA); International Society for Photogrammetry and Remote Sensing (ISPRS); International Union of Geodesy and Geophysics (IUGG); International Union of Geological Sciences (IUGS); International Union of Soil Sciences (IUSS). It is especially important for the promotion of science education in a broader sense that incorporates sustainability of the complex socio-ecological systems.

Besides these list of GeoUnions, for the Arctic research and education, it is extremely important to tighten contacts with different Arctic scientific organizations. From this point of view, the IGU-CHAR participation in the Agreement on Enhancing International Arctic Scientific Cooperation, (which had been sighed by the Arctic Council (AC) foreign ministries of eight Arctic States, in Fairbanks on 11th May, 2017) should be very effective. According to this Arctic Science Agreement three organizations such as IASC (International Arctic Science Committee), IASSA (International Arctic Social Science Association), University of the Arctic (UA), as main AC observing organizations should participate in this agreement implementation. This is the third legally binding instrument to emerge from the efforts of the Arctic States, following the search-and-rescue and marine oil pollution preparedness and response.

This legally binding agreement recognizes first “the importance of maintaining peace, stability, and constructive cooperation in the Arctic. It ” aims to enhance scientific cooperation

by “removing obstacles” and by providing a basic road map and commitment to facilitate consistent access for marine, terrestrial, and atmospheric research on a pan-Arctic scale. The agreement aims to improve use of existing infrastructures that were previously unavailable; enable new movement of researchers, students, equipment, and materials; promote sharing of data and metadata in ways that were not previously possible; and encourage holders of traditional and local knowledge to participate in scientific activities across territories. Each party identified geographic areas over which the agreement pertains (Berkman et al., 2017)

It is also very important that the Arctic Science Agreement will set up research partnerships across borders; increase support for field and summer schools and related means for training the next generation of Arctic scientists; promote well-formulated comparative studies designed to examine common issues at multiple locations across the Arctic; create innovative venues that integrate natural and social sciences along with indigenous knowledge to address common concerns. The agreement was designed to be inclusive and contains articles that discuss education, career development and training, traditional and local knowledge, and cooperation with parties other than the eight Arctic nations.

Although the Arctic States are the signatories, the agreement emphasizes that these States “may continue to enhance and facilitate cooperation with non-Parties with regard to Arctic science.” This holistic (international, interdisciplinary, and inclusive) science cooperation broadens the scope of the agreement beyond its defined area.

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BACK

VIEW OF THE SHORE GEOMORPHOLOGIST ON THE PROBLEM OF COASTAL EROSION AND SHORE PROTECTION IN HIGH LATITUDES

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The traditional way of life of aboriginal peoples of the Arctic coast along with the maximum approach to the objects of the fishery took into account the features of the cost structure using sand and pebbly accumulative bars and spits for settlement and economic activities. In permafrost conditions, these were often the only possible places for permanent residence. A high level of specialization in life support and an abundance of marine fishery resources resulted in the XIX - early XX century on the northeastern coast of Russia and the northwestern coast of North America, one of the highest density of coastal hunters in the subpolar range is up to 3 people per square kilometer (Krupnik 1989). Obviously, permanent settlements arose primarily in places of settlements of extinct or emigrated communities, temporary fishing grounds and seasonal hunting camps, which during the life of several generations did not experience the destructive effects of the sea. In the period of industrial development of these territories, the experience of the local population played a very significant role among the criteria for choosing the location for an industrial site or a settlement.

At the present time, we cannot assert that catastrophic rise in level and erosion of coastal accumulative forms of the Arctic and subarctic seas as a result of a series of storms of exceptional strength, similar to those observed at the end of the XIX th and beginning of the XXth century on the southern coast of the Seward Peninsula (Mason et al. 1996) bypassed these settlements side. However, there is no evidence that they were catastrophic in the framework of the traditional life support system.

Over the past few decades in the Arctic an increase in air temperature and a decrease in the area of the ice cover were seen, which has important consequences for the climate, the ocean, the coastal zone and the traditional way of life of the population (Kinnard et al., 2011; Polyak et al., 2010; Streletskiy et al., 2012). The reduction in the area of drifting and pack ice

leads to an increase in the length of gathering speed and, accordingly, of the parameters of the wind waves, in addition, the growing ice-free period increases the duration of the wave action on the shores. As noted in the climate assessment report in Alaska, climate change is much faster than previously forecast, which increases the level of danger to coastal settelements and energy-related infrastructure (Markon et al., 2012).

On the shores of the Chuckchee Sea, the coastal forms created by swelling predominate (Ionin et al., 1971). However, at the present time, under conditions of increased wave activity, the susceptibility of the coast of the Chuckchee Sea to abrasion processes is the lowest of the northern seas of Russia (Molchanov et al., 2011). In addition, there are only a few settlements on hundreds of kilometers of the sea coast. In the area of the western entrance to the Longa Strait that connects the East Siberian Sea with the Chuckchee Sea, on the bar of the lagoon Valkarkynmangkak there is the native village of Billings with a population of about 200 people. Features of the morpholithodynamics of the coastal zone, due to the small width and depth of the coastal summer polynia on which the wind waving develops, as well as the nature of the atmospheric circulation during the warm period are such that the buildings are located practically on the beach and no one is going to transfer them.

Unlike the settlement Billings located on a typical lagoon bar, the village of Vankarem is located on a tombolo formed in the wave shadow of the eponymous rocky cape at the distal end of the western lagoon spit. The villages of Inchun, Uelen, Neshkan, Cape Schmidt are located on the barrier forms of the lagoon directly near the stone banks, which are actively destroyed by frost weathering and abrasion, which are a powerful source of sediments.

On the Bering Sea coast of Chukotka at present time all the settlements are located in closed bays and on high terraces. However, at the beginning of the last century all the coast was densely populated, there were several dozens of aboriginal villages and settlements whose inhabitants were subsequently collected in large settlements (Krupnik 1989). One of the main reasons for relocation along with the change in the life support system is the degradation of the Holocene coastal accumulative formations on which these settlements were located (Kaplin and Porotov 2002). The last in this row was the village of Beringovsky, located on the Lakhtin lagoon. Fighting with erosion here began just after the construction in 1945 of a mooring pier with a length of 80 m (Afanasyev et al., 1998). In 1952-1954 to protect the shore from erosion in the area of the village 11 wooden bunks were built with an interval of 100 m. They were quickly destroyed with ice and stormy waving. The epic with coast protection lasted almost 50 years, until the inhabitants were moved to the settlement Nagorny, renamed after the people left by the village of Beringovsky.

The problem of coastal protection is not indicated in the normative legal field of the Kamchatka region. Nevertheless, it exists. In connection with the change of technologies for processing fish, some of the settlements created at the fish bases were closed in the 60-70years. Then followed a wave of "enlargements" of settlements, which mainly touched native villages. After the earthquake in 2007, village Korf, located on the eponymous spit, was resettled. The problem of coastal protection, thus, has lost its sharpness. However, the inhabitants of settlements Ilpyrskoye, Ivashka, Apuka and Pakhachi in the north-east of Kamchatka, a total of 1,260 people, are currently protecting their homes with improvised tools, mainly of old barges and fishing vessels.

Such settlements as Osora, Karaga, Vyvenka, Kostroma, village Tilichiki, located on low accumulative terraces and spits closed from waving with stable feeding of deposits, have no problems with shore erosion at present.

The problem with erosion and protection of shores is more well known on the West Kamchatka coast (Vladimirov 1961; Zenkovich et al 1971; Gorin et al., 2012). And if small settlements and fish bases here have not existed, the Oktyabrsky settlement with a population of 1600 people, located on the October Spit, still struggles with the sea disaster.

A similar situation develops on the western, mainland coast of the Sea of Okhotsk. The erosion of low Holocene terraces, bars and spits on which dozens of abandoned settlements and fishery bases are located is of no interest to anyone except scientists and local lore. However, the first in the Far East city, and now the village of Okhotsk with a population of 3,500 people, located on the Tunguska Spit and onshore bars of the river Okhota practically from the beginning of its foundation and up to the present time "fights" with the sea (Gershanovich and Zabelina 1957; Zabelina 1961). And if the territory of the port on the distal end of the spit has been protected for several decades by repeatedly repaired wooden wave walls, the houses periodically flood with storms during the high tides that reach here 4 meters. The funding requested for bank protection is about 70 million rubles.

On the southern shores of the Sea of Okhotsk attributed by us to the subarctic type and on the Sakhalin coast of the Tatar Strait, the morpholithodynamic justification and design of more than 30 km of bank protection structures were fulfilled, of which about 15 km have already been built (Afanasyev 2015). Nevertheless, here coastal cities and settlements are degraded and absorbed by sea, port facilities are destroyed and even existing protection projects in city Krasnogorsk, Uglegorsk, Vzmorie are not realized for decades.

A slightly different situation and a different view to the problem on the eastern shores of the Bering and Chuckchee seas. The environmental changes associated with accelerated

erosion and floods threatening communities in coastal areas in Alaska are under the scrutiny of scientists and the government (Villages 2003; Mittal 2009; Gibbs and Richmond 2015). Human rights organizations are also very active, emphasizing that the indigenous population of Alaska is concentrated in the permanent settlements that were selected by the federal government, mainly because of the requirement of the US Department of Education's Bureau of Education to create permanent school facilities (Bronen 2013). Nevertheless, now, budget constraints of existing laws do not allow the relocation of even the most needy Alaska communities affected by problems associated with shore erosion. Moreover, after 2009, federal funding for shore protection facilities can be accessed only in the case of 35% co-financing by the community (Smith and Sattineni 2016).

In 2006, of the 7 settlements that required priority attention, 4 were located directly in the coastal zone. The national settlements of Shishmaref and Kivalina (with a total population of 997 people) were recommended for resettlement, estimated at 250-305 million. dollars, and for the towns of Kaktovik and Unalakleet (with a total population of 949 people in 2016), bank protection was supposed to cost about 70 million (USACE, 2006). In 2009, the priority solution required the problems of 10 coastal settlements (USACE, 2009). Over the past few years about 40 million dollars have already been spent on coastal protection. According to the plans of U.S. Army Corps of Engineers, not less than 150 million. dollars are necessary for the protection of such settlements as Shaktoolik, Unalakleet, Shishmaref, Kaktovik, Kotzebue. The largest settlements on the coast of Kotzebue and Nome have a length of a protected shoreline of more than 4.5 km and until recently solved these problems themselves. The total length of the coast protection on the eastern shores of the Chuckchee Sea is currently about 2.8 km of rock revetments and sandbags and about 2.0 km of riprap revetment. On the eastern shores of the Bering Sea, a little over 3 km of coast protection was built. There is incomparably more extent of riprap revetment in the northern part of the Gulf of Alaska. Protected, mainly, the territory of large settlements and transport highways. Coastal structures on the eastern shores of the Chuckchee and Bering seas have evolved from offshore dredging to beach nourishment (Barrow), timber seawall, barrels of filled sand to gabion walls, sandbags, geotextile tube, cement block mat revetment and rock revetment. At present, rock revetment is built on the most problematic areas, located on barrier forms and spits in native village Unalakleet (400m), native village Kivalina (730m), native village Shishmaref (800m).

As the review of the problem shows, shore protection is primarily needed for settlements located on Holocene sand and gravel-pebble accumulative formations (barrier islands and spits). Only two protected settlements Barrow and Wainwright, are located on 5-15m terraces

of the coast with a high content of the underground ice in the sediments of bluffs. Without doubt, due to the presence of permafrost and underground ice, the erosion of coastlines in the moderate, subarctic and arctic regions has significant differences (Are et al 2002; Overduin et al 2014). However, despite a certain difference in operating mechanisms, the quantitative difference in the intensity and activity of abrasion and thermoabrasive arctic coasts may be less significant than expected (Leont'yev 2004).

Nevertheless, the focus in recent years has been on the study of rapid coastal erosion that occurs along these permafrost-dominated shorelines (Brown et al 2003; Overeem et al., 2011; Barnhart et al., 2014). On the basis of the analysis of remote sensing data of various types, practically all authors note that since the middle of the last century and up to the present time, the speed of erosion of the banks has increased. Minimal movements are noted for spits and offshore bars, and maximum erosion rates are observed for the bluffs of the youngest land surface, recently drained lakes (Jones et al. 2009; Gibbs and Richmond 2017) Sand and gravel-pebble barrier islands on the delta coasts are stable, or are growing (Grigoriev et al. 2001; Jorgenson and Brown 2005). The increase in sediment accumulation in the areas of inherited accumulation with increased erosion of the coasts observed from the forties of the last century was established by us in analyzing of the changes in the morphometric parameters of the accumulative formations of the Okhotsk Sea coast (Afanasyev and Uba 2017). Bars and spits that do not lose connection with modern areas of alimentation, thus, do not degrade both under the conditions of the subarctic and in the conditions of the Arctic coast.

The accumulative forms, the shape of which formed during the last rhythm of coastal-marine accumulation associated with the rise in the ocean level, are rebuilt, but in conditions of minor tides (microtidal (<1 m) and short period of wave action are enough stable. In particular, Elson Lagoon bars and the bars in the area of Billings, where the rates of destruction of the lagoon's coasts are much higher than the speed of the displacement of the bars, in addition, the lagoon area is also increasing due to the addition of permafrost lakes (Brown 2003).

Comparison of the position of coastlines (aerial photography, maps and geological descriptions) became also the basis for determining the long-term trends of erosion (coastal erosion) of barrier forms and spits (Mason et al. 2012; Gorokhovich and Leiserowiz 2011). As main results, it can be noted that the observed spatial structure of erosion in basic features exists at least since the 30s of this century. For some regions, the features of the change in erosion activity are established. So, for example, the correspondence of actual trends in the development of the coastal zone, established as a result of observations and analysis of AFS base of different years, long-term changes in the intensity of wind- wave impact on the coast (calculated wind

energy characteristics) allowed to construct the statistical models for forecasting the erosion of the northern shores of the island Sakhalin (Afanasyev 1998). However, when we speak about barrier forms and spits, the main planned changes (reducing, increasing in area) are considerably connected with the mechanisms of development of these forms, due to the parameters of the long-distance migration of sediments, the trends in the displacement of lagoon straits, the seasonal features of the structure of the coastal profile (Afanasyev and Uba 2015; Leont'ev and Afanasyev 2016; Afanasyev and Uba 2017).

Storms and erosion undoubtedly represent a danger on the shores of this type. However, the danger multiplies with the ignoring of natural mechanisms and development trends. For example, bank protection in the well-known village of Shishmaref between 1983 and 2003 led to low erosion and a rate of erosion twice that of unprotected shores. A newly built rock revetment protected the village from erosion even in the abnormally strong southern winds of the "Great Storm of 2011" (Mason O.K. et al 2012). Coastal erosion limiting permafrost is noted under the sediments of the active layer. We also consider the worsening of the wave-breaking properties of the shore profile during the freezing of beach sediments and the resulting increase in erosion of the shores. The concept of the dynamics of the coastal profile in the sequence; freezing of the beach, formation of marginal ice, formation of fast ice is developed (Afanasyev 2016, Afanasyev et al., 2017; Afanasiev 2017).

The first author was born and spent his childhood on the coastal spit of the Bering Sea and knows firsthand about possible dangers. Now we are absolutely sure that solving the problem of protection and planning activities on the coast of cold seas is a very real challenge for modern geomorphological science. However, scientific methods should offer the perspectives on the basis of a complete set of data on the development and dynamics of the coastal zone.

Keywords: coastal erosion, coastal protection, freezing beach, permafrost, Arctic coast, Subarctic sea.

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BACK

USE OF NATURAL RESOURCES IN POST-SOVIET RUSSIA: TERRITORIAL ASPECT

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Natural resources, for which the territory of Russia has long been famous, are still providing Russia with survival and even development (however, very unstable development) in the conditions of the continuing crisis of recent decades. The contribution of the export of mineral resources alone to the country's hard currency proceeds is 65–70% (40–54% in the Soviet Union in the 1980s) and at least half of the income of the federal budget (Klyuev 2015).

After a significant drop in the 1990s, the production of irrecoverable mineral resources in Russia practically reached the Soviet level by the 2010s and even exceeded it in some positions. An exception is the extraction of nonmetallic building materials, which shrank by two times between 1990 and 2010. This was caused by a drastic reduction in industrial, transport, and residential construction, since the industry of construction materials works for the domestic market. On the contrary, the extraction of fuel and energy resources, ferrous and nonferrous metal ores, and chemical raw materials are largely export oriented, which predetermines Russia's status as a warehouse of the world's mineral resources.

The export orientation of the mining industry significantly increased during the years of restoration of capitalism in Russia. Russia is the world's largest exporter of natural gas, while the gasification of, for example, Sakhalin oblast (a gas-producing region) is 9%; in rural districts this index is much lower. Russia exports most (up to 90%) of the aluminum, copper, nickel, and zinc it produces as the domestic consumption of the products of ferrous metallurgy, which refines the economy and makes its structure more progressive, has dropped drastically. The Soviet Union consumed over 10% of the world's aluminum; contemporary Russia consumes 10 times less; copper consumption has decreased by 8 times, and nickel consumption has decreased by 12 times (Kashin 2009).

Against the backdrop of the increasing exploitation of the subsurface, renewable resource–based industries have drastically reduced production over the post-Soviet period. It is

noteworthy that sustainable development implies the gradual replacement of nonrenewable natural resources with renewable ones. It is clear that this problem cannot be solved overnight. However, it is hard to rely on solving it if we move in the opposite direction.

A distinctive geographical feature of the Russian natural-resource complex has been the almost full territorial incongruity of human and resource distribution (an exception is the soil–climatic resources). Siberia and the Far East, inhabited by 20% of the population, have 70% of the natural-resource potential, excluding agricultural resources. This circumstance predetermines the key problems of developing the country's natural resources: expensive extraction in the conditions of "ice isotherms"; the absence of roads, infrastructure, and labor; and the high price of the transportation of extracted raw materials to consumers. All these problems only worsen with time.

The characteristic features of the current period are the preferred shrinkage of the Russian resource space, the concentration of nature management in "central parts," and the economic desolation of the periphery. This is indicated by the distribution of industrial investments, which are, in fact, future anthropogenic loads, by the country's regions. What we have now is the concentration of nature management on relatively welldeveloped (by the Russian measures) territories, where the loads on nature were previously small as well. Beyond the Urals, only the Khanty–Mansi and Yamalo–Nenets autonomous districts in Tyumen' oblast are noticeably distinguished by the level of investment concentration.

The map reflecting the main features of industrial and transport development of the territory of post-Soviet Russia was drawn up. The map is based on the inventory of implemented investment projects. An exceptional territorial differentiation of industrial construction is revealed, expressed primarily in its superconcentration in the Moscow region, as well as in the north-west (St. Petersburg and Leningrad region). The northern and eastern regions of the country are characterized by focal industrial development and the dominance of mining enterprises. In Asiatic Russia large-scale industrial construction is allocated to Kuzbas, Khanty–Mansi, and Yamalo–Nenets autonomous districts, but the "density" of development is small (Fig 1). The analysis of the structure of new industrial construction did not reveal any signs of its greening. 2/3 of new facilities are related to basic, environmentally "aggressive" industries.

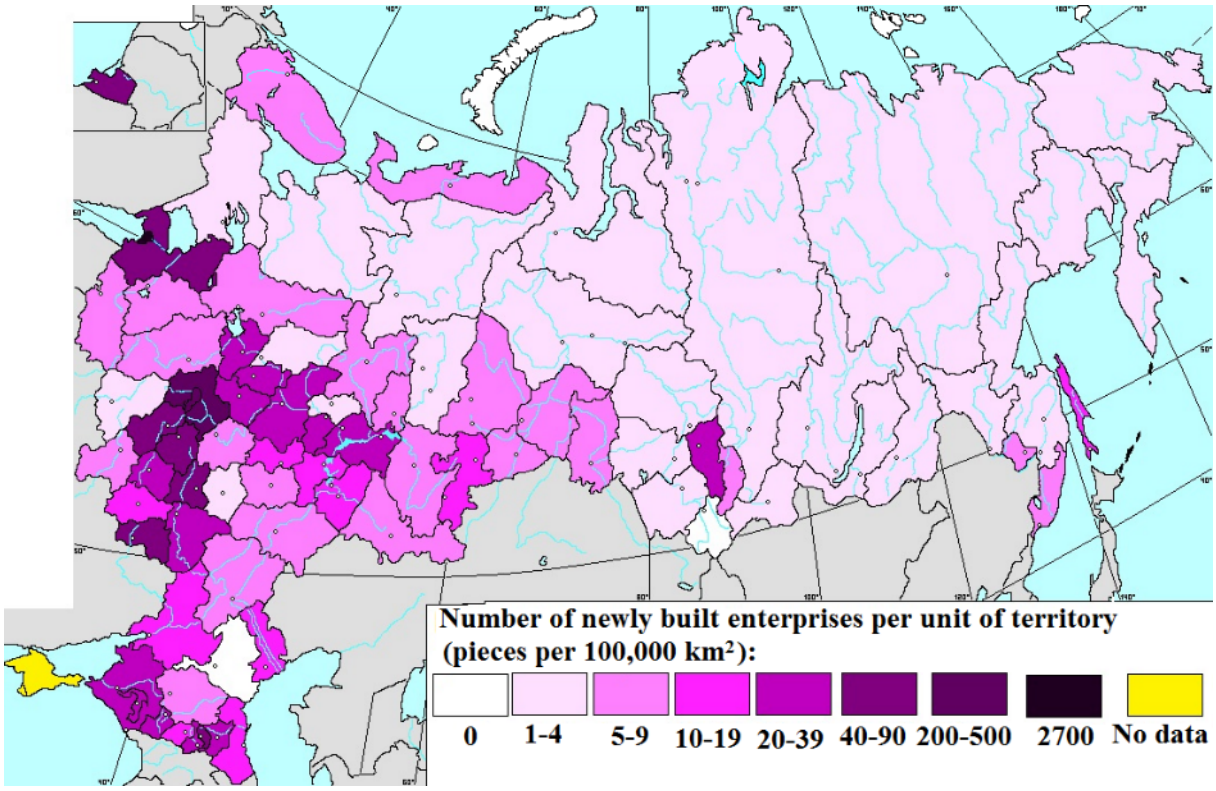

Fig. 1. Industrial construction in Russia in the post-Soviet period

The key cause and, simultaneously, indicator of the desolation of northern and eastern regions of the country is the reduction of their population. Between 1991 and 2016, the reduction amounted to 35% in Murmansk oblast, 61% in Magadan oblast, and almost 68% in Chukotka Autonomous Okrug.

The rate of drawdown in forest harvesting in the main forestry regions is higher than in other regions of the country. Remote wood cutting areas are abandoned, and forest extraction is concentrated near thoroughfares. In forest deficient regions, where the forests are heavily disturbed, increased felling is observed. In mountainous regions, especially in the North Caucasus, mid-mountain and low-mountain forests and shrubs are felled intensively for firewood, thus increasing the areas of mudflow sites.

At the same time, the 2000s witnessed patchy involvement of export-oriented resources in newly developed regions, mainly in the north and east of the country. Among large subsurface development projects in post-Soviet Russia, we should note oil and gas extraction at the Vankor oil and gas, Yurobcheno–Tokhomsk oil and gas condensate (Krasnoyarsk krai), and Talakan oil (Yakutia) fields on the shelves of the Okhotsk, Caspian, Baltic, and Barents seas; the advance of gas extraction in the Yamalo–Nenets Autonomous District to the north; the preparation of the development of Timan bauxites; etc.

The focal development of resources is becoming more deconcentrated. Now there are no giant deposits like Samotlor, Urengoy, and Medvezh'e. In the early 1970s, the average size of reserves at newly discovered oil deposits in Western Siberia was 77 million tons (30 million tons in the Russian Soviet Federative Socialist Republic); now it is 1 million tons. What we see now are the signs of a late stage in the life cycle in the country's main "hard currency shop"—the Western Siberian oil and gas province. An increasing number of infield and interfield pipelines is needed for each unit of resources extracted. This increases the ecological risks, since such pipelines spill at least 1% of the oil produced.

Against the background of the significant reduction in transportation, which reduced the effects of hazardous transport on roadside landscapes on territories between populated localities, a pipeline–port boom is observed, causing the transfer of transport–ecological threats to offshore zones and their approach to the Russian borders. Here we may single out the Blue Stream, Nord Stream, and Yamal–Europe gas pipelines; the Turkish Stream and Power of Siberia gas pipeline projects; the Eastern Siberia–Pacific Ocean oil pipeline; the Baltic Kirishi–Primorsk pipeline system; the Primorsk oil transshipment terminal; the Vitino (Murmansk oblast) and Privodino (Arkhangelsk oblast) oil terminals; etc. The export-oriented raw-stock model of the Russian economy is secured in new investments.

"The whole history of Russia is related to the development a vast dry land… . This is its function and, if you like, mission" (Sysoeva 2007). Therefore, the development of new mineral resources follows the main path of the country's development, but with an important reservation. The key innovation of the contemporary world is the ecological imperative. The unique diversity of Russian landscapes should be developed carefully, with account for the spatiotemporal characteristics of their resistance to technogenesis. Development is not just the expansion of mining facilities, which leave behind an anthropogenic desert. Ecological development implies the arrangement of a territory, the organization of tourist and recreation zones on it, territories of different security levels, organic agriculture, progressive means of transportation and communications, traditional crafts of small nations, etc.

Thus far, unfortunately, the principles of sustainable development have not become a regular fixture in domestic nature management. At first sight, new mining facilities should show a high degree of environmental friendliness. However, this is not always the case. New oil extraction fields in the Khanty–Mansi Autonomous District are not included into the network of operations that utilize the associated petroleum gas. Newly commissioned oil fields have a very low degree of gas utilization. Only at old and well-developed fields can it reach 60–90%.

Russian oil and gas deposits on the Arctic shelf should be viewed as a resource for future generations. Their frontal development in the next 10–20 years is unwarranted for several reasons, including those related to climate transformation. Changes are manifested, in particular, in the acceleration of extremely hazardous phenomena, fraught with environmental emergencies. Severe but stable natural conditions are very costly; however, they do not involve readily predictable consequences. At the same time, the "efficient presence" on a territory is needed for geopolitical reasons—infrastructural development of navigation in Arctic regions, the intensification of the information stage of their development (exploration, monitoring, etc.), and colossal capital investments, required for new shelf projects, must be channeled to improve the recovery of oil and gas resources at already developed deposits.

Unfavorable features of the geographical position of our country hinder its frontal inclusion into international labor division. A scientifically justified territorial policy can and should strengthen the merits of Russia's location and smooth out its drawbacks. This can be done by organizing railroad and marine super-thoroughfares "from the English to the Japanese" and a central link of a single integral infrastructure of Eurasia on Russian land and in Russian waters.

The years of perestroika, crises, and reforms have escalated the problem of information support for the country's natural-resource complex. The development of mineral riches has still been mainly based on reserves explored by Soviet geologists, which betokens an imminent resource crisis. The programs of environmental monitoring programs have been cut sharply. The reduction of things to order in the "book accounting" of natural values is an important task of national administration, and geographers can and should contribute to its solution. Knowledge obtained by the earth sciences is of strategic importance for the country's sustainable development. It is necessary to intensify the scientific investigation of Russian territory - the most ecological and geopolitically essential form of its development.

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Keywords: natural resource use, regional development, new trends, post-soviet Russia.

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BACK

SLUSHFLOWS AS A LANDSCULPTURING AGENT IN MOUNTAIN VALLEYS OF THE KOLA PENINSULA, NORTHWESTERN RUSSIA

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Slushflows – hazardous and potentially dangerous events – are widespread in arctic and subarctic mountainous environments (Fleishman 1978; Nyberg 1989; André 1995; Bozhinsky et al. 2001; Laroque et al. 2001) and represent a specific type of gravitational flow of water-saturated mixture of snow with relatively limited amount of clastic sediment (common < 12%, size up to 1-2 m) occurring in low-order stream channels. They are considered either subtypes of wet snow avalanches, or debris flows, or independent phenomena between the latter two (Perov 1966; Hestnes 1998, Eckerstorfer and Christiansen 2012). Several recent events, some with fatal consequences, reported for Scandinavia (Hestnes and Kristensen. 2010), have increased both the scientific community and public awareness and social demands for reliable risk assessment, prediction and sound protective measures (Relf et al. 2015). All these, however, are still limited by insufficient knowledge of spatial distribution, magnitude and frequency of such hazardous events, especially in the distant past.

Khibinskiye and Lovozerskiye Tundry – compact low mountain massifs located in central part of the Kola Peninsula – are extremely reach in minerals, especially in apatite and nepheline ores, and rare earth elements (Fig 1). Thus, they have been intensely explored since the 1920s and lately became a focus of rapidly growing recreational industry. At the same time, they are an arena of widespread hazardous processes amongst which are snow avalanches, rockfalls and screes, slushflows and debris flows (Belyaev et al. 2015). Ski resorts, tracking mountainous paths and newly established National park combined with complex industrial (quarries, mines, plants, roads etc.) and civil infrastructure stipulate the need to estimate potential risks of those hazards on a basis of thorough understanding of its nature and dynamics.

The largest Kola mountain massif of Khibiny (up to 1201 m ASL) and its smaller neighbor – Lovozerskiye Tundry (1120 m ASL) located 10 km eastward – are both Devonian age plutons of multiphase alkaline intrusions of nepheline syenites (Pozhilenko et al. 2002)

partly exposed by denudation. Plateau-shaped summits with relatively steep slopes are dissected by numerous deep (100-500 m) erosional valleys, glacial troughs and cirques, and tectonic lineaments. Debris flows at the Khibiny were thoroughly investigated over the 50 years (Bozhinsky et al. 2001) producing a unique dataset of >200 slushflow-affected mountainous catchments that have been active at least once in centennial. However, those surveys concentrated largely on monitoring the consequences of presently observed events. Other mountainous areas of the Kola Peninsula remain practically unstudied in terms of the hazardous natural processes. Especially there is no reliable published data on localization, dynamics and intensity of slushflows despite the occasionally reported hazardous events such as locomotive thrown down from the railway at the western foothills of Lovorerskiye Tundry in the 1970-s.

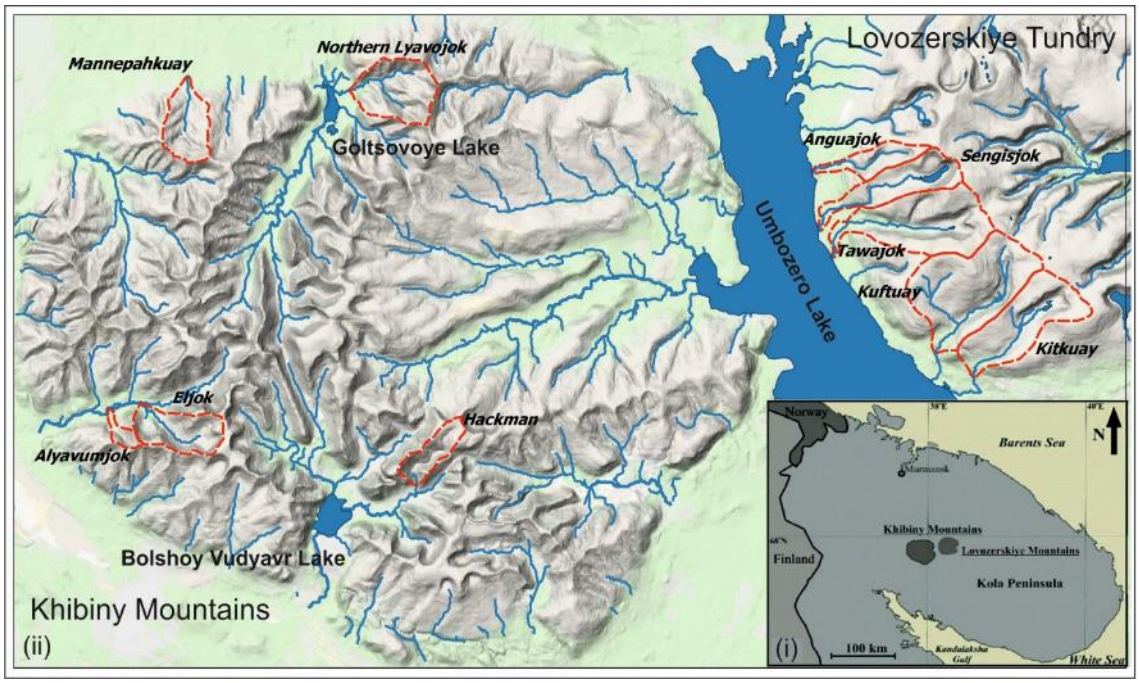

Fig. 1. Location of the Khibinskiye and Lovozerskiye low mountain massifs at the Kola Peninsula, Russia (i) and case study valleys at both massifs (ii) (source: Google global topography, infrustructure and settlements)

Here we report an attempt to reconstruct slushflow activity, evaluate its contribution into sediment budgets and impact on geomorphic structure and fluvial processes in several mountain valleys of the Kola Peninsula by means of detailed study of associated landforms and correlated deposits. Several comprehensive section descriptions and sediment sampling were accomplished through 2015-2017 fieldworks. Grainsize analysis, ^{232}Th radionuclide fingerprinting and ^{14}C dating were applied to reveal the age and common structure of slushflow environments. Geomorphic interpretation of high-resolution aerial and satellite imagery from public services and topographic maps presented widespread geomorphic evidences of debris

flow phenomena within the studied massifs. Most of the valleys are regularly affected by modern slushflows and even typical debris flows. For example, specific landforms and deposits distinguishing active slushflow origination, transit and deposition zones were detected and lately directly observed in 22 out of 30 investigated Lovozerskiye Tundry valleys longer than 3 km. More elaborate examination of a number of mountain valleys at the Khibinskiye and Lovozerskiye Tundry (Fig 1) displayed that frequency and thickness of slushflows (and other debris flow phenomena) depend on the morphology, development history and age of the basins.

Debris flow patterns and landforms distribution at places are strongly controlled by the tectonic structure. For example, the Mannepahkuay basin has feather-shaped drainage network pattern caused by the combination of meridional, northeastern and northwestern lineaments inherited by tributary valleys practically perpendicular to each other. Thus, tributary slushflows runout zones are located in the main valley bottom sometimes completely blocking it. Such coarse debris dams provoke the stream to filtrate through deposits and may lead to further debris flow outbursts. All that cause unequal transporting distances of sediment load and specific "wavy" structure of slushflow deposition further downstream into the piedmont forest zone.

Dramatic imprints of extreme events (both slushflow and rockfall) great in clastic volume but transported for relatively short distances were observed in several other basins. At the Northern Khibiny, they are traced in the headwaters of neighboring Northern Lyavojok, Kalijok and Perevalnaya valleys mostly as large debris bodies and fans occupying the foothills of glacial cirques walls and the apertures of short outflows, respectively. At the Western Khibiny, left bank tributaries of the Malaya Belaya river (Eljok-Lednikovaya and Alyavumjok catchments) also show the presence of incompatibly great accumulative landforms either in the upper reaches or in the main valley bottom. Dense lineament structure, poorly sorted large clastic material (more then 1-2 m size) and widespread ongoing rock failures on valley sides suggest unreleased internal tension of the bedrock and a certain relationship of active seismotectonic zones to the distribution and magnitude of those catastrophic events.

The Northern Khibiny valleys are almost devoid of typical glacial deposits and were apparently less affected by the last (Late Pleistocene) continental ice cover (in comparison with southern and western segments of the massif). Nevertheless, widespread thick discontinuous debris bodies (as fans, ridges and elevated fragments of former valley floors) prove the high intensity of debris flows in the past. They were interrupted by several major valley incision cycles (probably due to the local base level subsidence during deglaciation and continuing tectonic uplift). On the other hand, the valleys incising the western slopes of the Lovozerskiye Tundry and Khibiny have significant glacial landforms (Tawajok, Sengisiok, Anguayok,

Malaya Belaya, etc.). However, those glacial morphology underwent essential changes by other processes during the Holocene.

The Sengisjok (about 7 km long) is an example of major transformation of initially trough-like valley by debris flows. The modern V-shaped valley deeply cuts into the older wide valley bottom partly infilled by glacial, glaciofluvial, glaciolacustrine and debris flow deposits. Within it, there are two terrace-like units, lower of which (up to 20-25 m above the river floor) is undoubtedly formed by repeated high-magnitude debris flows. Its unsorted coarse clastic material (boulders up to 3 m in size) with dense loamy sand matrix cemented by nepheline gels, up to 15-20 m thick, overlies the laminated glacial lake sediments. Such sequences can be correlated with moraine-dammed lakes outbursts during the colder stages of Holocene when smaller glacier still survived in the headwaters cirque. It can also be possibly linked to extreme debris flow discharges and large-scale deposition on the Sengisjok relic fan (area >4 km^2) at the western piedmont. The modern Sengisjok valley morphology reflects later dominant incision trend, mainly associated with continuing debris flow and slushflow activity, though at much smaller scales and transporting capacity of sediment load than in the past.

Obtained results at both Kola mountainous massifs suggest that slushflows and, possibly for some valleys, typical debris flows with lower frequency are a leading mechanism of downstream sediment delivery and valley floor topography formation of the first-order streams. In typical erosion valleys with narrow floor and V-shaped cross-section (Mannepahkuay, Northern Lyavojok, Alyavumjok, Eliok, Hackman, Sengisjok, Anguajok, etc.), fluvial process is almost completely paralyzed by even minor deposition of high-frequency slushflows. A stream is redirected to wash out and re-deposit the finer fractions of debris flow fans and internal deltas (both recent and older ones), forming secondary alluvial features downstream. Small river valleys with typical glacial topography (wide-bottomed troughs with steep slopes) are usually devoid of debris flow sources in the headwaters (Malaya Belaya, Lednikovaya, Tavajok, Kuftuay, Kitkuay, etc.). Only rare extreme slushflow ejections from tributaries producing large superimposed fans in the main valley floor can influence its fluvial cycle. Those lead to major river channel shifts (forced meanders with up to 300-500 m radius of the Malaya Belaya river), 5-10 m deep fresh-looking incisions and au contraire ungraded convex fragments of valley bottom long profiles (e.g. large slushflow deposit body more than 500 m long in the Lednikovaya valley descended from the Eljok inflow).

To evaluate geomorphic effects of hazardous slushflow processes it is important to distinguish both main sediment sources with their relative contribution and zones of debris deposition. Radionuclide fingerprinting approach has been proved to be useful for

determination of sediment sources and sinks in wide variety of geomorphic landscapes. Radionuclides can be used for fingerprinting purposes in cases if their chemical properties determine dominant redistribution in fixed conditions with sediment particles (Titaeva, Taskaev 1983). The Hackman valley located in the southern Khibiny is affected by frequent slushflows. Its geological structure is characterized by alternation of plutonic rocks with different content of radionuclides (Zak et al. 1972). In addition, radioactive mine was active in the basin in the 1930-s (Krasotkin et al. 2008). Despite closing, its damps on the right valley side at its middle reach still represent the potential source of radioactive material for the stream and slushflow sediment transport. Gamma-spectrometry analysis of the ^{232}Th radionuclide content in valley bottom deposits and on adjacent colluvial slopes help confirming the role of slushflows in episodic powerful removal and mixing of material along the valley (Garankina and Ivanov, 2016). Contribution of constant water flow within the stream channel is limited to washing out of fine fractions of loose material. The latter, according to the first results of alpha-spectrometry, make the most relevant contribution to the total radioactivity of the samples and, possibly, can cause positive radioactive anomalies in the sedimentation basins (deltas, lakes, artificial ponds) outside the studied catchments.

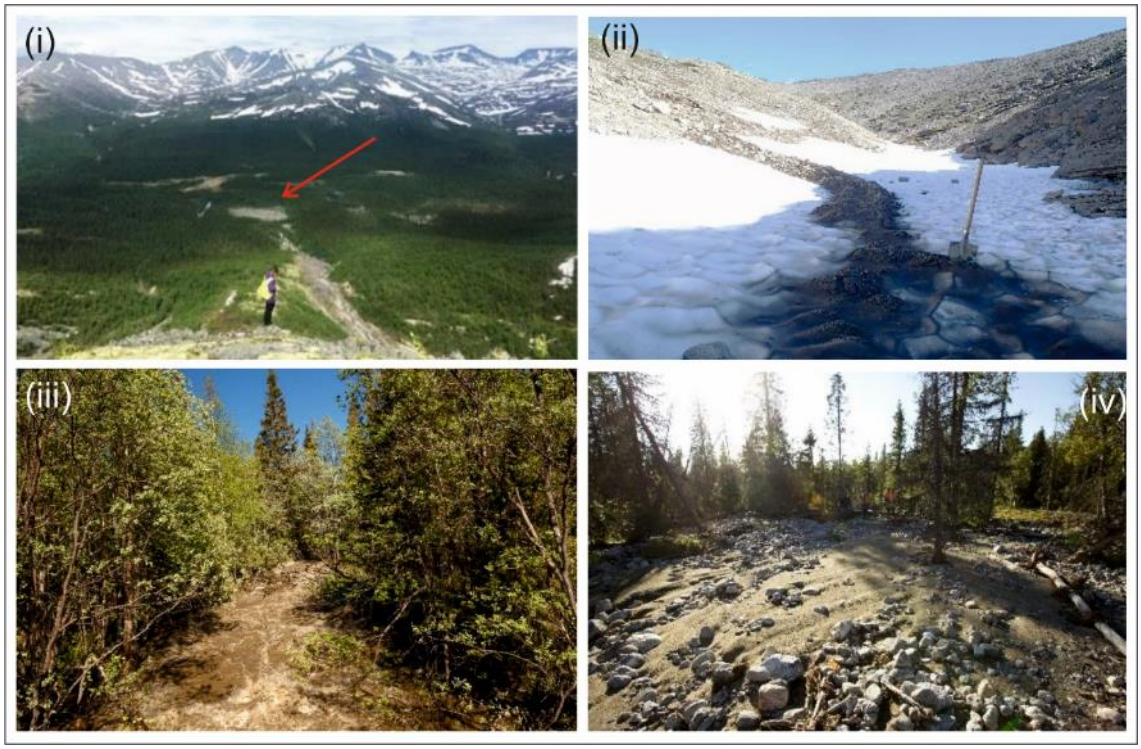

Fig. 2. Slushflow landforms: (i) large fan and (ii) fresh deposits, Alyavumjok valley. (iii) Granular debris flow on June 3 2017 and (iv) its deposits, Sengisjok valley

Recurrence interval of medium-magnitude slushflows in several studied valleys does not exceed 10-30 years, which is in agreement with the published monitoring data. Largest numbers of slushflow events within a single year have been detected at the Khibiny in 1943 and 1946 (presumably), 1950-1952, 1960, 1966, 1969, 1977, 1987 and 1995 (Bozhinsky et al. 2001; Ananiev 1998). At the Sengisjok valley of the Lovozery even higher frequency of debris flows was revealed by repeated fieldwork. Notable slushflow events have reorganized valley floor at least twice since 2009 with the latest one transforming from slushflow at the origin to the granular debris flow occurring on June 3 2017 (Fig 2). Fluvial topography is extremely suppressed or nonexistent under such conditions, as stream channels are unable to rework slushflow deposits and are forced to passively adjust.

Frequency of extreme events is however much lower. For example, large (about 150x300 m) and still non-vegetated slushflow fan of the Alyavumjok superimposed onto the forested floor of the Malaya Belaya valley, acording to historical topographic maps and aerial photographs, is at least 90 years old (Fig 2). Interval between extreme events in the Mannepahkuay valley causing debris fan formation within forested piedmont zone is about 500 years (540±80 (IGRAS-5404) и 1310±70 yrs (IGRAS-5402) according to ^{14}C dating of humic layers separating different slushflow deposit bodies, Fig 3).

Numerous attempts to determine periods of relative landscape stability and activation of catastrophic processes in the more distant past were undertaken (Perov 1971; Sulerzhitskiy et al. 1986; Vashchalova 1987; Bozhinsky et al. 2001; Vladychensky et al. 2007; Kosareva 2007; Romanenko et al. 2011, Romanenko and Shilovtseva, 2016). According to the radiocarbon dating, avalanche-rockfall, slushflow and debris flow activity decreased during 4100-3800 and 2760-2120 BC, 400 BC – 300 AD, 790-1560 AD allowing soil covers to develop on the surface of colluvial and debris flow fans. Oppositely, the highest intensity of avalanches coincides with the Little Ice Age of XIV-XIX centuries. In addition, slope and debris flow processes are assumed to be highly active during the climatic optimum of Holocene (7500-4800 BP). It is partially in coherence with the newly obtained radiocarbon date 4640±70 (LU-8763) for the Sengisjok valley (Fig 3) showing the 5 ka BP age of a peat lens clamped between slushflow deposits underneath and a layer of hyperconcentrated flow sediments. However, low position above the valley floor at upper reaches and particularly well-sorted sediments are somewhat in contradiction with the conditions of high-intensity sedimentation.

Nevertheless, extensive occurrence of distinctive large relic landforms and thick bottom deposits without any detectable organic material indicates substantially higher magnitude debris flows activity in the past. Most likely they functioned in colder environments during the

last deglaciation stages , particularly those associated with moraine-dammed lakes outbursts. Reliable chronology of those stages is yet to be obtained and represents the most challenging problem for future research in the area.

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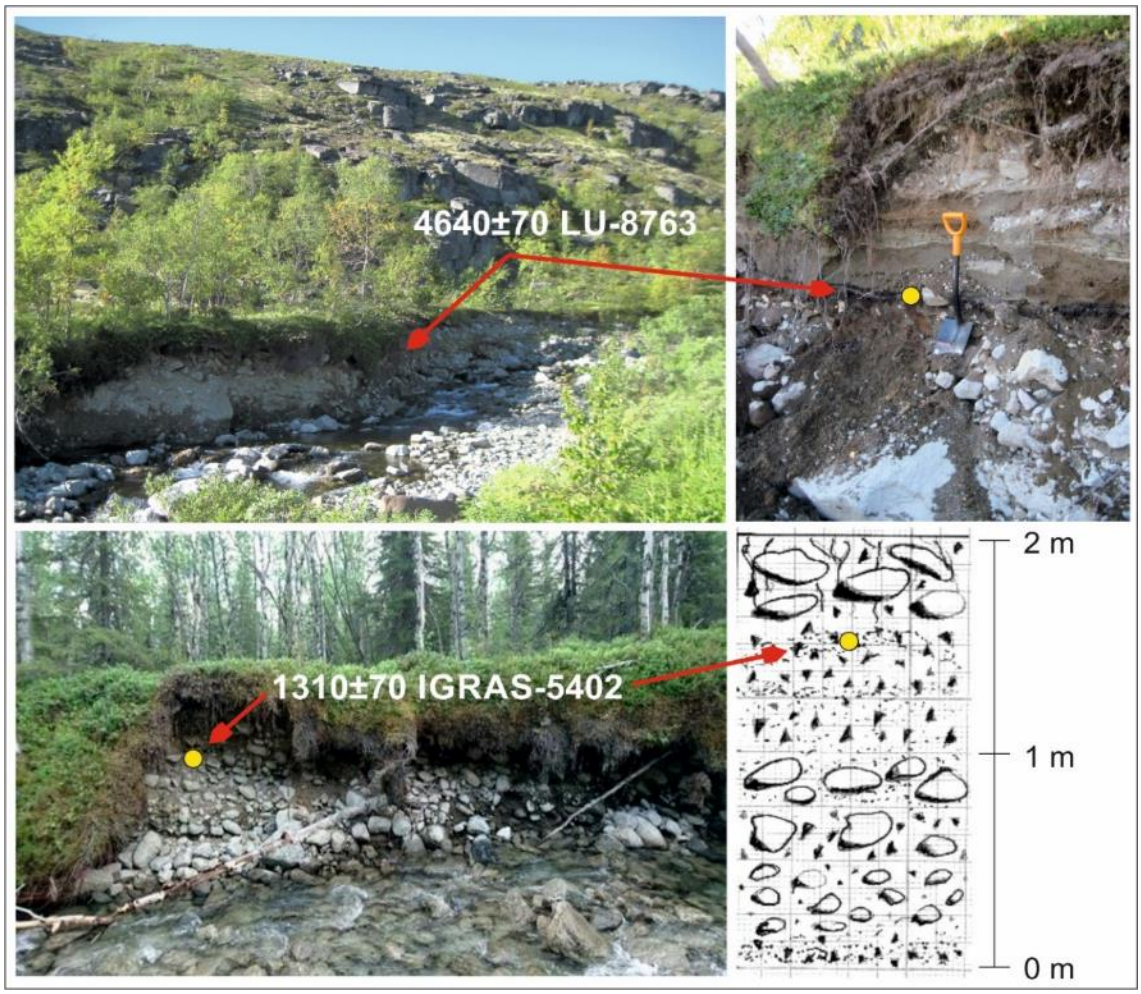

Fig. 3. Radiocarbon dates of burried organic layers in cross-sections of slushflow terraces at the upper Sengisjok valleys (i) and at the fan of the Mannepahkuay valley (ii)

Keywords: slushflow, debris flow, mountain, valley, subarctic.

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BACK

DETERMINING THE BOUNDARIES OF DAMAGING AND LETHAL EFFECTS OF POLLUTANTS ON FOREST ECOSYSTEMS IN THE NORILSK INDUSTRIAL REGION

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The present study proposes new approaches to describing changes in the ecosystem caused by exposure to pollutants as dependent on the local concentration of pollutants and duration of exposure. Based on rather simple assumptions about the effects of a pollutant on biota, this process can be considered as an ecological analog of second-order phase transitions. Analysis and verification of the proposed model have been performed using the data on the state of forest ecosystems located close to a powerful source of pollutants – MMC "Nornickel" in Norilsk (the Krasnoyarskii Krai).

Research on the effects of industrial pollutants on the environment is largely aimed at solving practical problems with the state of biota and developing measures for environmental management. Special models should be constructed to describe in detail changes that occur in biota in response to both direct impacts of pollutants and their indirect impacts, which are associated with changes in interactions between ecosystem components induced by pollutants. There are models describing processes of dispersion of pollutants in the air or water, which are based on the aerodynamics of impurity transfer (Bäumer et al., 2005; Ehrhard et al., 2000; Nuterman et al., 2010). It is important, however, to describe the effects of pollutants on biota rather than their dispersion. A number of well-known models (Tarko et al., 1995; Rapport, Whitford, 1999) relate the impact of the pollutant on biota to the local concentration of the pollutant, C, or the distance to the source of the pollutant, L.

The simplest model of the effect of pollutants can be written as follows:

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(1)

where E is the effect of the pollutant; E_m is the maximal effect of the pollutant on a selected property of the ecosystem at $L \to 0$, λ being constant.

The static model (1) obviously does not take into account the duration of exposure to pollutants, T. Moreover, this model cannot describe the delay in biota's response to the impact of pollutants and determine the lag period of biota's response to the impact of pollutants: the period of time between the beginning of the exposure to pollutants and the time when biota components begin to respond to the impact. It is also unclear how models of type (1) can be used to describe the dynamic response of biota components to temporally varying effects of pollutants, which are associated with cyclic variations (daily, weekly, seasonal ones) and trend changes in the production rate, which may be caused by an increase in production output (and, hence, higher emissions of pollutants), construction of additional pollution control facilities and filters, etc. Note that models of type (1) are no-threshold models, and, according to them, the pollutant will affect biota at an indefinitely long distance from the pollution source.

The present study discusses possible approaches to describing changes in the ecosystem induced by direct and indirect effects of pollutants, the lag period and thresholds in biota's response to the impact of pollutants, and possible adaptation of biota components to external impacts and recovery of biota after exposure to pollutants ceases. Analysis and verification of proposed models will be performed using the available literature data on the state of forest ecosystems close to a powerful point source of pollutants in the city of Norilsk.

Studies of the effects of pollutants on biota close to copper smelters situated in Russia – "Severonickel" in Monchegorsk (the Murmansk Oblast), Karabash Smelter in Karabash (the Chelyabinsk Oblast), and MMC "Nornickel" in Norilsk (the Krasnoyarskii Krai) – have been conducted for a long period of time. The major atmospheric pollutants at copper smelters are sulfur dioxide (over 90%) and metal-containing dust consisting of copper, zinc, and nickel oxides, lead compounds, and other substances (Chernenkova, 2002; Usoltsev et al., 2012). The toxic effect of copper smelter emissions on plant communities results from the combined exposure to heavy metals and sulfur dioxide. Sulfur dioxide acidifies the medium and, thus, increases the mobility and biological activity of metal ions, dramatically intensifying their toxic effects on biota (Vorobeichik, Khantemirova, 1994). Differences in the effects of pollutants on biota were found to depend on the distance from the point source of pollutants.

A model of second-order phase transitions used to describe the effects of pollutants on woody plants

To construct a universal model of the effects of pollutants on biota, let us say that biota may be either in the undisturbed phase or in the impact phase. In the undisturbed phase, no effects of pollutants are manifested, and the state of biota is determined by the interactions between its components and the effects of modifying factors such as climate. In the impact phase, the state of biota is largely determined by its exposure to pollutants, and it changes gradually. To characterize the state of biota, let us introduce some value *q*, which will be called the order parameter, by analogy with parameters of physical systems (Landau, Lifshits, 1964). The simplest model of first-order phase transitions deals with the relationship between some macroscopic characteristic of the state of the modelled system *q* (this variable must be determined based on the specific properties of the modelled system) and the external factor, *X*, affecting the system. The equation of the relationship between these variables is written as follows (Landau, Lifshits, 1964):

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(2)

where $0 < q < 1$, *A* and *B* are some free parameters, X_c is the critical value of the state of the outer environment or duration of the exposure at which a phase transition occurs.

As an order parameter, *q*, which characterizes response of forest stands to exposure to pollutants, let us use value , where

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V(X) is the selected parameter (phytomass, proportion of healthy trees in the stand, etc. as dependent on the magnitude of external impact *X*), V_0 is this parameter in undamaged, control, stands, and *X* is the characteristic of the impact. In all these cases, the value of the order parameter varies between 0 and 1. Let us define *q*(T) as the proportion of live trees in the stand after exposure to pollutants of duration T. For undamaged stands, $q(T=0) = 1$, and for dead stands, $q(T > T_c) = 0$ (where T_c is the critical duration of exposure). As evident from (2), at $T > T_c$, $q = 0$, i.e. all trees in the stand die.

Results and Discussion

Verification of the phase transition model was performed using the data reported in a study by Kirdyanov et al. (2014): the data on the tree mortality between 1930 and 2010 in Siberian larch (*Larix sibirica* Ledeb.) stands located at 22 km (sample area L22), 45 km (sample area L45), 68 km (sample area L68), and 85 km (sample area L85) away from the source of pollutants – MMC “Nornickel”. On sampling areas L22, L45, and L68, all trees had died by the 1970s, while on sampling area L85, about 10% of the initial number of trees were alive in 2010.

To construct the model of second-order phase transitions, the order parameter will be represented by the proportion of live trees *q(L,T)* in the stand at a distance *L* from the source of pollutants affecting the stand for *T* years, since the facility began operation. In what follows, tree mortality on sample areas will be studied by employing a model in which tree mortality rate will be expressed by parameter *B*, characterizing the annual decrease in the proportion of live trees. Table 1 lists coefficients of equation (2) for each sample area for this period. In tree stand L22, four main phases of tree death can be distinguished. Until 1949, mortality rate *B* had been low, characterizing natural mortality. Over a decade (from 1953 to 1963), tree mortality had increased by nearly an order of magnitude compared to natural tree mortality. During Phase 3, mortality grew further, and by 1969 (i.e. about T_c +18 years since the beginning of the exposure), all trees in the stand had died.

Table 1. Parameters of equations (2) for each sample area

Sample area	Years	Parameters of equation (2)			
		A	*B*	R^2	*Tc, years*
L22	1930-1949	0.999	0.004	0.994	249.8
	1953-1963	1.068	0.0326	0.97	32.8
	1964-1968	2.553	0.141	0.97	18.1
L45	1937-1949	1.07	0.011	0.98	97.3
	1950-1953	1.12	0.031	0.99	36.1
	1954-1962	2.12	0.109	0.99	19.5
L68	1964-1970	2.438	0.119	0.96	20.5
L85	1950-1973	0.85	0.0044	0.91	193.2
	1974-1982	2.87	0.090	0.98	31.9

For sample area L45, mortality rate *B* increased about threefold between 1950 and 1953 compared to mortality rate between 1937 and 1948, and then, from 1954 to 1962, it increased threefold again. That effect could be attributed to facility reconstruction and a rise in pollutant emission levels. For sample area L68, which is located at a greater distance from the source of pollutants, mortality variations in the early period are more complex than on sample areas L22 and L45, but for the period from 1964, the phase transition model adequately describes tree mortality on this sample area, too (Table 1).

The tree mortality rate on sample area L85, located at the longest distance from the source of pollutants, was somewhat slower than mortality rates on sample areas situated closer to the source of pollutants, but even on this sample area, tree mortality can be described by the model of second-order phase transitions (Table 1).

In all tree stands, the *B* values of natural mortality rate were low (no greater than 0.01) while the *B* values of the rate of mortality after the facility was put into operation were considerably higher (above 0.09) (Table 1).

In addition to describing the relationship between tree mortality and the distance from the stand to the source of pollutants, *L*, the model of second-order phase transitions must describe tree mortality rate in the stand as dependent on the exposure dose, *D*, which will be defined as the ratio of exposure duration, *T*, to the distance between the stand and the source of pollutants, *L* (or logarithm of the distance, *L*). Two threshold parameters can be determined: dose D_0, below which the pollutant does not affect trees, and dose D_c, which characterizes the level of exposure to the pollutant at which the stand dies, **Error! Objects cannot be created from editing field codes.**. For tree stands of similar age and with similar species composition, the critical exposure dose, D_c, at which the stand dies, must be the same whatever the distance from the sampling area to the point source of pollutants (Table 2).

Table 2. Parameters of the model of second-order phase transitions showing the relationship between squared proportion of live trees in the stand and pollutant exposure dose.

Distance from the stand to the source, *L*, km	Parameters of the model of second-order phase transitions			
	A	*B*	R^2	D_c
22	1.30	0.78	0.97	1.67
45	1.13	0.62	0.96	1.82
68	1.25	0.70	0.96	1.78
85*	2.24	0.54	0.99	4.18
85**	1.13	0.59	0.98	1.93

***** 1950 – 1973; ** after 1973

Coefficient of variation for the values for sample areas L22, L45, and L68 (Table 2) is about 4%, which is quite acceptable for field data. For sampling area L85, D_c approaches the D_c values for other sampling areas if the lag period for this stand, which is situated farther away from the source of pollutants than the other stands, is assumed to be longer than the lag periods for the stands on the other sampling areas.

Conclusion

The data on time- and distance-dependent damage done to trees by pollutants can be adequately described by an ecological analog of the model of second-order phase transitions. This model can be used to determine critical distances from the source, at which pollutants stop exerting significant effects on biota, and the critical exposure dose, at which the impact of pollutants causes decline of a tree stand. The values of model parameters and critical values can vary in different ecosystems, but the relationship between the selected characteristics of the effect and exposure dose are invariably described by the model of second-order phase transitions.

The model of second-order phase transitions proposed in this study can be used to plan biota monitoring close to point sources of pollutants and to estimate critical distances from the pollution source. This model can be useful in siting of industry. To classify an area by the environmental risk of exposure to pollutants, one can use the model of second-order phase transitions to determine L_c – the distance to the reference background region.

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Keywords: forest stands, pollution, source, impact, dose, response, model, second-order phase transition.

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BACK

GLACIAL RETREAT AND ASSOCIATED GLACIAL HAZARDS IN BHILANGANA BASIN, UTTARAKHAND

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Glaciers occupy about 10% of the Earth's land surface (~ 16 million Km) but hold roughly 77% of its fresh water; more than 96% of glacier ice lies in the Polar Regions, Antarctica and Greenland.In the Himalayas, the glaciers cover approximately 33,000 sq km area and this is one of the largest concentrations of glacier-stored water outside the Polar Regions. Post industrial revolution, with the rise in level of CO2, the natural climate of earth is susceptible to frequent unpredictable fluctuations. Since glaciers are considered as the best indicators to Climate Change, the study tries to deduce a positive relationship between the increasing temperatures and Climate change by studying Khatling Glacier, the lateral glacier situated in Tehri district(Uttarakhand) which is the source of river Bhilangana. The moraines on the side of the glaciers look like standing walls of gravel mud. To assess glacial changes AwiFS data of resourcesat satellite will be observed and algorithm based on Normalized Difference Snow Index (NDSI) will be used to map snow cover (Kulkarni et al, 2006). The study will help in assessing the glacial change in the region and also find out any developing Glacial Lakes (moraine dammed lakes) in the region which will help in striking a relationship between rising temperature and climate change and also risk mitigation in case of Glacial lake outburst flood in case of dam breach in flood plains.

BACK

TOPOGRAPHICAL INFLUENCES ON GLACIERS IN THE JANKAR CHHU WATERSHED, NW HIMALAYA (INDIA)

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This paper examines the influences of topographical factors on glaciers between 1971 and 2016 for 127 glaciers in Jankar Chhu watershed, north-west (NW) Himalaya using satellite remote sensing data and limited field observation. Change detection was done based on Corona KH-4B (1971), Landsat ETM+ (2000) and Sentinel 2A (2016) imageries restricted only to a set of 127 glaciers due to cloud masking. The relationship between the magnitude of glacier changes and a set of local factors was carried out using multivariate statistical techniques. Cumulative influence of this factors was evaluated for each glacier using Topographic Influence Index (TII) proposed by Garg et al., (2017). Our result show that: (1) glacier area decreased by 7.48 ± 2.17% between 1971 to 2016; whereas glacier retreated at an average rate of ~4.82 ± 0.35 m a^{-1}; (2) The debris cover area increased by 56.77 ± 3.33%, and the average ELA changed to ~20 m; (3) Δ Area (%) and Δ retreat (m) of glacier are strongly affected by local factors while Δ ELA does not show any significant relationship, indicating that it may be controlled by climatic factors and; (4) More than 75% of glaciers show moderate to high influence of local factors on Δ area based on TII values. This study provides important insight into the local controls on recent de-glaciation which are of critical importance to assess the future glacier dynamics on a regional scale.

BACK

RUSSIAN ARCTIC USES, DISCOURSES AND IMPLICATIONS FOR CLIMATE CHANGE AND SUSTAINABILITY OF THE REGION

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The Russian Arctic is experiencing in recent years a revival of human and industrial activities. For this reason, the first part of the presentation is focused on three growing Russian Arctic uses: natural resource extraction, transportation and security and military activities. A brief overview of the biggest Russian Arctic extraction projects, especially in the offshore natural gas sector is done. The recent developments on the Northern Sea Route will be also addressed. The growing maritime activity is mainly linked to the new LNG terminal in Yamal peninsula and the export of natural resources from the Arctic region, while trans-Arctic shipping is still underdeveloped. Russia has recently reopened some abandoned military bases and increased the security focus on the region. These deployments will be put in perspective.

In the second part, on the background of the above mentioned activities, the presentation will discuss the Russian strategy for the region and the Arctic vision of Russian leaders. It is very important to understand how Russia sees the Arctic and what are the national priorities there. While the development of natural resources of the Arctic zone of the Russian Federation remains an absolute priority, in recent years more focus is put on climate change an the sustainable development of the region. The presentation in the conclusion would try to address the following questions: to what extent is climate change considered in the Russian Arctic policy and discourses? Could be the current path of development of the Russian Arctic sustainable? What are the benefits and the incentives for Russia to develop its vast Arctic territory according to sustainability standards and why is international cooperation crucial to achieve these goals.

Keywords: Russian Arctic uses, Arctic policy, sustainability discourses, climate change.

BACK

MONITORING TRADITIONAL SUBSISTENCE SOCIO-ECOLOGICAL SYSTEMS SUSTAINABILITY IN THE ARCTIC: THE CASE FROM EVENKIA

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This presentation evaluates the importance of the traditional subsistence and agricultural socio-ecological systems investigation and continuous socially-oriented monitoring involving broad participation of local people with their knowledge and perceptions of contemporary issues and ways of their solution. In 2016 the ARUN Association of indigenous peoples of Evenkia sent the application to Institute of Geography,RAS to help with practical solutions of arising issues indigenous people tackle in developing traditional activities in their communities. Traditional subsistence socio-ecological systems (TSSESs) based on hunting, gathering and fishing are widely spread all-over Evenkia. Nowadays they are strongly impacted by several ivers of change, coming from human activities and climate changes with cascading both positive and negative effects on all components of ecosystem functions and services. The effects may influence quality of life of indigenous people and human capacities. Key multi-scale issues and possible ways of their solution are identified in TSSESs of Evenkia municipal district based on scientific research and traditional local knowledge and perceptions integration. Among key issues the degradation of ecosystems heavily impacting local subsistence resources availability (fish and meat for food as well as wild animals' skins for sale) is the most urgent for the indigenous people living on land. Several negative driving forces both socio-economic and natural such as widespread poaching, forest land auctions and increasing annual rent obligations for hunting grounds to the indigenous peoples, imposing limits (quarters) without taking into account real subsistence need of indigenous communities, non-compensated impact of spreading infrastructure and logging on taiga forest ecosystems and hunting grounds, as well as climate changes, are impacting quality of life and human capacities of indigenous people. This analysis of key issues and driving forces leading to them gives us opportunity to propose several

ways of such issues solution. The improvement of control and management of TSSESs sustainability with active participation of indigenous people in monitoring activities is the principle way for achieving TSSESs resilience and sustainability.

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Keywords: traditional activities, poaching, logging, sustainability, monitoring, local people.

BACK

TUNDRA "GREENING" AS RUSSIAN ARCTIC BIOTA'S MODERN DYNAMIC'S DRIVER

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On the base of remote sensing materials' (2000-2015 MODIS archives) analyses and syntheses with the original methodic modern climatic and anthropogenic changes of Russian Arctic biota were evaluated. New technologies of spatial extrapolations, estimations and scenarios for adequate reflection of arctic ecosystems' transformation confirm modern processes of tundra "greening" due to increasing of grasses' and bushes' total coverage and productivity (Tishkov, Krenke, 2015; Belonovskaya et al., 2016; Tishkov et al., 2016).

As a result of this large-scale and long-lived phenomenon sharply changes tundra zonal characteristics became evident. Following modern trends of the arctic terrestrial biota key groups could be observed:

- decreasing of climatic-adaptive areas of some birds species' habitats and breeding locations (for example, for waders; Wauchope, et al., 2017);
- changes of arctic Anseriformes' migration's ways as well as appearance of summer migrations to more productive territories (the phenomena was confirmed with the GPS-GSM transducers fixed on birds (Kölzsch, et al., 2016);
- changes of the key mammals' (reindeer, musk ox, polar fox, etc.) area's limits and abundance dynamic, some boreal predators' (brown bear, lynx, etc.) invasion into tundra zone;
- increasing of some water birds (for example, Anseriformes) population and widening of their habitats' area;
- «smoothing» of various lemmings' species population 3-4-years cycles throughout all tundra zone and therefore decreasing of predators' (polar fox, seahawk, snowy owl, buteos) population, changing of their migration ways and feeding;
- intensification of terrestrial alien animal and plant species invasions due not only for climatic warming but also for new habitats' development in tundra (Tishkov, 2012). (For marine arctic biota invasions became important factor of destabilizing).

Following modern changes of tundra biota, caused by synergism of climatic changes and development of arctic regions, cardinal reconstructions of traditional land use of the North native people take place (reindeer breeding, hunting, nomadic ways, etc.). And "vegetation-soils frozen earth" system's restructurings caused by tundra "greening" change the fields of the practical geocryology's using orders.

Gratitude the Russian Academy of Sciences Presidium Programme "Arctic biota and ecosystems' modern changes' regularities as a base for new monitoring technologies and nature conservation of Russian Arctic" for financial support.

BACK

DRIP FREEZING FOR DESALINATION AND PURIFICATION OF SALINE WATERS IN COLD AND HIGH-ALTITUDE REGIONS

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The problem of many Arctic regions, including the Arctic Islands, is the lack of sufficient fresh water. For the autonomous water supply of settlements, a snow harvesting is used. However, in dry winters harvesting snow is ineffective. In addition, melt water contains not enough minerals and trace elements. Intensive economic development of the Russian part of the Arctic led to pollution of rivers and lakes with sewage and industrial water. For cleaning and desalination of large volumes of natural and man-made waters, including for the purposes of water supply, it is necessary to use economic technologies based on application of renewable types of natural energy.

It is known that when saline water freezes, it is partially desalinated. However, the method of natural freezing is characterized by low efficiency. To increase the effectiveness of desalination an artificial ice rain can be used, created by long-range sprinkler systems. If the natural ice rain causes great problems for the infrastructure of settlements, the artificial ice rain can be used to clean and desalinate contaminated mineralized waters. Ice shells are forming at freezing water drops, and salts are rejected into the central unfrozen core of the drops. When a drop falls to the ground and the ice shell is destroyed, the unfrozen brine drains out of the drop and is filtered outside a porous ice massif, which significantly reduces the mineralization of the massif. This allows even at the stage of freezing to reduce the mineralization of the porous ice body by an order of magnitude. The remaining brine is removed in the process of melting.

Results of a preliminary experimental study on the desalination of saline waters by the method of drip freezing are presented.

Keywords: cold regions, fresh water, desalination, method of drip freezing.

BACK

MONITORING SUSTAINABILITY AS A GOVERNANCE CHALLENGE: COMPARATIVE STUDY OF ARCTIC POLICY DOCUMENTS

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High-level policy documents adopted in all circumpolar states acknowledge the need for both protecting the vulnerable Arctic environment and ensuring socio-economic resilience and development of the local population. As our comparative graphic model demonstrates, striking this balance is a country-specific task reflecting the unique domestic political agenda of each Arctic nation, including notably priorities of its environmental, regional, foreign, and resource policies.

Finding adequate solutions ti this task becomes increasingly relevant. Over the past few years, pertaining low oil prices and a number of large-scale industrial incidents have revived the traditional mental dichotomy *'industry vs nature'*, with a strong focus on environmental protection, which was among other manifest in several policy statements. Now, with the growing oil prices and massive progress in extraction technologies, the problem is likely to be revisited. The choices will be increasingly sophisticated, requiring a more fundamental research justification and a stronger international coordination.

Quantifying sustainability goals in binding documents is another key issue, as governments prefer generally to explore various options in the Arctic, not confining themselves to narrow goals. Among all Arctic states, only Russian policy papers outline specific quantitative indicators. Still, there is a need for more coherence between the 2013 national strategy, the actual 2017 edition of the respective government program, and the latest draft law on the Arctic Zone, which is heavily biased towards resource development through implementing large-scale privileged investment projects.

These challenges can be best met through multidisciplinary research, to be done in international networks, with the findings presented to the Arctic Council for further practical action like developing generally accepted sustainability indices. These indices may then be reflected in national policy papers, as well as in unified minimal standards for regional, municipal, and corporate sustainability reporting.

Keywords: Policy papers, Arctic, sustainability, development, environment, challenges, research coordination

BACK

THE EFFECT OF CLIMATE CHANGE ON BOREAL FORESTS OF ARCTIC EUROPEAN RUSSIA

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This work attempts to determine the effect that modern climatic changes in the northern parts of European Russia have on the forest stand, using sequences of linear pine growth which present a convenient tool to assess spacial variability in growth parameters of internode distances across short periods (up to 30 years). Linear tree-ring analysis data provide a means to distinguish between climate-related organism response and year-to-year growth variations, i.e. to achieve a certain low level of 'noise' masking the relationship in question. The investigation was carried out in raised bogs of Russian Northern protected areas.

The analysis of data on the boreal forest stand response to climatic changes shows that apical growth of Scots pine (*Pinus sylvestris*) in raised bogs largely depends on year-to-year variations of temperature and precipitation. Of the meteorological parameters measured, the precipitation during the vegetation season of the previous year was shown to have the greatest effect on growth variations.

Regularities such as this should be taken into account when determining and analysing trends in the status of forest ecosystems of the northern parts of European Russia in the context of the Earth climate changes. Understanding the role of climatic and cenotic factors in forming forest biogeocenoses is vital for successful development of the methodology needed to assess natural boreal ecosystems state.

BACK

THE REVIVAL AND ADVANCES OF GLACIERS DURING THE WARMING PERIOD

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The modern epoch, defined as global warming, is accompanied by almost universal retreat of mountain glaciers. However, with detailed consideration it turns out that the retreat of glaciers in particular regions is not equal at different rates, and sometimes accompanied by the advance of individual glaciers. The causes of such advances can be very different: from the peculiarities of the occurrence of specific glaciers in the surrounding terrain, which causes the peculiarity of their feed and existence, to the dominance of special climatic conditions in a particular territory. The report considers two such special cases: the revival of the removed out surging glacier and the impact on the glaciers of some natural processes in areas of active volcanism.

On the northern slope of the Central Caucasus, on the slope of Mount Kazbek there is the widely known surging glacier Kolka. The previous surges of this glacier took place in the middle of the XIX century, in 1902, 1969/1970 and 2002. The last surge was particularly grandiose: almost the entire glacier "left" from its circus, and huge masses of ice were carried down the valley by a powerful ice-rock mudflow. However, in subsequent years, distinguished by weather conditions that did not at all contribute to the existence of glaciers, the glacier began to revive, and over the past decade or more its mass has been steadily increasing, even in the conditions of a reduction in surrounding glaciers. Thus, even in the era of global warming and the widespread retreat of glaciers, the suddenly destroyed glacier tends to regain its dimensions.

Another vivid example of the advance of glaciers in conditions of general warming is the areas of active volcanism in Kamchatka. Thus, the area of glaciers of the Klyuchevskaya group of volcanoes increased from 1950 to 2010-2015 by 4.3%, while the glaciation of Kamchatka as a whole decreased by 10.6%. The cause of the advance of individual glaciers are active volcanoes, which supply volcanic material to the surface of glaciers that contribute to the preservation of ice, and have a seismic effect on them that facilitates the movement of ice. Since

1945, the Herman Glacier, the largest mountain glacier in Russia, has almost continuously advanced.

The studied examples show that in the modern era of global warming, natural processes are not so unambiguous, and to predict a sharp general reduction in terrestrial glaciation of the Earth in the future is a big mistake.

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Keywords: glaciers, global warming, glacier surges, active volcanism.

BACK

NATIONAL ATLAS OF THE ARCTIC

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The National Atlas of the Arctic was created in response to the list of the executive actions by the President and the Government of the Russian Federation. The Atlas is a set of spatial-temporal information about the geographic, ecological, economic, historical-ethnographic, cultural, and social features of the Arctic compiled as a cartographic model of the territory. The Atlas is intended for use in a wide range of scientific, management, economic, defense, educational, and public activities. The state policy of the Russian Federation in the Arctic for the period until 2020 and beyond, approved by the President in 2008, states that the Arctic is of strategic importance for Russia in the 21st century. A detailed description of all sections of the Atlas is given. The Atlas can be used as an information-reference and educational resource or as a gift edition.

BACK

CONTEMPORARY CHANGES OF GEO-RUNOFF COMPONENTS IN THE LARGEST RUSSIAN ARCTIC RIVERS

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Long-term phases of changes in naturalized components of the geo-runoff (streamflow, heat flow and suspended sediment yield) of Russian Arctic Rivers during the period of observation (from 1930-1940 till 2000s) were revealed on the basis of normalized cumulative curves. Their characteristics and the effects of impact of anthropogenic factors are evaluated.

Since 1930-1940s till the beginning of the 21st century, the naturalized annual and seasonal river runoff in the largest river basins (Ob', Yenisei, Lena) was characterized by two main long-term phases of its changes. The phase of decreased runoff (since the 1930-1940s) was replaced in the 1970-1980s by a long-term phase of increased streamflow. The duration of phases was several decades and are characterized by significant runoff differences.

In the long-term variations of the heat flow of the Ob, Yenisei, Lena also were found two major long-term phases. The phase of the heat flow decrease, which began in 1930-1940-ies and lasted for 35-55 years, was replaced in 1970-1980 by 20-year phase of its increase (except the Yenisei, where this phase began in the late 1990s.) and has continued until now. Similar long-term phases are observed for river water temperature of considered rivers. Differences in heat flow reaches 20% during the phase of its increased and decreased values for the Yenisei Rivers, but for other rivers they are not higher than 10%.

Long-term changes of annual suspended sediment yield for the Yenisei and Lena Rivers are also characterized by two major long-term phases, which replaced each another in the 1970-1990. Differences in the suspended sediment yield during the increase and decrease phases reach 40% for Lena, whereas for Yenisei they are substantially less (10%). Anthropogenic factors (mainly water reservoirs) have significantly changed the characteristics of the long-term phases on the Yenisei River while their impact is not significant on other rivers.

The long-term phases of decrease and increase of "conditionally natural" components of Arctic Rivers of Russia geo-runoff are closely associated with the indices of zonal atmospheric air transport intensity.

Keywords: geo-runoff components, russian arctic rivers, contemporary changes.

BACK

CONTEMPORARY ENVIRONMENTAL CHALLENGES FOR SUSTAINABLE DEVELOPMENT OF EASTERN CHUKOTKA SETTLEMENTS

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Chukotka is remote Arctic region, which occupies northeastern tip of Eurasia. This area was discovered by Russians in 17th century. Intensive development of the region was during Soviet times in 1930-1980 and aimed to mining industry in western part of the region, while Eastern Chukotka was the place of significant military presence (border troops). After Soviet Union collapse the economy of Chukotka was dramatically shrinking. The most developed areas have experienced the most significant damage, but almost all settlements of Eastern Chukotka, populated mainly by indigenous peoples (Chukchi, Yupik, Evens, etc.) survived crisis. New period in Chukotka economic development was in 2001-2008, when industrial magnate roman Abramovich was elected as governor. This period was characterized by restoration of mining industry, intensive housebuilding and increasing of living standards.

The settlements of Eastern Chukotka are confined to sea coast and characterized by predominance of indigenous population. There is no large manufactures or mining facilities, but climate changes have negative effect on traditional environmental management and housings. Shrinking sea ice extent and increasing of duration of open water period causes accelerated coastal erosion, changing of marine mammal migration routes and worsening of sea hunting conditions. Active layer thickening, revealed through monitoring measurements in 2000-2017, facilitates thaw slumps, ravines development and increases risks of ice-cellars (meat pits in permafrost) exploitation. Sociological survey conducted in 2017 indicated that local long-term residents testify about tundra bushing, southern species invasion, shifting of seasonal periodicity.

Despite all mentioned challenges, there is no any effective strategy on adaptation to climate and environmental changes and mitigation its consequences. Government, scientists, local communities and the other stakeholders need to combine efforts and develop roadmap to sustainable development, considering regional specific features.

BACK

ANTARCTICA – GEOGRAPHICAL FEATURE OF SCIENTIFIC AND TECHNICAL PROGRESS

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Antarctica is the most isolated, high-latitudinal and high-mountainous Earth's continent. Zone of tundra, rivers and bogs are absent in Antarctica.

Unique geographical economic, military-strategic and political-legal conditions of Antarctica determined a specific character of activity in this region.

Complex scientific programs of investigation of Antarctic nature began from 1957 in the framework of the International Geophysical Year (IGY) 1957-1958.

Fulfillment of the IGY Program practically coincided with the beginning of space era of mankind when on 4 October 1957 the USSR launched the first Earth's satellite. In the 1960s, satellites with instruments of remote sounding of the Earth's underlying surface began operation. In 1968, first instruments for receiving information from such satellites were installed at Mirny station.

In the 1970s, a great deal of attention was focused on exploration of biological and mineral resources of the Antarctic. This determined new directions of research and oceanographic, hydrographic and hydrometeorological support of ship operations in the Southern Ocean. In order to extend understanding of the geological structure of the Antarctic, modern types of geophysical studies were applied.

Increased information flow required introduction into the expedition practice of advance computer and communication technologies.

In 1970, a Project of Deep Ice Sheet Drilling at Vostok station was undertaken to reconstruct paleoclimatic changes based on ice core data. As a result, a geo-chronological curve of climate variability of Antarctica for the last 420 kyr was constructed by the middle of the 1950s, on which four periods are identified that characterize transfer from warming of the Antarctic atmosphere to its cooling.

In late 20th century, the subglacial aquatic systems of the sixth continent became a new target of Antarctic studies, including Lake Vostok. Methods of molecular biology and isotopic analyses began to be widely applied in these studies.

In the end of the 20th, one began studies in cosmogony, astronomy and astrophysics, full-scale trials of new space materials, technologies and engineering solutions and specialized physiological and psychological investigations for modeling long space flights of man.

BACK

NEW DATA ON ICE THICKNESS AND INTERNAL STRUCTURE OF GLACIERS IN TIEN-SHAN AND PAMIR-ALAY (KYRGYZSTAN)

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Glacier thickness and volume estimations are key parameters for many glaciological applications. Furthermore, the thermal state and internal structure of glaciers are linked with local climate conditions. Ongoing glacier recession affects local river discharge and contributes to global sea level rise. However, direct measurements of ice thickness are still sparse because of its high costs and labor intensity, especially in remote glacierized areas in Central Asia. In this region, there are two glaciers with very detailed legacy data on ice thickness and thermal regime – Abramov glacier in the Pamir Alay Mountains and Gregoriev ice cap in the inner Tien-Shan.

During a recent field campaign, we conducted GPR measurements along 24 and 27 km of profiles on Abramov and Gregoriev glaciers, respectively, with a 20 MHz VIRL-7 monopulse radar. Ice thickness maps were constructed for the investigated parts of the glaciers and the internal structure mapped. Obtained radar data shows the presence of a core of temperate ice on Gregoriev ice cap which was previously considered cold based and a predominantly temperate structure of Abramov glacier. Maximal measured ice thickness reaches 220 m on Abramov glacier and 110 m on Gregoriev ice cap. This research allows to assess changes of Abramov glacier thickness and provides a first estimate of the total volume of Gregoriev ice cap, the biggest glacier in Tien-Shan of this morphological type. Furthermore, this data will contribute to the glacier thickness database (GlaThiDa) for future improvement of glacier thickness modelling.

BACK

INTERNATIONAL AND INTERDISCIPLINARY PROJECTS IN THE ARCTIC AND ANTARCTIC

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Arctic and Antarctic Research Institute (AARI) scientific infrastructure is described. AARI has three modern observatories: in Barentsburg (Spitsbergen), Tiksi (Republic of Sakha Yakutia) and on Cape Baranova (Severnaya Zemlya). Substantial reconstruction and the modern scientific instrumentation of the observatory took place in Barentsburg. Priority fields of scientific research include comprehensive study of environment and climate of archipelago and environmental pollution monitoring. Tiksi Hydrometeorological Observatory has been reconstructed during the International Polar Year 2007/08. More than 150 measurements include trace gases, greenhouse gases, aerosols, mercury and persistent organic pollutants. The measurements of short-lived climate forcers such as black carbon, ozone and methane has been taking during the last years. Tiksi Observatory participate in different international programs implemented under the World Meteorological Organization (WMO) and it is the part of the International Arctic Systems for Observing the Atmosphere network. In 2013 «Cape Baranova» Ice Base in the Severnaya Zemlya archipelago has been organized to provide the full spectrum of year-round observations. The new impulse in the development of the international cooperation in Tiksi and Cape Baranova could be initiated with the implementation of WMO project “Year of Polar Prediction” (YOPP) in 2018 – 2020.

Some international AARI projects in the Arctic and Antarctic are described. Among the Arctic there are Russian – German project *Changing Arctic Transpolar System* (Transdrift) and Russia – USA project *Nansen Amundsen Basins Observational System* (NABOS). In the Antarctic these are Russian – Swiss project *Antarctic Circumnavigation Expedition* (ACE), *Southern Ocean Observing System* (SOOS) and YOPP – Southern Hemisphere.

Keywords: Arctic, Antarctic, climate, international, polar, WMO.

BACK

THE ORIGIN OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS AND SNOW COVER OF SVALBARD DEVELOPMENTS AFFECTED BY COAL MINING

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Svalbard is a unique area of International Arctic that started its initial development as a coal mining archipelago but now increasingly becoming a field of global research, baseline environmental monitoring and the region-specific recreation. One of the reasons for the parallel trend to renewable energy is the long-term multi-chemical contamination originated from local operations with bituminous coal including its extraction, transportation and combustion.

Numerous polycyclic aromatic hydrocarbons (PAHs) are among the coal's native compounds the load of which on Svalbard's landscapes increased significantly with opening the mines some 100 years ago. In addition, the local coal-firing power plants produced huge amounts of heavier and much more toxic PAH derivatives associated now with unburnt coal-bound hydrocarbons in air/snow particulates, fallouts, soil matrix and bottom sediments.

This three years long study was focused on identifying both natural and technogenic PAH associations in soils and snow cover sampled within a variety of landscapes with location of emission sources and natural factors of contaminants' distribution having been taken into account.

In two expeditions (Spring 2013 and 2014), we took probes for geochemical studies of the snow covers, and in three additional expeditions (summer-autumn 2013, 2014, 2015), samples for soil surveys were gathered.

The presence of different substances including polycyclic hydrocarbons (as 16 individual structures listed by US EPA as those of priority assessment) was measured in accordance with the ISO 12884:2000 standard using a liquid chromatograph (LC-20 ominence, Shimadzu) coupled to a fluorometric detector (RF-20A).

The results indicate that a significant level of contribution arose from local sources. The highest levels of PAHs were found near operating coal mines, coal terminal areas and coal-fired power plants. Two main PAH generations were discovered. The first is related to coal

particulates while the second stems from combustion products that originated from local and, to a far lesser degree, remote sources.

The results also helped determining the spatial distribution of contamination. In addition, the assessment of recipients improved our understanding of geochemical features in Arctic landscapes under industrial pressure.

Keywords: The Arctic, Svalbard, mining activities, Polycyclic aromatic hydrocarbons (PAHs) contamination, geochemistry of the Arctic landscapes.

BACK

APPLICATION OF THE UNIVERSAL THERMAL COMFORT INDEX (UTCI) FOR THE INVESTIGATION OF RUSSIAN BIOCLIMATE IN THE BEGINNING OF THE XXI CENTURY

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Overall impact of climatic conditions on human can be estimated using bioclimatic indexes. We used UTCI index to estimate bioclimate for the Russian territory. Initiated by Commission of the International Society of Biometeorology, and developed with support from the European Union within the COST Action 730, the Universal Thermal Climate Index (UTCI) aims at the assessment of the outdoor thermal conditions in the major fields of human biometeorology. This index was designed using the simulation of the human reaction by a multi-node model of human thermoregulation, which was integrated with an adaptive clothing model. Index UTCI can be described as an equivalent environment temperature (° C) which provides the same physiological impact on human as the actual environment. Furthermore, similar to the human body, the UTCI is very sensitive to changes in ambient stimuli: temperature, solar radiation, wind and humidity. The UTCI scale is able to express even slight differences in the intensity of meteorological parameters. This feature allows to use UTCI throughout the Russian territory. The assesment of the bioclimatic conditions is shown for the territory of Russia during the climate change. The calculation of monthly and seasonal average values of UTCI index for 512 meteorological stations in Russia was made using the program package BioKlima 2.6. Seasonal fluctuations of UTCI index and changes of distribution of discomfort (comfort) levels during the climate change were shown for the Russian territory. Cold stress conditions (from low to extreme) were observed in the almost all territory of Russia for about 8–11 months a year. During the rest part of the year conditions are neutral or heat comfortable. The period of extreme and very high cold stress decreases during the modern climate warming, especially in Arctic, in the European part of Russia, in the western and central Siberia At the same time, the period with neutral and comfortable heat loads enhances.

Keywords: Universal Thermal Climate Index (UTCI), cold stress, heat loads, climate change.

BACK

RESILIENCE AND ADAPTATION: MONITORING URBAN CHANGES IN THE CONTEXT OF RISK EXPOSURES, CLIMATE AND SOCIETAL CHANGES (YAKUTIA)

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Several challenges affect Yakutia territory in the triple context of climate changes, increasing natural risks exposures, and massive urban transformations: metropolisation dynamics in Yakutsk, decreasing of populations in the Arctic settlements, multiple exposures of populations to the flooding, pollution, permafrost melting, etc. If the local populations would implement territorial strategies and develop specific behaviours to the annual flooding for example, the massive transformations of the region of Yakutsk would generate new challenges and impose interdisciplinary approach combining local knowledge, participatory approach, GIS, and remote sensing monitoring. The lack of systematic data as well as monitoring of the fast territorial transformations and urban sprawls has broken the dynamics of resilience and adaptation made before by the local populations in the flooding areas, permafrost risk zones, and polluted spaces. This aspect constitutes a challenge for the sustainability of Yakutsk. The absence of clear scenarios, assessment of potential impacts and consequences of the climate change, territorial dynamics, and societal transformations also threatens sustainability of the city. Approach under development combines three methods: remote sensing monitoring of the urban and territorial transformations, spatial modelling of the gradient of risk exposures, monitoring and modelling of annual or constant geophysical and environmental hazard, and integrates human adaptation strategies and resilience.

Keywords: Monitoring, Remote Sensing, Urbanisation, Participative approach, Resilience and Adaptation, Yakutsk.

BACK

YAKUTSK: CULTURE FOR SUSTAINABILITY?

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Despite its location below the Arctic circle, Yakutsk serves as one of the main centers of discussions about the Arctic sustainability. First, as a capital of the biggest region of Russia located above the Arctic circle, it has developed specific regional policy related to the issues of the Arctic territories: subsidies for transportation accessibility and Northern provision, territories of traditional land use, and not only preservation but also revitalization of indigenous cultures. Second, it serves as a place of migration inflow for those migrants, who moved from the smaller rural and urban Arctic settlements. The previous studies have shown that Yakutsk has been the only city where infant mortality, suicide and outmigration have decreased in the Republic of Sakha (Yakutia) (Fondahl, Crate & Filippova, 2014). Third, the city serves as a transportation hub for most of the air routes within the region, connects to the Northern sea route with the Lena river, and has all but the bridge to connect with the railroad. Fourth, with the migrants keeping ties with the homeland, and transport-geographical location, the city serves as a hub of social networks that, strengthened by the transportation, communication and Internet technologies, affects sustainability of the regional Arctic settlements that, in turn, increase the importance and sustainability of the Yakutsk itself.

With the strong representation of the indigenous people, the studies in the city can support our understanding of the role of culture for sustainability (Gartler, Schweitzer, Kuklina, unpublished). For instance, support of provision of food from traditional activities does not have substantial share in general, however, the efforts to promote traditional activities are significant both in terms of the budget expenses and cultural value. Another significant part of the local budget is related to organization and support of big events, such as “Children of Asia” games and national Ysyakh holidays with becoming regular Guinness record achievements and horse races. While these events receive critics from those who would prefer to spend on social issues, the others appreciate them as an opportunity to promote and revitalize circumpolar cultures. Also, it is difficult to overestimate parents’ from both the city and other settlements’ efforts to give children better education that includes studies in the national gymnasium and in

the East-Siberian Federal University with all the expenses it takes: transportation costs, cost of education, and cost of living in Yakutsk. Relied mostly on social networks, this example shows importance of social capital in adaptation of regional in-migrants to the urban conditions. Finally, proliferation of businesses selling ethnic clothing, kitchenware, jewelry, souvenirs, films and music also exceed development of social and economic indicators. As a result, studies of role of culture for sustainability in Yakutsk allow to ask more questions about social, economic, or cultural priorities in the city's development, planning, and everyday life.

The presentation is based on the materials from the fields studies conducted by the author in June 2017.

BACK

POSTER

ENVIRONMENT OF THE EVENTS IN ARCTIC IN THE PLIOCENE AND AT THE END OF THE QUARTERNARY (THE LATE GLACIAL TIME)

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The Laboratory of Evolutionary Geography is carrying out the reconstruction of ecosystems during cold stages and glaciations, and also warmings of different rank, initiated by prof. AA. Velichko. The authors worked out the problem of the natural environment in the Arctic for the beginning and end of the Quarternary (Velichko et al. 2017; Pisareva and Faustova 2017) for forecast purposes.

The mean global temperature of atmospheric boundary layer should be higher by 4° (Budyko 1977) to the middle of the 21st century, according to the available estimations. The highest temperature rise is expected in high latitudes. In this regard the Pliocene optimum has a special interest as an analogue of future climate changes.

The warming in the Early Pliocene was manifested itself in the composition of the fauna of deep-sea sediments and has led to a shift of the Gulf Stream to the north by about 8°. About 5,15 million years ago the Atlantic mollusk Astarte was penetrated into the Pacific Ocean. The increase in water temperature in its central part is confirmed by fauna finds Neogloboquadrina pachiderma and by subtropical species of the genus Globorotalia (Borzenkova and Zubakov 1985). Migration of warm water fauna complexes to the north from the Pacific region has been identified by Yu.B. Gladenkov (Gladenkov 1991).

During the warming in Iceland spread birch and alder woodlands and willow thickets with areas of arctic-steppe communications (Akhmetev et al. 1978). In the NW Europe and in the central regions of Eastern Europe, coniferous-broad-leaved forests were dominated with rare Taxodiaceae, Sequoia, Glyptostrobus. Winter temperatures reached +10°C, summer temperatures - +28°C, the amount of precipitation was about 1000 mm/year. In Western Siberia, in forests dominated by spruce, Tsuga and warm-temperate tree species met. In the eastern sector of the Arctic, in Chukotka, the warmest conditions are established for the intervals 3.55-

3.4 and 3.275-2.6 million years ago. Here was dominated by dark coniferous forests with Larix, Abies and Tsuga (Andreev et al. 2013). In the south of Eastern Siberia, along with mixed forests, steppefied areas were encountered (Volkova and Belova 1985).

The global cooling in the beginning of Gelasian led to the development of continental glaciations, the filling of the Baltic and North Sea depressions with the Scandinavian ice and to the emergence of the Barents Sea Shield. This caused the expansion of boreal vegetation and the invasion of northern elements of the flora. In the fauna appeared lemmings. Tundra and forest-tundra vegetation developed on the shores of the Arctic Basin. In Eastern Siberia, along with the tundra, there were steppe communities.

In the Tegelen in the Central regions of Eastern Europe coniferous-broad-leaved forests with Tsuga Cupressaceae and undergrowth from Dierwilla and Ligustrum were spread. The tundra zone was absent. In the basins of the Middle and Lower Volga, Dnieper and Don forest-steppes existed, in the Azov region - steppes. About 2.4 million years ago the Greenland ice sheet disappeared and forest vegetation spread. This is evidenced by findings in the sections of the Cape Copenhagen formation of woody remains with Taxus. Mean July temperature exceeded +10° C, mean January temperature was about 17° C (currently, respectively, – + 4° C and 30 °C). In Western Siberia, warm and humid phases have alternated with arid phases., The climate was drier and colder in Chukotka.

Warmings at the end of the Quarternary (final part of Valdai glacial epoch - the Late Glacial time) can not be regarded as a significant warming scenario (see above) in contrast to the Pliocene. Continental ice sheets continued to exist at the Late Glacial time. During the Late Glacial time the lobes in their edges have lost gradually connection with the areas of snow supply, as the ice dynamics was determined by the regional climatic and geological environments (topography and tectonics), as well as by rate of isostatic and eustatic changes. It was reflected in the frequent ice edge fluctuations of varying amplitude and duration, corresponding to short-term warmings (Bølling, Allerød) and coolings (Oldest Dryas, Older Dryas, Younger Dryas). The marine glaciation persisted on the vast shallow Arctic shelves during the warmings of the Late Glacial time.

The subsequent most pronounced Late Glacial warming - interstadial Allerød - lasted for more than a thousand years, from 13.9 to 12.65 cal.kyr BP (11.9 – 10.1514C kyr BP). It was characterized by climatic fluctuations: from the warmest phase (optimum) in the first half of Allerød (interval G1-1c on the GRIP curve) to the cooling in the second half of it (interval G1-1b) and to final warm phase (interval G1-1a). During the Allerød optimum the SIS shrank significantly (Fig. 1A).

A significant improvement in the climate during Allerød (mean January temperatures reconstructed from paleoflora varied at the southern edge of the periglacial zone from -17 ° to -19 ° C, and those of July 14 ° to 17 ° C, that is by 2 ° and 1 ° respectively below those of the present-day, annual rainfall was 25 mm higher than the modern value). This led to the accumulation of organic matter and the penetration trees and shrubs into the Arctic. In northern Fennoscandia the northern coast of Norway (Varanger Peninsula) became ice-free. In the vegetation, together with tundra communities including Dryas, Cerastium alpine, Saxyfraga oppositifolia, Gentiana nivalis, also Helianthemum nummularium and Ephedra occurred. Locally spruce, birch, pine could be found. In the north of Scandinavia, the forest-tundra associations have been existed. The coast of the Kola Peninsula was also freed from the Scandinavian ice. The vegetation was dominated by birch and pine–birch open woodlands in combination with communities of grasses, as well as those of dwarf shrubs and moss, in common with tundra, steppe and halophytic communities. Coniferous forests of pine and spruce grew locally for example in the lower and middle reaches of the Voronya and Tuloma rivers (Corner et al. 2001). In the Allerød optimum open birch forests covered the southern part of Scandinavia (southern Sweden). The Gulf of Finland coasts were noted for pine and birch forests with mesophilic herbs in the ground cover at the Allerød optimum. Proportion of spruce in forests increased at the southern margin of the periglacial zone and further east. The south-eastern slope of the ice sheet retreated from SW Karelia to SW Finland. In the south it bordered on the Baltic Ice Lake (BIL), which formed a deep-water bay in place of the present-day Lake Ladozhskoye, free of ice sheet by that time (Subetto et al. 2003). In Allerød (11.4 14 C kyr BP) Onega proglacial lake lost contact with the ice sheet, the latter having retreated to the north-west, to the modern border with Finland. At the Allerød optimum the lake reached its maximum size. Large massifs of dead ice in the lake drainage basin persisted till the end of Allerød, and locally even up to the Boreal time (Demidov and Lavrova 2001). Among paleogeographic factors having noticeably affected the periglacial vegetation there should be noted the cold freshwater basin that occupied the White Sea basin since the Allerød, remnants of proglacial lakes and also large blocks of dead ice. So, the vegetation was depended heavily on the local environments. Dwarf birch – Betula nana – grew on the coasts of the Dvina and the Onega bays. The ground cover, besides Dryas octopetala, included Lycopodium appressum, L. alpinum. Communities of steppe plants were confined to uplands.

The end of Allerød featured a gradual retreat of ice. The late Allerød cooling left its imprint on the North European Plain noticeable within the limits of present-day Denmark, Southwestern Norway, Eastern Netherlands and in the west of the North German lowland. At

the end of Allerød in the Baltic sector the ice front advanced from the territories of Finland and southern Sweden onto the western coast of Estonia (the Palivere oscillation, 11.2-11.5 14C kyr BP). The deterioration of climate around 11.1 14C kyr BP resulted in an increasing number of grasses and appearance of spruce that moved as far north as the latitude of Helsinki (Elina et al. 2000). At the south-eastern margin of the Scandinavian ice sheet the cooling led to an increasing proportion of shrub birch and grasses. Pine appeared in the most distal part of the periglacial zone, but in the drainage basin of the Sukhona River it gave way to spruce, the latter being represented on the East European Plain by two species: Picea exelsa and Picea obovata.

The warming in the optimum of the Allerød also affected the northern regions of Central and Eastern Siberia. It is known that on the shores of the Taimyr Lake the hunters have used willows for fireplace. At the settlements in the area of Indigirka a charcoal (12240 + 60 and 11830 + 110) was discovered (Levkovskaya 1974).

The climate of the Late Glacial was characterized by quick change of warm and cold stages. The subsequent cold phase, Younger Dryas was deep and global in occurrence. It lasted, according to the GRIP and GISP2 scales 1150-1200 years. The upper limit of Younger Dryas is fixed at 11.6 cal. kyr BP or 10.3 14C kyr BP. According to the study of sediments in the lakes of north-west Russia, the change of vegetation indicating the transition to other climatic conditions occurred later in the east (Subetto et al. 2003). The entire perimeter of the Scandinavian ice sheet, was put forward, especially at the south-western and south-eastern margins, which led to the formation of the belt of terminal moraines: Ra in Norway, the complex of ridges in Central Sweden, Salpausselkä ridges in Finland, Kalevala and Rugozero marginal formations in Russia. They formed during the entire Dryas.

Mean temperatures were in the periglacial zone of the Atlantic Sector of SIS according to paleobotanical data at least 6-8 °C lower than today's. To the east, this cooling was more pronounced. Mean January temperatures in the northwestern regions of Eastern Europe (the Upper Volga basin) were lower than today's 10° C. It is reflected in the vegetation of the preglacial zone in the north, west and east of Fennoscandia. Younger Dryas cooling was noted for an increase of grass and shrub pollen and abundance periglacial flora components (Fig.2).

The mosaic vegetation was formed. It consisted of sagebrush, sedge, shade-tolerant grasses such as Pleurospermum austriacum, wetland and near-shore aquatic plants. In the south of modern Denmark pine and birch grew occasionally.

On the northern edge of Fennoscandia (Murmansk coast) the Younger Dryas cooling was studied in lacustrine sequences (Snyder et al. 2000). The composition of diatom and pollen

assemblages indicate a cold and extreme continental climate, the vegetation being dominated by xerophytes and Artemisia.

The Baltic sector was deforestated, forests being replaced by the cold steppe vegetation with tundra communities. To the East, in the northwestern regions of the East European Plain (Valdai Upland), the presence of tundra vegetation with Betula nana and Dryas octopetala is evidence of severe climatic conditions.

South-eastern slope of the Scandinavian ice sheet advanced noticeably at the Younger Dryas maximum, but experienced a great reduction by the end of the cooling. Early in the SE Karelia region was dominated by tundra vegetation with arctic-alpine and steppe plant assemblages. Communities of dwarf birch-green moss and those of herbs, shrubs and green mosses played a significant role. The herbs were dominated by Artemisia and Chenopodiaceae. In the depressions between ridges and in river valleys some areas of birch and alder woodland could persist (Filimonova 2005).

The relative climate warming in the middle of the Younger Dryas was best pronounced in Western Karelia where birch woodland with a small admixture of pine became widely spread.

The transition from the Younger Dryas to the Early Holocene (Preboreal) was characterized by an improvement of climatic conditions more noticeable than in Allerød. In the Preboreal in the Arctic, degradation of tundra-steppe paleoivironments occurred and the forest vegetation spread.

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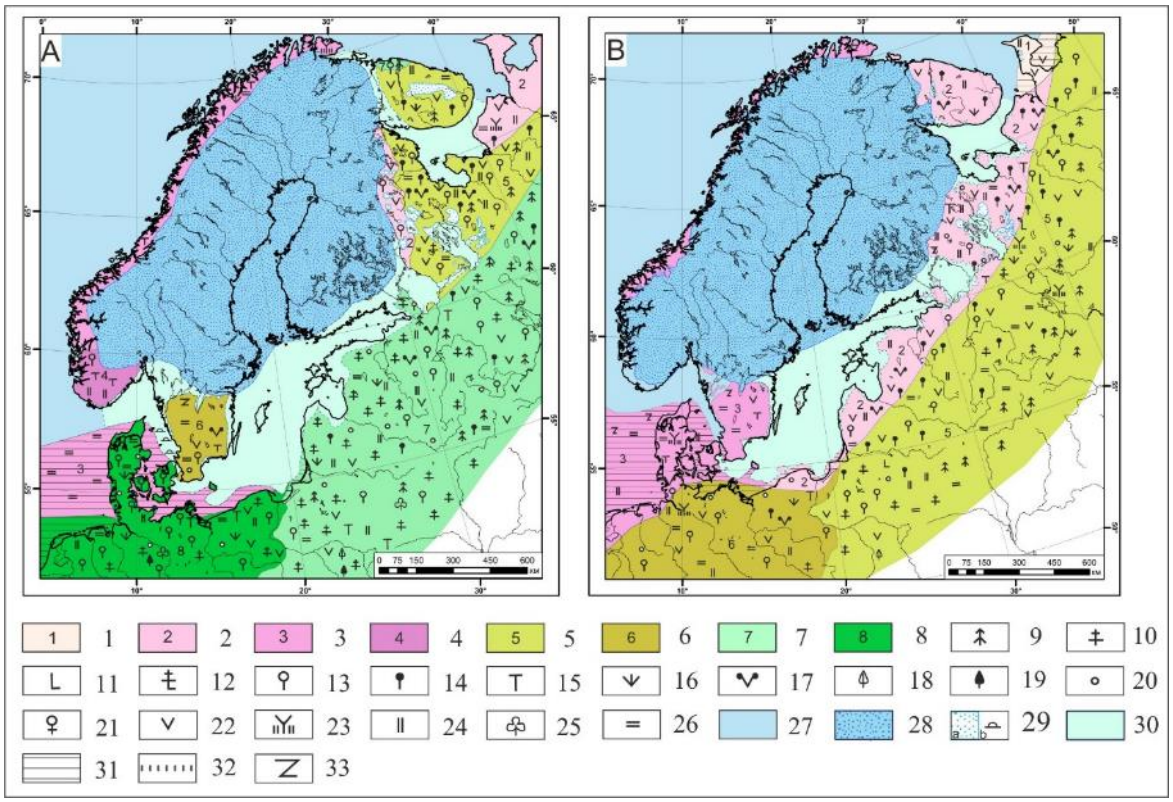

Figure 1. Maps of paleolandscapes: A - Paleoinvironments at the Allerød optimum; B - Paleoinvironments in the Younger Dryas (maximum spread of ice sheet).

Legend: ***Types of vegetations:*** *1 – Arctic tundra with Artemisia and Chenopodiaceae; 2 – Herbaceous and dwarf shrub-moss tundra with the grass and halophytic groups; 3 – Subarctic meadows with shrub-moss tundra and birch open woodlandsc; 4 – Herbaceous and dwarf shrub-moss tundra combined with pine, larch, birch open woodlands and the grass and halophytic groups; 5 – Birch, pine- birch, spruce- birch open woodlands combined with herbaceous and dwarf shrub-moss tundra and the grass and halophytic groups; 6 – Birch open woodlands combined with meadow herbs and arctic-alpine and the grass groups (park tundra); 7 – Light pine-birch and pine forests, in the east– with a predominance of spruce, on the south– with rare broad-leaved trees; 8 – Birch forests in the Atlantic Sector with an abundance of shade-tolerant meadow grasses and admixture of steppe plants;.* ***Plants:*** *9 – Picea; 10 – Pinus; 11 – Larix; 12 – Abies; 13 – Betula s. Albae; 14 – Betula nana; 15 – Juniperus; 16 – Ericales; 17 – Salix; 18 – Alnus; 19 – Corylus; 20 – Hippophae; 21 – Populus tremula; 22 – Artemisia; 23 – Dryas flora; 24 – Herbs; 25 – Broad-leaved trees; 26 – Meadow grasses; 27 – Ocean; 28 – Ice Sheets; 29 – Dead Ice: a - on the land; b – offshore; 30 – Proglacial Lakes; 31 – Exposed shelf; 32 – Exposed shelf boundary; 33 – Disturbed grounds.*

Keywords: reconstruction of ecosystems, pollen analysis, Arctic, Pliocene, Late glacial time.

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BACK

SYNOPTIC MECHANISMS OF FREEZING RAIN EVENTS

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The atmospheric circulation conditions above Moscow in December 2010 and November 2016, which led to the unprecedented freezing rain and to the glazed ice of strong intensity, were examined. It was shown, that in both cases the freezing rain related with the active warm frontal zone, which was situated between the surface positions of the polar and arctic fronts.

It was established, that in 2010 together with the powerful advection of the warm and humid air on the frontal surface, the cold advection in the cold air mass above the front was observed. In other words, in the lower troposphere in the freezing rain zone, the double-layer advection was observed. This caused a very long time of icing on the wires and trees. In 2016 cold advection in the cold air mass above the front was not very powerful. This caused a rapid melting of the icing on the surface, wires and trees.

Numerical experiments with the COSMO-CLM model reproduced the main signs of freezing rain, which indicates the possibility of using the developed schemes for forecasting this weather phenomenon.

Keywords: freezing rain, Mediterranean cyclone, double-layer advection occluded front, COSMO-CLM.

BACK

THE IMPACT OF CLIMATE CHANGE IN MONGOL ALTAI MOUNTAIN RANGE

Tsedevdorj Ser-od, Enkhjargal Purevsuren, Gombodorj Munkhtsetseg, Khurelbaatar Tsogbadral, Tsedev Bat-Erdene, Amgalan Avkhinsukh

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The Altai mountain range located on the border of Mongolia, Russia, China and Kazakhstan is a big mountain range, the watershed between the Arctic Ocean basin and Inner Asia closed drainage area. Because of its altitude distance from the ocean, the ecoregion has an cold semi-arid climate. This indicates a local climate characterized by cool summers, and cold, dry winters. These climate regions tend to be found at higher elevations in the middle of continents, with wide differences between day and night temperatures.

Still there are few data about the mass balance, modern morphometric features, glacio and hydro-climatic relations of large glaciers in the Mongolian part of the region. Climate change is projected to have a strongly negative effect on water supplies in the Mongol Altai mountain, significantly impacting thousands of people. As one of the poorest countries in the region, Mongolia is particularly vulnerable to such changes due to its limited capacity to adapt.

Water security is threatened further by glacial recession with Mongol Altai mountain glaciers losing nearly half their ice mass over the past 70 years raising serious water management concerns. This review examines current trends in water availability and glacier melt in the Mongol Altai Mountain, assesses the driving factors of reduced water availability and identifies key gaps in our knowledge of the Altai cryosphere.

Keywords: Climate change, Water resources, Glacier, Permafrost, Meteorological station.

BACK

MICROBIAL EUKARYOTES FROM THE NOVAYA ZEMLYA ARCHIPELAGO (RUSSIAN ARCTIC): FILLING THE GAP IN TESTATE AMOEBAE BIOGEOGRAPHY

Yuri A. Mazei[1], Andrey N. Tsyganov[2], Natalia G. Mazei[1], Viktor A. Chernyshov[2], Sergei A. Ivanchin[2], Richard J. Payne[3]

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Testate amoebae have proved a useful group of species to understand the biogeography of larger microorganisms. The Arctic has attracted particular interest in such studies but there are large geographic gaps in current knowledge. Here we present the first ever study of testate amoebae from the Novaya Zemlya archipelago in Arctic Russia. We investigated testate amoebae from the northernmost island of Novaya Zemlya proper and two smaller islands to the south: Dolgii Island and Matveev Island. We found that testate amoebae were present and active even in the extreme physical environment of Novaya Zemlya. Further south in the tundra zone of Dolgii and Matveev islands, testate amoebae were notably abundant and diverse. There were distinct differences in assemblage between all three islands and particularly between Novaya Zemlya and the two more southerly islands. The assemblage of Novaya Zemlya was distinctive with a surprising abundance of larger taxa. Comparisons to previous data suggest that the testate amoeba assemblages of these islands may show more affinity to those further west in Greenland and Svalbard than those further east in Siberia. Results highlight the limited knowledge of the abundance and diversity of these functionally-significant protists in large areas of the globe.

Keywords: Protist; Biogeography; Arctic; Protozoa.

BACK

C6.08 Environment Evolution

Chairperson(s):

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C16.08 Environment Evolution – Climate: vegetation interaction under present and projected future climate conditions

CLIMATE FACTORS IN THE ECOLOGICAL SECOND-ORDER PHASE TRANSITIONS MODEL OF THE PLANT ECOTONES BOUNDARIES, SAYAN MOUNTAINS

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The model of ecological second-order phase transitions has been used to describe height-dependent changes in the species composition of mountain forest ecosystems. Forest inventory data on the distribution of various tree species in the Sayan Mountains (south Middle Siberia) are in good agreement with the model proposed in this study. The model was used to estimate critical heights for different altitudinal belts of vegetation, determine the boundaries and extents of ecotones between different vegetation belts, and reveal differences in the ecotone boundaries between the north- and south-facing transects. An additional model is proposed to describe ecotone boundary shifts caused by climate change.

Any plant community has its own species composition and spatial structure. Within the space occupied by the community, it may be regarded as uniform and characterized by spatially invariable parameters. The boundaries of a community are determined by the effects of external modifying factors (such as temperature) on the plants and competitive interactions with the species that are not characteristic of this community but are present in the neighboring one. For the past millennia, the boundaries of the natural zones have shifted many times. Climate changes may be a reason for the shifts of the boundaries of the natural zones. It is very important to determine the shifts of the geographical boundaries and to find the factors influencing this process both for theoretical ecology and for effective ecological management.

The transition between biomes – ecotone – is a spatially non-uniform community that is different from the ecosystems separated by it. Thus, ecotones are transition areas between

different natural systems (ecosystems, landscapes), between natural and anthropogenic systems, between different media (water-land), and between biomes. Ecotones occur in nature very frequently, and they play an important part in the life of biotic communities. These transition areas have a specific structure, enabling formation and preservation of species and biological diversity.

Although the properties of ecotones have attracted great attention of researchers (Chen X-W 2002; Janik 1992; Peters et al. 2006), no generally accepted methodological and theoretical tools for describing and explaining the dynamics of ecotones as independent study systems have been developed yet. In the present study, we have adapted models used to describe qualitative changes – phase transitions – in physical systems to describe ecotones (Ivanova and Soukhovolsky 2016).

The study site

Analysis of the properties of ecotones should be performed on the plant communities minimally affected by human activities and with few external factors influencing the plants. Mountain forest communities seem to satisfy these requirements. These forests form altitudinal belts, which differ in their species composition and the diversity of the species of trees, shrubs, and herbs. Altitudinal belts often overlap, creating ecotones. To model ecotones, we used the data on altitudinal zonation of forest vegetation of the medium-altitude rain-barrier landscapes in the West Sayan Mountains (Polikarpov et al. 1986). The model was constructed for the forest ecosystems situated on the Kulumys Ridge. The study site was described by using a geographic information system based on the forest management data of the Tanzybey Forestry (forest stand maps, 1:50 000) and the SRTM radar data. The layers from the scanned forest stand maps were vectorized in the Easy Trace 7.99 software package.

To analyze changes in the altitudinal zonation of woody vegetation, we chose two transects about 45 km long, with the average width about 3 km, with the minimal height of 320 m a.s.l. and the maximal height of 1700 m a.s.l. Transect 1 comprised 858 plots, Transect 2 – 506 plots, with the total area of the plots 7908 and 9799 ha, respectively. The species composition of the stands was as follows: birch *Betula pendula*, aspen *Populis tremula*, Siberian fir *Abies sibirica* Ledeb, Siberian pine *Pinus sibirica* Du Tour, and Scots pine *Pinus sylvestris* L.

Forest inventory data provided such parameters as the plot area; the formula of the composition of the first and second layers in the tree stand and their density; the average heights of the major species in the first and second layers, their ages; the species composition of the shrubs and the herbaceous layer (Soukhovolsky et al. 2014).

To analyze altitudinal changes in the species composition of the stands, we used absolute height, H, a.s.l., and relative height of the tree stand, $h = H - H_0$, where H_0 = 320 m, the height of the lowermost points of the transects. At regular intervals of 47.6 m along the transects, we estimated the areas and the species compositions of the forest stands. It was assumed that the fraction of the total area of the plot occupied by trees of a certain species was proportional to the percentage of the trees of this species growing on the plot. The area S_{ij} occupied by trees of species i in the altitudinal belt j was determined as follows:

$$S_{ij} = \sum_{k=1}^{k=n_j} p_{ijk} S_{jk} \qquad (1)$$

where i is the index characterizing the tree species (i=1,…m); j is the index of the altitudinal belt; k is the number of the plot within the j^{th} altitudinal belt; p_{ijk} is the percentage of the trees of species i on plot k of altitudinal belt j; and S_{jk} is the area of the k^{th} plot within the j^{th} altitudinal belt.

Ecotone boundary model

We take two plant communities, I and II, located at heights between H_0 and H_1. These communities will be characterized by the fraction $q_a(H)$ of the area occupied by the major species, *A*, of community I at height *H* and the fraction $q_b(H)$ of the area occupied by the major species, *B*, of community II at height *H*. If only two species, *A* and *B*, occur at all heights, $q_a(H) + q_b(H) \equiv 1$ for any height *H* along transects. The ecotone is an extended ecological entity if the following condition holds for the relative frequency of occurrence $q_a(H)$ of species *A*:

$$q_a(T) = \begin{cases} q_1, & H_0 \le H < H_{c1} \\ q(H), & H_{c1} \le H \le H_{c2} \\ q_2, & H_{c2} < H \le H_1 \end{cases} \qquad (2)$$

where q_1=1 is the relative frequency of occurrence of species *A* in community I at heights between H_0 and H_{c1}, q_2 = 0 is the relative frequency of occurrence of species *A* in community II at heights above H_{c2}, and $0 < q(H) < 1$ is the relative frequency of occurrence of species *A* in the ecotone zone located between two critical heights, H_{c1} and H_{c2}.

The critical heights, H_{c1} and H_{c2}, at which the ecotone is created are determined by the particular species composition of plant communities and physiological properties of the major plant species. If $q_a(H) + q_b(H) < 1$ for any values of *H*, there are not only *A* and *B* but also other species in the communities. The total abundance $s(H) = 1 - q_a(H) - q_b(H)$ of these species may also change with the height along the ecotone.

We assume that in the model ecotone, the species structures of the neighboring plant communities have reached stability after a more or less long transition stage, and, thus, time as a model variable need not be taken into account. This assumption is quite realistic in the case when changes in the species composition occur at a slow rate; moreover, it makes the model substantially simpler.

By using the approach proposed by L. Landau (Landau and Lifshitz 1980), we assume that potential *G* may depend on the value of the order parameter, *q*, and function *G(q)* can be expanded into the Taylor series for even powers of *q*. The stable states of the ecosystem will correspond to the minima of function *G(q)*, and the height, *H*, which is closely related to the annual average temperature of the air, *T*, decreasing, on average, by 5°C with every kilometer upwards, will be used as the external regulating factor that causes changes in *q*. Then, using Landau's model to describe the change in the tree species composition in the mountain forest communities with height, we can write

$$G(q) = G_0 + a(H - H_c)q^2 + bq^4 \qquad (3)$$

where *a*, *b* are constants, H_c is the critical value of *H* on the transect, at which the species composition begins to change.

Stable states of the plant community will be characterized by the minima of function *G(q)*, which can be found by using standard conditions $\frac{\partial G}{\partial q} = 0$ and $\frac{\partial^2 G}{\partial q^2} > 0$:

$$\frac{\partial G}{\partial q} = 2a(H - H_c)q + 4bq^3 = 0 \qquad (4)$$

From (4) we obtain:

$$q^2 = \begin{cases} 0, H > H_c \\ \frac{a}{2b}(H_c - H), H \le H_c \end{cases} \qquad (5)$$

Let us first examine the transition between the mountain forest and the mountain meadow. In this case, the order parameter *q* ($0 \le q \le 1$) will be defined as the fraction of the area occupied by forest vegetation at height *H*. As can be seen from Table 1, the upper boundaries of the conifer – mountain meadow ecotones were located at nearly the same heights on the north- and south-facing transects. The transition from the forest belt to the mountain meadow may be caused by the temperature decrease with height and the impairment of the growing conditions for all tree species. The gradual ousting of coniferous trees by hardwood species may characterize the interactions between these two groups, additionally modulated by the environmental factors.

Table 1. Characteristics of the forest – meadow and the hardwood – conifer ecotones*

Slope	Critical heights*	Ecotone	
		hardwood - conifer	conifer - meadow
South-facing	LB	420	1157
	UB	600	1610
	ΔH	180	453
North-facing	LB	308	1380
	UB	694	1627
	ΔH	386	247

*LB – the lower boundary of the ecotone, m a.s.l.; UB – the upper boundary of the ecotone, m a.s.l.; ΔH – the vertical extent of the ecotone, m.

Climate factors in the model

A number of different approaches can be used to describe the influence of climate factors on the position and extent of ecotones using the model of second-order phase transitions. One approach is to renormalize the relationship between temperature *T* and height *H*. Under current conditions, this relationship is described by equation $T = T_0 + kH$, but under climate change (e.g., warming), this relationship will be expressed by equation $T = T_0 + kH + T_{add}$. Then, according to model (7 a), the boundaries of all ecotones will be shifted upwards, i.e. both the upper and the lower boundaries of the conifer – mountain meadow ecotone must be located higher on the south-facing transect. This conclusion, however, is not consistent with the data in Table 1, showing that the upper boundaries of the conifer – mountain meadow ecotone are located at similar heights on the north- and south-facing transects, while the lower boundary of this ecotone is almost 200 m higher on the north-facing transect.

Another approach to describing the influence of climate changes on the position and extent of the ecotone on the mountains is to treat rather small temperature shifts as an additional "field", *h*, influencing the particular plant community. Then, equation (3) can be written as follows:

$$G(q) = G_0 + a(H - H_c)q^2 + bq^4 - qh \qquad (6)$$

The stable state of the plant community for model (6) will be also characterized by the minimum of function *G(q)*:

$$\frac{\partial G}{\partial q} = 2a(H - H_c)q + 4bq^3 - h = 0 \qquad (7)$$

It would be very interesting to estimate the likelihood of the shift of the conifer – mountain meadow boundary under climate warming. If an additional temperature field, *h*, is small, in the region where $H > H_c$ and $q \to 0$ (i.e. above the upper boundary of the conifer –

mountain meadow ecotone), in model (7), ignoring term q^3, we obtain $q \cong \frac{h}{2a(H_c - H)} > 0$. In this case, we should expect the upper boundary of the conifer – meadow ecotone to shift upwards. The higher the value of h and the lower the value of coefficient a, the more the boundary of the conifer – mountain meadow ecotone will rise.

In the region where $H < H_c$, we can roughly write

$$q \approx \left(\frac{a}{2b}(H_c - H) \right)^{1/2} + \frac{h}{4a(H_c - H)} \qquad (8)$$

The first term in (8) is the value of the order parameter if there is no additional field. The second term in (8) depends on the value of the additional field, coefficient a, and the difference $(H_c - H)$. The greater the values of a and $(H_c - H)$, the less the order parameter will be different from its value in the absence of the additional field. Thus, for the conifer – meadow phase transition, according to model (8), the lower boundary of the ecotone should not be expected to shift upwards over a considerable distance due to the influence of the additional field.

To describe the effect of changes in the temperature on the order parameter, which reflects the frequency of occurrence of the particular tree species, one can introduce the susceptibility function, $\chi = \frac{\partial q}{\partial h}$. The greater the value of the susceptibility function, the greater the change in the plant species composition under temperature change. If, however, $\chi \to 0$, the temperature does not influence the plant species composition. The susceptibility function can be written by differentiating (8):

$$\chi = \frac{\partial q}{\partial h} = \frac{1}{4a(H - H_c)} \qquad (9)$$

If $|H >> H_c|$, then $\frac{\partial q}{\partial h} \to 0$, and the effect of the additional temperature field on vegetation will be insignificant.

Thus, an increase in the temperature under possible climate change will primarily influence the position of the upper boundary of the conifer – mountain meadow ecotone and may cause the ecotone to expand.

Conclusions

Height-dependent changes in the species composition of forest communities can be described by the model of ecological second-order phase transitions. According to this model, there must be a critical height, H_r, from which upwards, the squared relative frequency of

occurrence of a particular species, $q^2(H)$, and the height, H, of its habitat will be linearly related. Analysis of the forest inventory data for the Sayan Mountains (the south of Middle Siberia) showed that the inventory data on the distribution of different tree species along the height transects were in good agreement with the model proposed in this study. By using the model of second-order phase transitions, we calculated the critical heights for different altitudinal belts of vegetation, determined the boundaries and lengths of the ecotones between different vegetation belts, and found the differences in the critical heights of the ecotones between the south- and north-facing transects. A supplementary model was proposed to describe the shifts of ecotone boundaries due to climate changes. The approach proposed in this study can be used to determine the boundaries between plant communities, to estimate the sizes of the ecotones between the neighboring communities, and to analyze the shifts in the positions of the communities.

The study was funded by RFBR and Russian Geographical Society according to the research project № 17-05-41012.

Keywords: Ecotone, boundaries of ecotones, mountain forest ecosystems, biodiversity.

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BACK

LONG-TERM MONITORING OF ENERGY AND GAS EXCHANGE ABOVE A MONSOON TROPICAL FOREST

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Seasonal tropical forests, especially of Southeast Asia, are less studied than rainforests. Meanwhile, seasonal forests have contrasting moisture conditions throughout a year allowing one to compare forest functioning during wet and dry seasons.

The energy, water vapour, and CO_2 exchange between a tall lowland mixed semi-evergreen tropical forest of Đồng Nai biosphere reserve (11°27'N, 107°24'E), Southern Vietnam, and the atmosphere was monitored during 2012-2017. The collected long-term data with 30-min timestamp covered wide range of climatic conditions due to included El Niño-La Niña episodes. The gas exchange using eddy covariance technique (FLUXNET methodology), as well as main meteorological parameters, were measured from a 50-m tall scaffold tower in the undisturbed homogenous forest massive.

Both radiation balance and global radiation of the given forest were ones of the highest among 20 eddy covariance sites in tropical forests, but a few seasonal forests like La Selva, Costa Rica. The radiation balance was 6 % higher in a wet season. The possible reason is shift of cloudiness and precipitation peak in Đồng Nai to the evening and night-time. The albedo varied from 10.6 (rainy months) to 12.2 % (driest months), while in some undisturbed rainforests the lower value of 6-8 % was observed.

The annual total evapotranspiration in Đồng Nai was 1510±80 mm, i.e. close to the mean for rainforests, despite a dry season of 3.5 months-lengh. Evapotranspiration was closely related to incoming radiation, except only few driest months of a year.

The net ecosystem exchange of CO_2 in all months except the hottest ones was negative, i.e. the forest was net sink of CO_2 from the atmosphere amounting to -400±140 g C m^{-2} a^{-1}.

The intensive drought with temperature reaching +40 °C under the forest canopy during El Niño event of 2015-2016 has a strong impact on the structure of the energy and gas fluxes.

Overall, the seasonal courses of the fluxes in the monsoon seasonally-dry forest was found to be comparable to the exchange fluxes in tropical rainforest world-wide.

This study was funded by Russian Foundation for Basic Research – Russian Geographical Society Project №17-05-41127.

Keywords: energy exchange, evapotranspiration, net ecosystem exchange, eddy covariance, tropical monsoon forest.

BACK

IMPACT OF SOIL DROUGHTS ON CO_2 FLUXES FROM GRASSY AND BARE PLOTS

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According to predictions based on global warming, the likelihood of heat waves, droughts, and flooding events will increase for the 21st century. Under some scenarios, regional climate projections show the amplification of aridity over most of European Russia and South Europe, Asian and Northern American countries. The repeatability of soil droughts in these regions will increase due to the air temperature rise and the decline in soil moisture during spring and summer. This study was aimed to assess the effect of droughts of different intensity on CO_2 fluxes from grassy and bare plots.

The impact of soil droughts on CO_2 emission from gray forest soil (*Luvic Phaeozems*) under grass vegetation and bare fallow was studied in a field simulation experiment (Pushchino, Moscow region; 54º20'N, 37º37'E) through the summer-autumn period of 2015. Under roof area allowing to prevent atmospheric precipitation, we simulated two short soil droughts (53 and 34 days) and a long one (94 days). A sample with regular moistening where soil moisture was maintained at a level corresponding to 60-70% of their water holding capacity was used as a reference. A significant decrease (by 1.8 times) in total CO_2 emission from soils over the whole observation period (June-August 2015) as a result of a moisture deficit was revealed only for grass plots under prolonged drought. A sharp increase in the intensity of soil respiration for the first hours after irrigation of dry soils (or the Birch effect) was observed. It comprised 84-104% and 114-133% for grass and bare soils, respectively. Due to this phenomenon, the total CO_2 emission from soils subjected to two short droughts was equal to the total soil CO_2 flux under regular moistening for the grass plots and exceeded it by 1.3 times for bare plots. However, the share of extra CO_2 flux induced by moistening of dry soils was not high and did not exceed 8-10% of the total CO_2 emissions over the whole observation period.

The study was supported by the Program of Presidium of RAS # 51.

Keywords: simulation experiment, soil respiration, Birch effect, hydrothermal regime of soils.

BACK

THE GEOGRAPHICAL STUDY ON THE LAND SURFACE TEMPERATURE CHANGES OF HUMAN ACTIVITIES IN YANGON CITY (1996, 2006 AND 2015)

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Yangon City is old capital, densely populated and rapid urbanization area of Myanmar. This study was investigated human impact of urban environment characterization on surface temperature changes of Yangon City. Moreover, the intension of this study is to analyze with demonstration and verify the spatial distribution property of the LST with urban spatial information related with Normalized Difference Vegetation Index (NDVI) using the Remote Sensing (RS) data and Geographic Information System (GIS). The main data was six Landsat images selected the images of less than 10 percent cloud cover condition for the summer and winter seasons and downloaded the required images. The single channel method and spatial statistical method were applied to process for LST variation. The study revealed that the LST was increased 1.43 ºC from 1996 to 2006 and added again 1.46 ºC between 2006 and 2015. The scatter plots results based on the 1909 (for summer) and 1759 (for winter) sample points for summer and winter gave the negative correlation with LST and NDVI in summer and winter that (-0.726) and (-0.727) for 1996, (-0.822) and (-0.756) for 2006, and (-0.845) and (-0.813) for 2015 with respectively. Zonal statistical analysis pointed out that the mean LST of downtown was warmer than suburban areas. The 95 % confidence levels of specific hot spot area lied at the downtown and with closely townships of suburban 1. Moreover, the Auselin Local Morans I statistical analysis proved that HH (High-High) cluster situation LST of human activities were taken place at the downtown and surrounding townships.

Keywords: Yangon City, Land Surface Temperature (LST), human activities.

BACK

MATHEMATICAL MODELLING OF NET ECOSYSTEM EXCHANGE IN WEST SIBERIAN PEATLANDS

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The model of net ecosystem exchange was used to study the influence of different environmental factors and to calculate daily and growing season carbon budget for oligotrophic bog at Taiga Zone of West Siberia, Russia. The model uses air and soil temperature, incoming photosynthetically active radiation, and leaf area index as the explanatory factors for gross primary production, heterotrophic and autotrophic respiration. The model coefficients were calibrated using data collected by automated soil CO2 flux system with clear long-term chamber. Observation sites were located at ridge and hollow at ridge-hollow complex, open sedge-sphagnum fen and pine-shrub-sphagnum community. The studied ecosystems are a sink of carbon according to modelling and observation results.

The reported study was funded by RFBR according to the research projects 16-07-01205 and 16-45-700562.

Keywords: Peatlands ecosystems, carbon balance, net ecosystem exchange, West Siberia.

BACK

DROUGHTS IN THE TERRITORY OF SOUTH SIBERIA: COMPARISON OF SOME QUANTITATIVE INDICES

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In the context of ongoing climate change, the monitoring of extreme natural and climatic events, including droughts, is actual. Various hydrothermal indices are used for the quantitative evaluation of droughts. The paper compares the most well-known quantitative indicators of the aridity: the Selyaninov hydrothermal coefficient (HTC), the Ped` aridity index (S), the standardized precipitation index (SPI) and the standardized precipitation and evaporation index (SPEI). The study area is South Siberia (50-65°N, 60-120°E). The analysis was carried out using the web-GIS "CLIMATE". The daily reanalysis data of ERA-Interim (0.75 × 0.75°) were used. This data were corrected according to data of weather stations for May-September from 1979 to 2017 years.

The highest coefficients of linear correlation (r) were obtained by comparing the indices SPI and SPEI (0.8-0.9), S and HTC (0.7-0.9) during the active vegetation period (July-August). In the other cases, the relationship between the aridity indices is statistically insignificant (r = ± 0.2) over most of the territory. Distribution of the number of strong and extreme droughts over the period according to SPI and SPEI indices is the same. Frequency of strong droughts is maximal in July and August (2-3 droughts per period). Centers with maximum frequency (up to 5 droughts per period) were detected in May and August. According to the analysis of S index, the highest frequency of strong droughts (up to 4) is also in July and August. But, unlike SPI and SPEI data, it is recorded only in the Sayan Mountains region. According to the results of the HTC index analysis, summer months (June-August) are most droughty, with a uniform distribution of the frequency of droughts over the territory (2-3 droughts per period).

The work was supported by the program of the Presidium of the RAS №51.

Keywords: drought indices, climatic extremes, Southern Siberia.

BACK

LANDSCAPE SUCCESSIONS IN THE ZONES OF DEBRIS FLOW ACTIVITY IN THE NORTHERN CAUCASUS

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The end of the XX century and the beginning of the XXI century are distinguished by large and disastrous debris flows including catastrophic events of 2017 in the Caucasus Mountains of Russia as a result of modern contrast climatic conditions and anthropogenic activity. These events became a good basis for study landscape successions as a kind of landscape dynamics in the zones of debris flow release. Repeated field observations on the model plots, interpretation of remote sensing data (TERRA, LANDSAT, World View-1), landscape mapping, phytoindication including lichenometry, phytocoenology and dendrochronology were used during the study. The ergodic and functional-dynamic approaches we also used in the investigations. The debris flow fans of different age and geosystems without debris flow release were chosen as the main model sites. Several types of landscape patterns were distinguished in the zone of debris flow impact according to their activity. Four main landscape succession stages (initial, formation, quasi-stable and destruction) with different vertical structure and time of existing were outlined in the study area. Some common and individual features of plant and soil formation with particular attention to the initiation stage on the debris flow deposits in the forest and steppe belts on different altitudes in various river valleys of the Central and Western Caucasus were revealed. Typical and specific species of plants of different ecological groups were determined for the stages of succession in the various altitudinal belts and river basins as indicators of these stages. The character and velocity of landscape succession depended on the type and volume of debris flows, their frequency, internal features of the affected landscapes, effect of other nature processers (snow avalanches and etc.) and anthropogenic activity. The high degree of geosystems in initial and second succession stages within the study area indicated the activity of debris flows. Special large-scale maps of landscape dynamics under effect of debris flows were compiled for the model regions.

Keywords: debris flow activity, landscape succession, Northern Caucasus.

BACK

MODELING THE POTENTIAL CHANGE OF FOREST FRAGMENTATION IN THE GARHWAL HIMALAYA OF INDIA

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This study aimed to model potential change of forest fragmentation in the Rudraprayag district of Uttarakhand state, situated in the Garhwal Himalaya of India. For this purpose, site-specific physical, and anthropogenic forest fragmentation conditioning factors were chosen. To obtain a final forest fragmentation probability map, patch forest that are completely degraded forests were considered as an evidence to apply weight-of-evidence model. The result of the weighted contrast value showed that the forest fragmentation probability was primarily observed near built-up area (less than 500 m), agriculture land (less than 500 m), roads (less than 1000 m), and streams (less than 500 m) with very gentle and gentle slopes (less than 25 degree) at the lower to middle altitude zone (less than 2000 m). The results also showed that the role of higher altitude zone (more than 2000 m) is less significant, and that factors such as distance to roads, distance to agriculture land, distance to built-up area and slopes are more important in this study area. The analysis of the forest fragmentation probability suggested that the area would experience more forest fragmentation in the future. The integrated methodology involving weight-of-evidence model, forest fragmentation approach and remote sensing and GIS techniques has proved useful in analyzing potential change of forest fragmentation and identifying its causative factors. Thus, the methodology adopted in this study can best be utilized for effective planning and management of forest ecosystem.

Keywords: Garhwal Himalaya, Forest fragmentation, Weight-of-evidence model, and GIS.

BACK

CLIMATE CHANGE IN RUSSIA OVER THE LAST DECADES: MAJOR TENDENCIES AND PECULARITIES

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Russia on average warms roughly as twice as the Globe since 1970s. This overall warming tendency is accompanied by strong regional peculiarities and intense temporal variations. Significant changes in temperature regime and hydrological cycle are linked to regional and large-scale atmospheric circulation processes and strongly affected by the neighboring Arctic that rapidly warms and loses sea ice cover. A number of unprecedented extremes in Russia in the recent years raise a question of their links to the ongoing warming and related processes.

Here, we present the analysis of the temperature, precipitation, snow cover and atmospheric circulation characteristic changes over Russia since 1970s until present based on Russian meteorological station network, gridded data archives and reanalyses. Changes of the annual and seasonal means, annual cycle parameters, daily temperature and precipitation characteristics, inter-annual and intra-monthly variability are considered. Tendencies in frequency and intensity of temperature and precipitation extremes are analysed. Links to atmospheric circulation, major natural climate variability modes as well as revealed data uncertainties are discussed.

Keywords: Climate change, Russia, extreme events, temperature, precipitation, snow cover.

BACK

SPATIAL STRUCTURE OF THE REGIONAL CLIMATE IN THE CONTEXT OF BIOLOGICAL PRODUCTIVITY AND TERRITORIAL PLANNING

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Under the climate it is usually understood the values of the variables that characterize it (mean monthly and annual average temperature, monthly and yearly precipitation, air humidity, wind speed and cloudiness) summarized for a period of thirty to fifty years. To this, it is obviously useful to add the value of the trend or the variance of these variables over the same period. At present time, both science and practice generally perceive both the climate and the weather on a small scale that corresponds to the scale of the map more than 1: 10,000,000. At the same time, it is obvious that this macro-climatic perception is substantially modified at the level of the mesoclimate corresponding to the scale from 1: 100 000 to 1: 10 000 000. In fact, it is the mesoclimate that has the greatest practical significance for all spheres of human activity above zonal level of differentiation. Territorially this level corresponds to the landscape in the understanding of the Russian landscape school. Apparently, the mesoclimate basically determines the variation in the biological productivity of the biosphere. It is this level of spatial variation of climatic variables that is displayed in the Worldclim project, as well as in the thermal channel of the MODIS satellite. This level is widely used in modeling the spread of individual plant and animal species. The proposed message shows one of the possible approaches based on data dimensionality reduction techniques and spectral analisis to explore the spatial structure and hierarchical organization of the mesoclimate of a specific region and creating a compact basis for planning its use as a supporting ecosystem service based on the WORDCLIM 1.4 database with a resolution of 1 km on the terrain. The supporting ecosystem service is decomposed into hierarchical levels, each of which can have a specific impact on the functioning of the landscape cover and, first of all, on biological productivity and soil-forming processes. The considered approach is realized on an example of the Samara region, as the important manufacturer of agricultural production.

Keywords: statistical analysis, hierarchy, climate, agriculture, biological production

BACK

EVELOPMENT OF A FLOATING *SPHAGNUM*-DOMINATED PEAT MAT IN A KARST POND: PALEOECOLOGICAL RECONSTRUCTION

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Terrestrialization is a process of peatland formation when peat develops on the margins of aquatic ecosystems with the subsequent expansion of floating vegetation mats over open water. The relative contribution of autogenic and allogenic drives to this process is not completely understood. We used a suite of palaeoecological analyses at Kartovoe mire (Mordovia, Russia) to reconstruct the formation of a floating *Sphagnum*-dominated peat mat over the karst pond. The results show that the basal layers of the peat mat were formed in the central part of the mire by ca. 1600 AD. Remains of *Scirpus* sp. and *Calamagostris* sp. in the basal layers indicate that these plants could form a framework on which *Sphagnum* mosses and sedges were established. The terrestrialization could be triggered by the Medieval Warm Period (950-1250 AD) as droughts reduce water levels and allow pioneering plants to colonise exposed bottom sediments on the margins. During the Little Ice Age (1400-1700 AD) the development of the peat mat was determined by climatic factors which reduced peat accumulation rates due to low temperatures slowing down the primary production of peat-forming vegetation. After that the floating peat mat was characterized by intensive peat accumulation which resulted in continuous reduction of surface wetness. These processes coincided with the increased human activity in area so that autogenic and allogenic effects were difficult to disentangle. At the beginning of the 20th century the fen transformed to raised mire. Our results show complex and context-dependent effect of autogenic and allogenic factors on the development of floating peat mats.

This study was supported by the Russian Science Foundation (project 16-17-10045).

Keywords: terrestrialization, mire, Mordovia, mixed forest.

BACK

MODELING APPROACH TO RECONSTRUCT THE POTENTIAL AND ACTUAL EVAPORATION OF FORESTED LANDSCAPES FROM PALAEOECOLOGICAL DATA

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To describe the main drivers of vegetation and land-use changes in the past epochs the precise information about surface temperature and moisture conditions is obviously required. Numerous palaeoecological studies are usually based on information about air temperature (annual, summer and winter) and precipitation that is taken by different methods from multi-proxy records. The annual precipitation in the case is used to characterize the surface moisture conditions. Effect of surface evapotranspiration on surface wetness in this case is usually ignored but it can be crucial in e.g. in regions with moderately wet or semi-arid regions.

Suggested model algorithms for calculation of potential and actual evaporation rates are based on the Priestley-Taylor equation (Priestley, Taylor, 1972) for potential evaporation, and Brutsaert-Stricker equation (Brutsaert, Stricker, 1976) for actual evaporation. As key parameters for calculation of evaporation rate the modeled data about net radiation, as well as the data about air temperature and humidity are used. For calculations of surface net radiation we use information about geographical location of the area, forest cover and species composition.

This study was supported by a grant from the Russian Science Foundation (14-14-00956).

Keywords: potential evaporation, actual evaporation, forest landscape, palaeoecological data .

BACK

SURFACE DYNAMICS AND PROPERTIES OF THE OLIGOTROPHIC BOG

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Oligotrophic bogs regulate the water regime of the surrounding areas, provide a carbon uptake from the atmosphere, are natural reserves of specific fauna and flora, etc. Specificity of the oligotrophic bogs is their autonomy, and the water mass transfer. Since the leading structure-forming processes are hydrological processes, they must be reflected in the dynamics of the surface, in the structure of the landscapes and drainage system of the upland bog. The definition of these characteristics of the swamp development is interesting for forecasting the growth of bogs, for example, in bogs overgrowing, for paleogeographic reconstructions, it is important suppression of forest fires, organization of land use, reserves, etc.

Oligotrophic bog "Staroselsky moss" (Central Forest Reserve, Tver Region) was studied in detail along a transect length of about 600 m latitudinal direction. The leveling of the profile showed a convex surface character, and modeling based on the Darcy equation on average hydroclimatic conditions showed that the surface profile slightly deviates from the normal gently convex shape. This corresponds to the age of the swamp by radiocarbon dating over 9000 years. Once for a number of years and half-mode geodetic measurements on a stationary network of rails showed the presence of significant changes in the level of the surface of the bog - the differences in vertical motion in its parts reach an amplitude of up to 40 cm in the western part of the transect, 20 cm in the central and less than 10 cm in its eastern part. Precision tachometric measurements also revealed horizontal displacements of the surface of the swamp. Georadar sounding in the upper part of the peat profile revealed an aquifer layer with a thickness of 45-60 cm to a depth of 75-105 cm, which is wedged to the surface in the western part of the bog in the stream. The existence of this horizon, confirmed by drilling data, ensures the subsurface run-off into the drainage network, and also causes the vertical dynamics of the surface of the swamp. Spreading water resulted in a spatial distribution of the chemical composition of the bog waters: the minimum pH, the electrical conductivity, K^{+}, Ca^{+2}, Mg^{+2}, and also Cu, Fe, and Mn is observed in the region of the most intensive spreading of bog waters.

Keywords: oligotrophic swamp, surface shape and dynamics, migration of elements.

BACK

BACK

ENERGY AND CO2 FLUXES OVER UNDISTURBED MATURE SPRUCE FOREST AND CLEAR-CUT IN WEST PART OF RUSSIA

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Clear-cutting and other forest disturbances substantially change natural biogeochemical and biogeophysical cycles and can influence climate conditions at local to global scales. How these forest disturbances will influence the ecosystem-atmosphere exchange has not yet been sufficiently investigated and requires aggregated experimental and modeling studies. Here we report novel results of eddy covariance flux measurements at two forest sites: an undisturbed mature spruce forest and a recently clear-cut area during the first growing season following harvest. We detected a strong influence of the clear-cut on energy balance components and CO_2 fluxes between forest ecosystems and the atmosphere. The latent (LE) and sensible (H) heat fluxes at the undisturbed forest site were predominantly larger of clear-cut fluxes over the entire measuring period. The Bowen ratio (β) for both sites varied significantly over time. When averaged for the entire measuring period, the mean β values of the two sites were similar ($\beta \approx$ 0.5 for both sites). By CO_2 flux analysis, we found that the clear-cut site was a permanent source of CO_2 for the atmosphere (net ecosystem exchange (*NEE*) 3.3 ± 1.3 $gC \cdot m^{-2} \cdot d^{-1}$), while the *NEE* of the mature undisturbed forest was close to zero (*NEE* 0.1 ± 1.9 $gC \cdot m^{-2} \cdot d^{-1}$). We detected substantial differences in gross primary production (*GPP*) between the sites (7.0 ± 4.1 $gC \cdot m^{-2} \cdot d^{-1}$ and 4.1 ± 3.0 $gC \cdot m^{-2} \cdot d^{-1}$ for the mature forest and clear-cut site respectively), whereas ecosystem respiration (*RE*) did not differ significantly (7.1 ± 3.6 $gC \cdot m^{-2} \cdot d^{-1}$ in the mature forest and 7.4 ± 3.4 $gC \cdot m^{-2} \cdot d^{-1}$ in the clear-cut). The clear-cut site of the southern taiga is distinguished by relatively high carbon dioxide fluxes over boreal clear-cut sites where carbon dioxide fluxes have been reported.

This study was supported by a grant from the Russian Science Foundation (14-14-00956-П).

Keywords: CO2 fluxes, sensible heat flux, latent heat flux, eddy covariance, clear-cut, southern taiga.

BACK

COLD-SEASON CO_2 EFFLUX FROM SOILS UNDER TEMPERATE CONTINENTAL CLIMATE: EFFECT OF SNOWPACK PATTERN

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Due to current climate changes, the snow cover period in many Russian regions has become shorter because of the later onset of snowpack formation and earlier start of snow cover loss. However, the seasonal snowpack plays an important role in the ecosystem-atmosphere CO_2 exchange, especially in temperate continental regions, preventing frost penetration into the soil and thus impacting the CO_2 efflux from soils. This study focuses mainly on the estimation of cold-season CO_2 effluxes from soils at different snow cover depths under the temperate continental climate. An experiment with regulated snow cover was established on grassland and bare soil *Haplic Luvisols* (in the Moscow region). For each land cover type, the following winter scenarios were applied: (1) *reference plot*, designated *"**Ref**"*, with natural depth of snowpack, (2) *no-frost*, *"**NoFr**"* (simulation of snow addition using artificial heat insulation material), and (3) *no-snow*, *"**NoSn**"* (removal of snowpack). The reduction of snow cover depth accompanied by the frost penetration into the soil was shown to decrease the cold-season CO_2 effluxes from soil by 1.7 – 2.5 times in comparison with unfrozen soil. During the cold season, there were four thaw events, which induced CO_2 efflux pulses of varying intensity. The highest peaks of CO_2 efflux (up to a 26-fold increase compared to the pre-thawing period) were revealed during the early spring thaw. These pulses in CO_2 effluxes during early spring contributed between 43 % and 70 % to the total cold-season CO_2 effluxes from frozen soils ('Ref" and "NoSn" variants) while the contribution of spring fluxes from unfrozen soils ("NoFr" treatment) was about 22 – 23 %. Grass cover provided both a later winter freezing and delay of spring thawing of soils. Our findings produce evidence that warm and dry winter of 2014-2015 in the temperate continental region is followed by disturbances of the seasonal snowpack, frequent thawing events, prolongation of the period when soils remain frozen that result in the cooling of soils and significant reduction of the cold-season soil CO_2 effluxes.

The study was supported by the Program of Presidium of RAS # 51.

Keywords: climate trends; grass and bare soils, freezing-thawing, simulation experiment.

BACK

POSTER

KEY POINTS SELECTION FOR PLANTS PROTECTED SPECIES OF "BOGDINSKO BOSKUNCHAKSKY" STATE NATURE RESERVE STATUS MONITORING WITH REMOTE SENSING DATA USAGE

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Application possibilities of Earth remote sensing data when choosing points of Bogdinsko-Baskunchaksky reserve vegetation cover monitoring are described in this article. Index NDVI application is described to define vegetation cover seasonal dynamics. Plots with more sustainable vegetation between seasons are defined. Obtained results are compared to reserve employees observation results to define plots with the highest protected species conglomeration.

Specially protected natural reservation (SPNR) creation and maintenance chains is one of the strategy key parts of biodiversity preservation. The main condition of their functioning maintenance is information richness. One of the data compilation optimization methods about SPNR territory is remote data sensing (ERS) usage. On a modern stage ERS are allowed to get and analyze wide information pattern, which includes data about vegetation, analysis of which Normalized Difference Vegetation Index (NDVI) can be used. (Kolotukhin, Rusakova, 2014).

NDVI is an indicator, which allows to define biomass phyto-synthesizer quantity on investigated territory. It is calculated through measuring the difference of reflected light intensity in visible range and infrared band divided into the sum of their intensities. The scale from 1 till -1is used for explanation, where 1 means the most plants quantity, and -1 means their full absence. Given index allows to monitor living biomass quantity, that is very important in the case of plants protected species monitoring in SPNR. (Kolotukhin, Barmin, Valov, Sintsov, 2016).

"Bogdinsko Baskunchaksky" state nature reserve was founded in 1997. It is situated in Astrakhan oblast Akhtubinsky district on the area of 18 478 hectares. There are great amount of unique natural objects on the reserve territory, which includes great amount of rare and

extinct species, also three species which are listed in Russian federation Red Book. (Kolotukhin, Barmin, Sintsov, 2017).

NDVI index dynamics with multi channel satellite Landsat 8 shots with combination on the basis of the fourth and fifth channels was revealed to define key reserve vegetation monitoring points. Obtained results are compared to vegetation monitoring results, which was carried out by reserve employees to define points where Red Book species of late tulip (*Tulipa schrenkii Regel*), comphrey crimson (*Delphinium puniceum Pall.*) and feather grass перистый (*Stipa pennata L. s.str. (S. joannis Celak.)* are met. The following results were obtained while analyzing gathered information. (table 1).

Table 1. “Bogdinsko Baskunchaksky” state nature reserve protected vegetation monitoring Points

№ of the testing site	Location	NDVI II decade of May	NDVI III decade of June	NDVI II decade of August	NDVI III of September	Red Book species
1	Bolshoe Bogdo west side-hill	0.7-1	0.5-0.6	(-0.1)-0.1	0.7-0.8	Late tulip (*Tulipa schrenkii Regel*); Comphrey crimson (*Delphinium puniceum Pall.*); Feather grass (*Stipa pennata L. s.str. (S. joannis Celak.)*
2	North karst field (west)	0.6-0.7	0-(-0.2)	0-0.3	0.4-0.8	Late tulip (*Tulipa schrenkii Regel*)
3	North karst field (east)	0.6-0.9	0-(-0.3)	0-(-0.3)	0.5-0.6	Late tulip (*Tulipa schrenkii Regel*); Comphrey crimson (*Delphinium puniceum Pall.*)
4	Gorkoe Lake	0.9	0.2-0.7	0-0.6	0.9-1	Late tulip (*Tulipa schrenkii Regel*)
6	Surikovskaya balka	0.6-1	0.3-0.8	0.2-0.7	0.8-1	Late tulip (*Tulipa schrenkii Regel*)
	Average	0.5	-0.1	-0.3	0.3	

Six key monitoring points were marked according to the investigation results. The points were chosen based on such criteria as plant cover seasonal stability and rare plant species

attendance. According to these results the most important for monitoring is Bolshoe Bogdo west side-hill plot which shows NDVI index excess in comparison with the other territory and stable seasonal dynamics, along with that all growing Red Book species are observed consistently on this plot.

Keywords: reserve, ERS (Earth remote sensing), NDVI, temperature regime, precipitations, seasonal dynamics.

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BACK

DROUGHT IN THE EAST EUROPEAN PLAIN ACCORDING TO HYDROMETEOROLOGICAL AND SATELLITE DATA

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In various studies the evidence was obtained that the Atlantic Ocean is the key driver of multidecadal variations of the European climate (Cherenkova 2017; Cherenkova and Semenov 2017; Robson et al. 2012; Semenov and Cherenkova 2018; Sutton and Hodson 2005; Sutton and Dong 2012). This study presents the spatio-temporal analysis of regional climate and spring and summer drought peculiarities in the East European Plain (EEP) during the periods of positive anomalies of North Atlantic sea surface temperature and positive phase of Atlantic Multidecadal Oscillation (AMO) (1926-1962 and 1995-2012) as compared with the period of its negative anomalies and negative phase of AMO (1963-1994). In spring the observed low frequency of cyclones centers over the study territory in comparison with norm is associated with drier climate when the North Atlantic Ocean was in the cold phase. The decrease of total precipitation in spring (the difference was on average 10%) in EEP was observed in the period 1963-1994 to the period 1995-2012. The largest reduction in total precipitation (25-30%) was found in the central and in the south-east of the East European Plain. The change of the North Atlantic warm phase to the cold phase is expected in the upcoming decades, what can result to the spring limits of water supply in the agricultural regions in the south of European Russia.

In contrast, in summer, the various drought indices, such as Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI) show the growth of severe meteorological drought frequency and increasing aridity of climate in the main grain regions of the European part of Russia during the periods of warm North Atlantic as compared with its cold period: in the Volga region (1-2 event / 10 years), in the Central Black Earth region and the Sea of Azov region (1 event / 10 years) (Figure 1). At the same time according to the Satellite Climatic Extremes Index (SCEI), based on the MODIS data of albedo, surface temperature and vegetation index (NDVI), the rise of drought frequency was observed in dry-

steppe and in the regions of semidesert pastures on the southeast of the European part of Russia in the period 2005–2014.

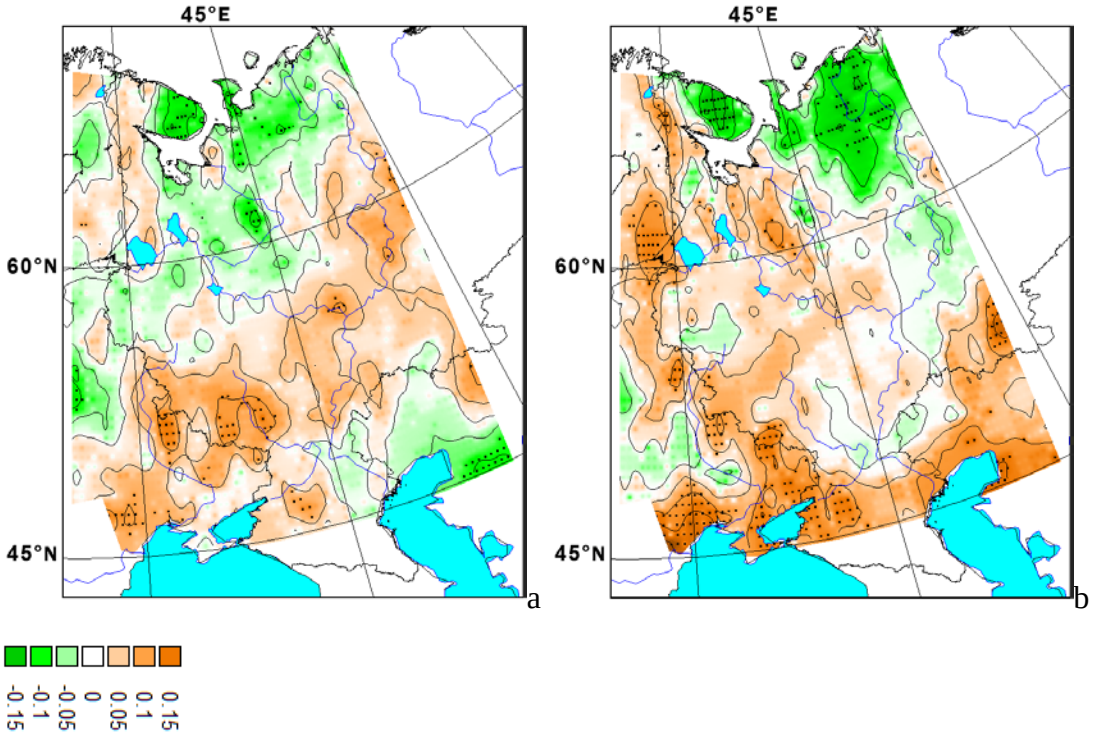

Fig. 1. Difference of severe drought frequency in the period of 1926-1962 (a) and 1995-2012 (b) compared with 1963-1994 according to the SPEI data.

Differences of the spring and summer climate in the opposite phases of AMO are explained by differences in circulation patterns. The results of analysis of the structure of the internal variability in the link between the ocean and atmosphere indicate the influence of the AMO on the atmospheric circulation in the Atlantic-European region. In spring, the AMO-related SST anomalies impact not only North Atlantic Oscillation, but also are associated with the fluctuation of a center of action over Scandinavia. The positive (negative) phase of AMO is characterized by the prevalence of negative (positive) values of NAO and Scand teleconnection indices. On the other hand, in summer, the positive (negative) phase of AMO is characterized by the predominance of negative (positive) values of NAO and EAWR indices. While the variability of NAO during the summer season is mainly related to the anomalies of regional circulation in Western Europe, EAWR is associated with a center of action located over European Russia, which can have a significant influence on regional climate in region.

This study was supported by the Russian Ministry of Education and Science, agreement № 14.616.21.0082 (RFMEFI61617X0082).

Keywords: drought, Standardized Precipitation Index, Standardized Precipitation Evapotranspiration Index, Atlantic Multidecadal Oscillation, teleconnection indices, East European Plain.

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BACK

CLIMATE CYCLIC CHANGE AS A FACTOR OF INTRAZONAL DELTOID LANDSCAPE DYNAMICS

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Climate changes are the most important factor which influences ecosystem functioning and defines main landscape dynamics profile. In recent decades, aridization process fortification is observed due to annual average temperature increase and atmospheric moistening decrease in many arid regions of the planet, consequences of which is severe cut of territories' biological productivity. Dynamic process study in alluvial plains and rivers deltas attracts great interest and high significance, as they are unique natural objects, which are characterized by complex system of landscape connections and high degree of different orientation anthropogenic impact.

Due to multi -year researches, it was revealed that hygrothermal phase of medium- term nature's cycle in the form of " bruckner" in the river Volga delta in 1978 to 2005 was observed, which is characterized by region's heat and moisture supply indices increase (especially in vegetative season), arid degree decrease (Selyaninov's hydrothermal index is increased from 0.33 in 1972 to 1981 till 0.46 in 1992 to 2001), the Caspian Sea flow-up and stabilization and intended economic charge decrease on the territory: irrigated plowland area severe cut and livestock, mowing peculiarities changes and hayland area decrease, hydrocarbon chemical contamination reduction, gamma-HCH, DDT, dichlorodiphenylethylene; however, synthetic surfactant contamination increase occurred, also contamination with phenol and sulphurous oxide, degree of recreational load rose; lowering of the Caspian Sea is occurred as a result of recreational load rise continuation from 2006 to 2016, also above mentioned chemical contamination growth, economic charge stabilization on the level at the beginning of 2002, caused by atmospheric precipitations amount reduction in vegetative season, spring-summer flooding volume reduction and upwelling level at temperature factor directional growth.

Arising changes of natural- anthropogenic conditions defined different directions of the river Volga delta landscape dynamics.

Keywords: aridization, river Volga delta, land cover dynamics, hydrometeorological changes, desert advancing.

BACK

CURRENT AND PROJECTED CHANGES IN WINTER EXTREME TEMPERATURES AND PRECIPITATION IN RUSSIA

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Spatio-temporal analysis of the frequency of extreme daily winter temperature and precipitation in the period 1970-2015 in Russia using the data of the weather stations and in the period 2041-2060 using the projections of global climate models HadGEM and MPI-M revealed statistically significant changes in densely populated regions of European Russia, in southern Siberia and in the Far East of Russia.

The statistically significant increase in the number of extremely warm days that did not exceed 1 day and the days with extremely high precipitation (by 1-3 days) prevailed in European Russia in the period 2000-2015 in comparison with 1970-1999. While frequency of extremely cold days reduced by 1 day at the most territories of Russia, a simultaneous combination of increased frequency of frosty days, extremely warm days and days with extreme precipitation in the winter at the beginning of the 21st century attracts attention in the south of Western and Eastern Siberia. At the same time, in the Far East of Russia in the same period there was a significant decrease in the frequency of extremely cold days; days with extreme amounts of precipitation started repeated more often.

According to HadGEM model projection (RCP 8.5 scenario), the extreme precipitation events in Russia may occur more often in the middle of the 21st century. The highest projected increase in the frequency of extreme daily precipitation is expected in the Altai and southeastern European Russia (by 2-3 days), in northern Siberia (4 days), in the Chukotski Peninsula (7 days). According to the MPI-M model projection (RCP 8.5 scenario), the highest increase in the frequency of days with extreme precipitation in the period 2041-2060 is expected in the center of European Russia (by 1 day) and in the Chukotski Peninsula (up to 3 days).

The research of the observed and projected extreme temperature and precipitation in Russia was supported by Russian Geographical Society and Russian Foundation for Basic Research (project no. 17-05-41085). The analysis of extreme precipitation at high-latitudes was supported by Russian Science Foundation (project no. 14-17-00647).

BACK

NET PRIMARY PRODUCTION OF FOREST STANDS: ESTIMATION BY "ECOSOLOW" MODEL

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Net primary production (NPP) is the integral value characterizing the efficiency of absorption of solar energy by plants in the process of photosynthesis for a certain period of time (month, year) over a certain area. NPP values are very important for understanding the mechanisms of production processes in plant ecosystems, monitoring and forecasts. In the present paper we have compared two approaches to the estimation of tree's NPP. Traditionally NPP estimated using the balance equations based on the measurement the aboveground parts of the tree (trunk, branches and leaves/needles). Authors have modified balance method and now we can calculate the root's phytomass for NPP's estimation.

In the second approach for estimating NPP we have used an economic model R.M. Solow (1956). In this case the photosynthetic processes are considered as an analogue of a production process. The authors suggest to consider a tree as a production system and this system consumes solar energy. The result of this activity is NPP. It is assumed that the production of tree's photosynthetic apparatus depends on the total biomass of a tree (capital) and on biomass of the photosynthetic apparatus (labor). To describe the tree's production function we have used the modified Cobb – Douglas's function. It is shown that the proposed approach to NPP's estimate with "ekoSolow" model can increase the accuracy of the calculations and reduce the amount of field data needed for the calculation.

The study was funded by RFBR according to the research project № 18-04-00119.

Keywords: Forest stands, biomass, net primary production.

BACK

EFFECT OF LARGE-SCALE ATMOSPHERIC CIRCULATION IN THE NORTH ATLANTIC SECTOR ON STATISTICS OF SYNOPTIC-SCALE VORTICES AND SURFACE TEMPERATURE OVER NORTH EURASIA

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Variations of principal circulation modes have significant effect on statistics of cyclones/anticyclones and blocking not only within domains of these modes, but also far downflow (and sometimes upflow). A comprehensive analysis based on the archive of cyclone and anticyclone tracks computed from baric fields of the NCEP/NCAR Reanalysis using author's identification method and several circulation indices reveals principal features of these effects. Large-scale circulation systems of the Atlantic sector, especially NAO and Scandinavian (SCA) modes are known to have a strong effect on surface temperature variations in North Eurasia, most pronounced in winter, late autumn and early spring. Particularly winter temperature over Russia demonstrates a strong oscillation of a period about 35 years with an amplitude of about 1.5-2°C superimposed with a global warming trend. This effect, at least partly, may be connected with a large displacement of anticyclonic blocking systems from the Urals –Western Siberia to European Russia between warm and cold phase of the mentioned oscillation. Associated temperature patterns are studied. The global warming trend is not geographically and seasonally uniform, and it occurs on the background of natural variations. Winter trend over Russia estimated directly from the time series of observations varies from 0.15°C/decade for 1976-2014 to 0.33°C /decade for 1976-2017, both insignificant at 5%. However, a simple statistical model that uses as regressors indices of NAO and SCA plus a piecewise-linear function of year equal to zero before 1976 and year thereafter (regression coefficient of this regressor is simply linear trend) separates contributions from natural variations and trend. It demonstrates that trend is close to the observed for the period 1976-2017 (when presumably a full cycle occurs) and highly significant.

Keywords: large-scale circulation, cyclone, anticyclone, blocking, climate variations.

BACK

THE FIRST RESULTS OF THE INDIVIDUAL TREE GROWTH ANALYSIS OF PINUS SYLVESTRIS IN VOLGA-KAMA NATURAL RESERVE

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The aim of the study is to analyze individual tree growth of Scots pine (*Pinus Sylvestris*) in two different cites of the forest – on the forest-edge and the forest-interior. The distance between sites is not more than 200 m. For each tree two radii were taken, the basal area increment and the tree height were measured. We built ring-width, early- and latewood chronologies for two cites. The length of the forest-edge chronology (RAPSE) goes up to 268 years and the length of the forest-interior chronology (RAPSI) is up to 252 years. To analyze the individual tree growth, we calculated basal area increment and ran principle component gradient analysis using R programming. There is a huge difference between tree growths on the forest-edge and the forest-interior. Analysis showed a few periods with changes of intensity and amplitude of tree growths for two sites: in first 100 years of wood production the tree growth on the forest-edge was much weaker than on the forest-interior and then the pattern changed to the opposite. This switches happened for three times and it could be explained by ecological (competition of species), physico-geographical reasons (different microclimatic and soil conditions, evapotranspiration etc.) or human impacts. Principal component gradient analysis of tree rings width, early- and latewood revealed distinct separation between two cites. That could be explained by the higher drought susceptibility of the edge compared to the interior.

Keywords: dendrochronology, tree rings, ring width, earlywood, latewood, forest-edge, forest-interior.

BACK

EFFECT OF ATMOSPHERIC CIRCULATION ON THE SCOTS PINE GROWTH IN SUB-TAIGA ECOSYSTEMS OF THE EAST EUROPEAN PLAIN

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Drastic divergences in tree growth from the average value are associated with temperature and precipitation anomalies determined by alterations in atmospheric circulation. An important indicator of circulation variability is the North Atlantic Oscillation (NAO) index. The aim of the present paper is to identify the modes of atmospheric circulation facilitating the formation of extremely narrow and broad annual rings of scots pine *(Pinus sylvestris)*.

The study area is situated in the southwest of the Meschera Lowlands (center of the East European Plain). It is covered with the mixed coniferous-deciduous forests. Pine core sampling was carried out in 2009-2016 in contrast topoecological conditions. Analysis of pointer years was used for studying the information contained in the single extreme annual tree rings. Analysis of pointer years is based on the annual comparison of tree growth and corresponding climatic conditions.

Positive (1953, 2004; in conditions of the 3rd terrace above the Oka river floodplain (dry sandy soils) – 1966; in wetlands – 1975) and negative (1964, 1965, 1967, 1976, 1995, 1996; in wetlands – 1966) pointer years have been identified, wherein the growth is correspondingly 1 standard deviation higher and lower than the average growth indices. The frequency of occurrence of pointer years in 1951-2009 was compared with the NAO index dynamics in December-March. The second half of 20th century and the beginning of the 21st century are related to the different NAO cycles: 1951-1970 are the ending of one 70 year cycle and 1971-2000 are the beginning and first half of the new 70 year cycle. It has been established that for pine growth in South Meschera the negative conditions are those which are provided by both extremely high (1993-1995) and extremely low (1996, 1960s) NAO values. The conditions of the years corresponding to the descending (1950s, 2000s) or ascending (1980s) branch of the 70-year NAO cycle are less extreme and significantly more favorable for the growth. At extremely high NAO values the mild wet winters provide conditions for over-

moisturization in wetlands and flat moist plains of Meschera. At extremely low NAO values the factors decreasing tree growth are winter frosts and acute deficiency of precipitation.

Keywords: tree rings, climate-growth relations, pointer years, North Atlantic Oscillation (NAO), *Pinus sylvestris*.

BACK

GLOBAL VEGETATION PRODUCTIVITY RESPONSES TO THE WEST PACIFIC WARM POOL

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Sea surface temperatures (SSTs) strongly influence atmospheric circulation and global climate change, which in turn significantly affects vegetation production. Most of the previous studies on the subject have focused on teleconnections between the El Niño-Southern Oscillation (ENSO) and vegetation production, but few studies have addressed SSTs or their effects on other regions of the Pacific Ocean. In this study, we use the highest SST value in the West Pacific Warm Pool (WPWP) to construct a climate index, known as the WPWP index (WPI), and subsequently, the impacts of the WPWP SSTs on global vegetation production are studied. We provide evidence for a robust link among the alternating warm and cool WPI pattern, terrestrial vegetation production and carbon balance. The analysis is based on both model simulations and satellite observations. The results of this study show that the warm and cool WPI phases have inverse effects on land surface temperature and precipitation. Thus, the warm and cool WPI phases have inverse effects on global vegetation production and the carbon balance.

BACK

A NEW APPROACH FOR EXTREME WINDS ESTIMATION APPLIED TO OBSERVATIONAL AND HIGH-RESOLUTION MODELLING DATA

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Previous analysis of wind speed maxima data on many Arctic stations for several decades revealed surprising features concerning the sample distribution, namely the data are belonging to two different statistical populations; each one is reliably described by own Weibull distribution parameters k and A (it were metaphorically called as ‘black swans’ and ‘dragons’ [Taleb, 2010; Sornette, 2009]). Since the ‘dragons’ distribution parameters are obeying to the fundamentally different statistical law, the statistic estimations based on standard parameters could underestimate extreme wind speeds significantly, including global atmospheric models (e.g., INM-CM4.0 [Kislov, Matveeva 2016]). Since extremes are belonging to diverse samples, the different underlying physical mechanisms of these extremes could be suggested. Besides, this difference need to be investigated using the mesoscale modelling.

Therefore, in this study we have applied the same approach according to many Russian Far East stations and, additionally, to the high-resolution model archive [Platonov et al., 2017]. It is the long-term (1985 – 2015) meteorological archive, with 13.2 spatial and 1-hour temporal resolution covering the Okhotsk Sea, Sakhalin Island and adjacent areas, obtained by regional climate simulation using the COSMO-CLM nonhydrostatic model.

Statistical analysis of observational data has revealed overwhelmingly the same features according to cold and warm seasons, as well coastal, as inland stations. Obtained Weibull distribution parameters were similar to the results cited above, e.g. wind speed thresholds for ‘dragons’ cases varies between 20 and 30 m/s on different stations.

Statistical analysis of high-resolution model data has shown contradictory results. On the one hand, the distribution pattern is very similar to the observational one, i.e. the sample is possible to be divided into two different populations, which refers to ability of the model to reproduce the statistical structure of wind maximum, and it is favorably different from the global model results. Moreover, the stations with greatest extremes among observations and

model are generally the same. In addition, model has reproduced the fact of general exceeding winter maximums over the summer ones.

On the other hand, wind speed thresholds and 0.99 quantiles are lower (12 – 22 m/s at most) the Weibull distribution parameters related to the ‘dragons’ sample differs significantly from the observational ones, i.e. the extremity of wind speed maximum would not well reproduced. Comparing of scatters between k and A Weibull parameters by observations and model data showed good match for ‘black swans’ and wide range for ‘dragons’.

Statistical analysis of the long-term model archive allowed to confirm the proposed approach based on the observations, and reproducibility of the ‘dragons’ extremes by the regional atmospheric model. However, model with a given resolution was not able to reproduce some essential parts of wind speed maximum’ statistical properties. Therefore, this gap could be covered as using higher resolution, as by areal estimation techniques and many others. These assumptions will be used as a basis for the further development of the study.

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ESTIMATING THE INFLUENCE OF FOREST COVER CHANGES ON THE REGIONAL WEATHER CONDITIONS

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Effects of deforestation and afforestation of a large area of the East-European plain on the spatial temperature and precipitation patterns as well as on the frequency of severe weather events, such as frosts, fogs, heavy rains, wind gusts, etc., were investigated by numerical experiments using the COSMO model with grid spacing of 6.6 km. For the numerical experiments the period of two years characterized by contrasting weather conditions was selected. Existence of the specified severe weather events was predicted on the basis of diagnostic ratios integrated within the COSMO-Ru model. The ICON global atmospheric reanalysis of the German Weather Service was used to quantify the initial and boundary model conditions. The TERRA model is used within COSMO to describe the land surface-atmosphere interactions.

Results of modeling experiments showed that the forest cover changes can result in significant changes of the temperature and precipitation patterns that are manifested differently in various seasons. Results of modeling experiments showed also a strong effect of forest cover changes on the frequency of severe weather events. Deforestation can lead to more frequent severe weather phenomena that are unfavorable for agriculture and any other economic activity (e.g. frosts, wind gusts) in the region. Influence of forest cover changes on fogs was ambiguous and dependent on time of days and regional synoptic processes.

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Keywords: deforestation, afforestation, regional weather conditions, COSMO model, numerical experiments.

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C16.08 Environment Evolution – Paleogeography: Learning Past for the Future

STUDY OF CYCLICITY IN THE EVOLUTION OF VEGETATION AND CLIMATE OF THE NEOPLEISTOCENE FOR SEARCHING OF PALAEOENVIRONMENTAL ANALOGUE OF THE HOLOCENE

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A search for palaeo-analogue of the present interglacial period (the Holocene) and detailed reconstructions of changes in vegetation and climate during the previous palaeoenvironmental history is essential for development of prognostic model of future environmental changes in any chosen region. The solution of this problem with the help of palynological and geochronological data is based in the present study on continuous records of evolution of Neopleistocene climate and vegetation and search for regularities of rhythmic and cyclic development of natural process through the time. The generalization of results of a detailed pollen analysis and the materials of multidisciplinary study of the reference sections in the glacial-periglacial and extraglacial zones of the East European Plain and also of the results of mollusc-based electron spin resonance (ESR) chronology of the warm climate-related shell-bearing deposits from the sections located mainly over a wide *climate-sensitive area of the* North Eurasian palaeoshelf has enabled us to carry out a detailed climatostratigraphic subdivision of sedimentary sequences and specify interglacial and glacial climatic rhythms over the last 900 ka.

It was found that climate-chronostratigraphic record of this period consists of a sequence of nine intervals (the Holocene included) of warm climate and sea-level highstand, and eight glacials or coolings having a glacial rank with sea-level lowstands (Bolikhovskaya 1995; Molodkov and Bolikhovskaya 2010). The ascertainment of the nearest palaeoenvironmental analogue of the present interglacial was based on comparison of floristic, phytocoenotic and climatic successions reconstructed from palynological data on the most comprehensive

Neopleistocene sections on the East European Plain. The probable palaeo-analogue of the *present interglacial* period is discussed.

Methods, study area, climatostratigraphical results.

We used palynological analysis as a base to reconstruct the evolution of terrestrial environments over the past 900 ka. The second method used in the present study is the ESR analysis and dating of subfossil mollusc shells. The use of this method has provided both the independent data on the main climatic changes during the Neopleistocene and their absolute geochronology.

Continuous terrestrial records of climatic changes spanning even two latest glacial-interglacial cycles – from MIS 7 to MIS 1 – are rare. Therefore, loess-palaeosol sections of the southern and central parts of the East European Plain comprising up to eight cycles can be regarded as unique because are the source of the most comprehensive data for tracing environmental changes on the continent through the series of glacial and interglacial periods. The structure and composition of the middle and late Neopleistocene vegetation are best characterized by the 140-m-thick Otkaznoe reference section situated in the middle Kuma River region, in the fescue and feather-grass steppe of the Northeastern Caucasus – one of the loess regions furthest from the ice sheet (Fig. 1). The loess and soil layers in this region are the thickest in the European continent. Palaeoenvironmental reconstruction of the majority of the middle and late Neopleistocene thermochrons and cryochrons was carried out by the first author on the basis of her detailed pollen analysis involving complex (lithological, palaeopedological, microteriological, etc.) investigation of the section (Bolikhovskaya 1995; Bolikhovskaya et al. 2016). Becides, data from several thoroughly investigated key sections in the central part of the East European Plain – Strelitsa, Likhvin, Arapovichi – were also widely used for reconstructing a long and continuous palaeoenvironmental records. During the Neopleistocene, this vast area was repeatedly subjected to ice sheet expansion, frost processes and loess formation (Bolikhovskaya 1995).

Most of the ESR data come from the palaeoshelf deposits of the north Eurasian continental margin, from the Kola Peninsula in the west to the New Siberian Islands in the east (Molodkov et al. 1992; Molodkov and Bolikhovskaya 2010 and references therein). This area is highly sensitive to global climatic changes and, therefore, can be regarded as a sensitive recorder of these changes in the Neopleistocene. Freshwater mollusc shells were collected from interglacial lake sediments in Lithuania (Gaigalas and Molodkov 2002), very old terrestrial mollusc shells – from the climate-sensitive shell- and culture-bearing deposits of an ancient

multi-level Lower Palaeolithic cave-site – Treugol′naya Cave – situated on the northern slope of the Greater Caucasus (Molodkov 2001).

Quaternary deposits correlated with majority of the middle Neopleistocene palaeogeographic events between the Oka (MIS 14–12) and the Dnieper (MIS 6) glaciations are most completely represented in the 50 m thick Likhvin section of loess, palaeosoil, tills, glacio-lacustrine, alluvial, lake, and bog formations. In the periglacial zone the most complete interglacial successions of vegetation are represented in the Otkaznoye section. A comprehensive layer-by-layer spore-and-pollen study of the whole sequence represented in the reference sections permitted its detailed subdivision and reconstruction of the diversified environmental and climatic events in the centre and south of the East European Plain. The sequence spans the period from the last pre-Brunhes/Matuyama interglacial (Petropavlovka) to the Holocene (Fig. 2), i.e. eight glacial epochs (Pokrovka, Devitsa, Don, Oka, Kaluga, Zhizdra, Dnieper, Valdai) and nine interglacials (Petropavlovka, Gremychie, Semiluki, Muchkap, Likhvin, Chekalin, Cherepet′, Mikulino, and the Holocene), which are represented either as complete climatic rhythms of glacial and interglacial rank, or as considerable portions of climatic-phytocoenotic phases – constituents of the rhythm (Bolikhovskaya 1995).

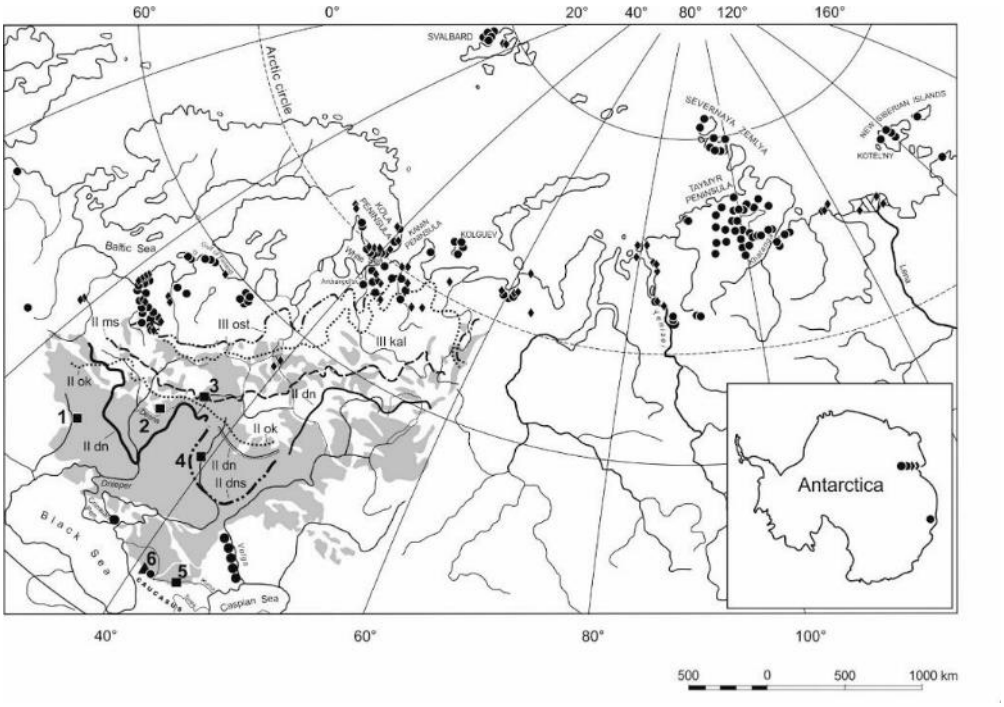

Fig. 1. Map of the study area showing localities of the investigated sections mentioned in the text (1 – Molodova, 2 – Arapovichi, 3 – Likhvin, 4 – Strelitsa, 5 – Otkaznoe, 6 – Triangular Cave), distribution of loesses on the East European Plain (grey area), localities of the main palynologically studied sections (squares), sedimentary samples collected for IR-OSL analyses (diamonds), shell samples for ESR analysis (circles) and limits of Neopleistocene glaciations

(after Zarrina 1991): 1 – Don (II dns), 2 – Oka (II ok), 3 – Dnieper (II dn), 4 – assumed Dnieper and Oka (II dn, II ok), 5 – Moscow (II ms), 6 – Kalinin (III kal), 7 – Ostashkovo (III ost).

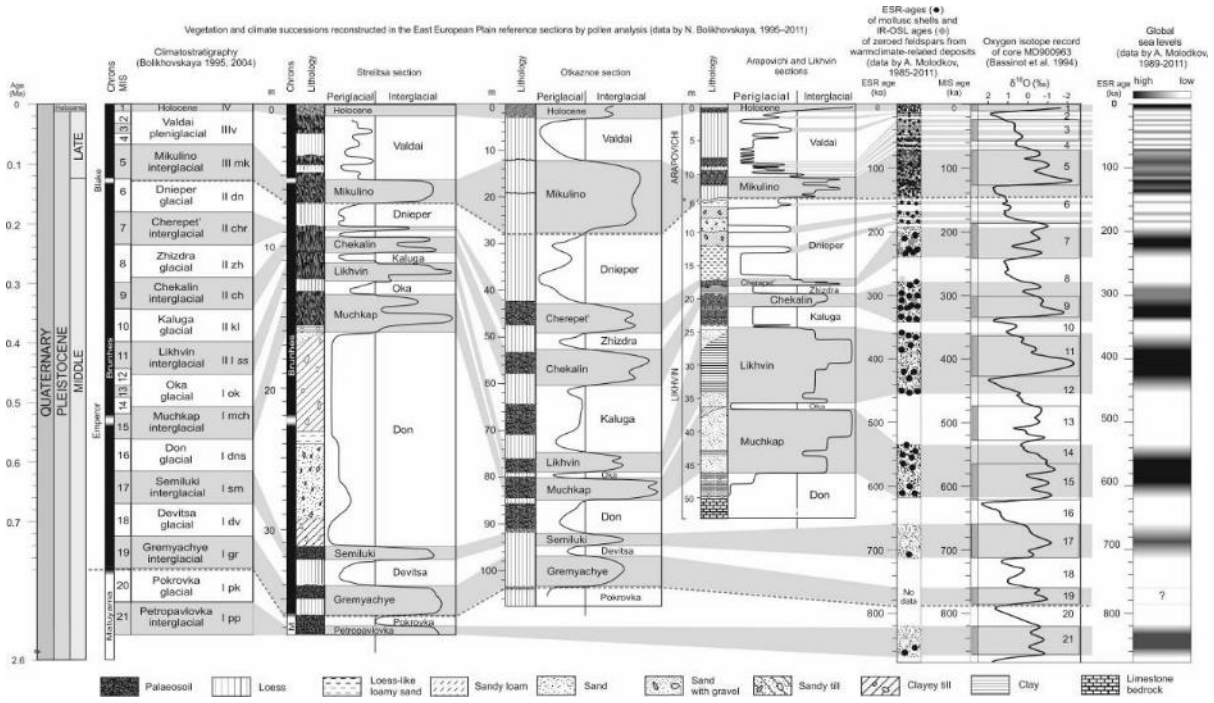

Fig. 2. Chronology and correlation of major palaeoenvironmental events. Climate changes are traced in different terrestrial and marine records over the last 900 ka (modified from Molodkov and Bolikhovskaya, 2010).

In order to determine the age and duration of the reconstructed warm and cold stages, we compared climate-related palynological signals from continental deposits in the glacial-periglacial and extraglacial zones of the East European Plain with the warm and cold climatic events reconstructed on the base of ESR analyses of subfossil mollusc shells. *As a result, it was found that* the structure of the pollen terrestrial record and principal palaeoclimatic signals recorded in it are strongly correlated with both the main signals of the ESR-based palaeoclimatic record and with reference levels of the climate-dependent $\delta^{18}O$ variations in deep-sea and on-land sequences. Such integrated approach based on the two independent methods and sources of climate- and chronostratigraphic information has provided a good opportunity for construction of a climato-chronostratigraphic framework for the last 900 ka (Fig. 2) (Bolikhovskaya and Molodkov 2002; Molodkov and Bolikhovskaya 2010).

Cycles in the evolution of the middle and late Neopleistocene vegetation and climate.

The precise comparative analyses of the floral, phytocenotic, and climatic successions have shown a certain recurrence of the major paleoenvironmental events: every interglacial and

glacial from the period spanning the Pokrovka cooling (MIS 20) through to the Likhvin interglacial (MIS 11) has its younger analogue, i.e., the episode with similar major palaeoclimatic characteristics from the period from the Kaluga glacial (MIS 10) through to the Holocene interglacial (MIS 1). Analogy is traced in the similarity of the eco-zonal attribution of the dominant vegetation, in the degree of aridity or humidity of the climate (compared to other warm and cold episodes within its own interval) as well as in the degree of expansion of the ice sheet during the correlate cryochrons, etc.

The Likhvin interglacial (MIS 11) demonstrates many common features with the present interglacial epoch (MIS 1). During the Likhvin interglacial, the ecosystem of the middle Kuma consisted of a typical steppe environment with predominantly gramineous plants, the most typical taxa of the local Holocene environment. Deposition of sediments at Otkaznoye during the Likhvin interglacial, same as during the Holocene, took place under conditions of the open forest-steppe and steppe environment (Fig. 3, 1st line from the top). On the basis of the array of available characteristics, it has been established that the Oka glacial (MIS 14–12), during which the ecosystems of the eastern piedmonts of the Caucasus were dominated by periglacial steppe, is a palaeoenvironmental analogue of the Valdai glacial (MIS 4–2), which is also characterized by predominantly periglacial forest-steppe and semidesert vegetation (Fig. 3, 2nd line from the top). It is worth also mentioning here that like the MIS 3, the MIS 13, which according to oxygen isotope climate-rhytmics should correspond to a warm interglacial stage, actually appears to be the most glaciated and coldest "interglacial" of the last one million years (see, e.g., Molodkov and Bolikhovskaya 2010).

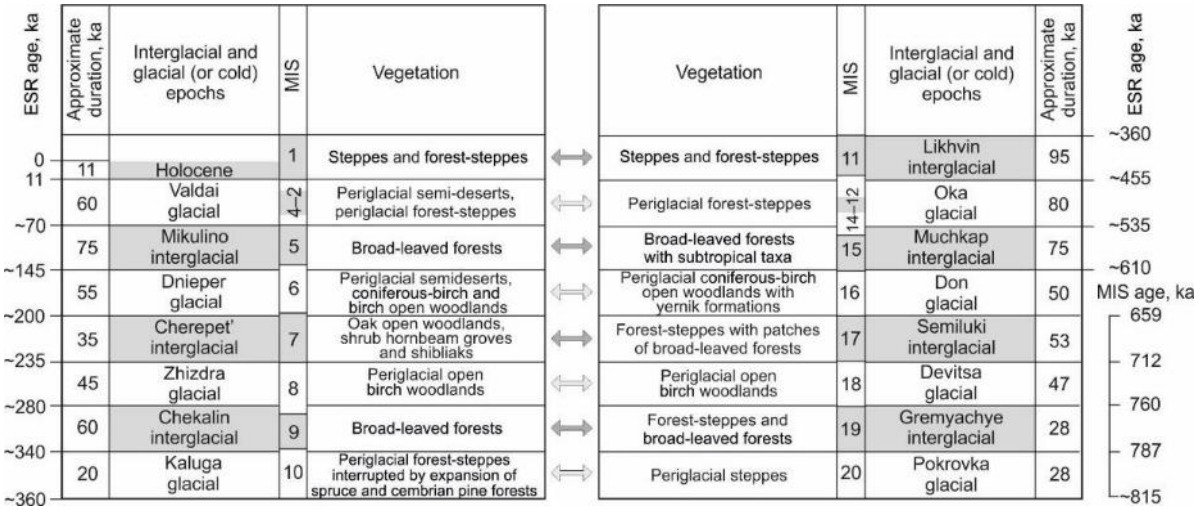

Fig. 3. ~450-ka-long cycles in the evolution of Neopleistocene vegetation and climate (based on pollen data from the southern and central parts of the East European Plain). Absolute dates and duration of climatic rhythms are based on ESR dates obtained by A. Molodkov (Molodkov

and Bolikhovskaya 2010). Boundary ages of marine isotope stages 17–20 are from Bassinot et al. (1994).

During the Muchkap thermochron, the region of the middle Kuma was mostly vegetated by the broadleaved forests with subtropical taxa, while most of the European part of the Russia was occupied by the forest zone dominated by forests with admixture of Neogene relict taxa during the interglacial optima. The Mikulino interglacial (MIS 5) we consider as a paleoenvironmental analogue of the Muchkap interglacial (MIS 15). During the Mikulino interglacial, the middle Kuma River region was vegetated by the broad-leaved forests, but without admixtures of subtropical taxa. During both the Muchkap and Mikulino interglacial periods, forest ecosystems were mostly developed over the Russian Plain (Bolikhovskaya, 1995) (Fig. 3, 3rd line from the top). The younger analogue of the Don glacial (MIS 16), the period of maximum development of the ice sheet during the Neopleistocene, is the Dnieper glacial (MIS 6), during which the ice sheet was only slightly smaller than during the Don glacial (see Fig. 1). During the latter, the middle Kuma basin was mostly occupied by periglacial open forests composed of coniferous trees, birches, and yernik formations. During the Dnieper glacial, the region was at first covered by periglacial open woodlands with a taxonomic composition similar to the Don vegetation. Then, under the increased *climate continentality*, open woodlands were replaced by periglacial semi-deserts (Fig. 3, 4th line from the top). The Cherepet' interglacial (MIS 7) is a younger analogue of the Semiluki interglacial (MIS 17). During the Semiluki period, the predominant ecosystems of the middle Kuma basin were forest-steppe with patches of broad-leaved vegetation — shrub hornbeam groves, mixed oak and hornbeam, linden and hornbeam, ash-tree, maple and hornbeam and birch forests. The vegetation cover of the Cherepet' interglacial shares many features with that of the Semiluki interglacial. Landscapes were dominated by open woodlands and xerophytic and warm-loving shrub communities: shrub hornbeam groves, oak, nut-tree, birch and other forests (Fig. 3, 4th line from the bottom). The Zhizdra glacial (MIS 8) is the analogue of the Devitsa cold period (MIS 18). Open birch forests dominated the periglacial landscapes of the Zhizdra glacial (Fig. 3, 3rd line from the bottom). The principal vegetation types of the Gremyachye interglacial (MIS 19), considered the paleoenvironmental analogue of the Chekalin intergalical (MIS 9), are the broad-leaved forests and forest-steppes. The forest successions of the Gremyachye interglacial were: birch forests, shrubby hornbeam groves as well as birch-oak, hornbeam, oak-linden-hornbeam, nut tree-beech-hornbeam, and oak-elm associations. The successive evolution of typical broad-leaved plant formations during the Chekalin interglacial represents

an interchanging of the major phytocenotic phases, during which a particular group of plants of generally similar compositions prevailed (linden-elm-hornbeam-oak, nut tree-oak, linden-elm-hornbeam-oak, oak-hornbeam, alder and birch) (Fig. 3, 2nd line from the bottom). The Pokrovka glacial period (MIS 20) is characterized by the development of periglacial steppe and is considered the paleoenvironmental analogue of the Kaluga cryochron (MIS 10). The features of the Kaluga climate and environment suggest that during the coldest period, the region was covered by mostly periglacial forest-steppe, interrupted by the expansion of spruce and cedar-spruce forests (Fig. 3, 1st line from the bottom).

The above palaeoenvironmental correlations support both the cyclic nature of the evolution of the environment during post-MIS 21 periods and the directional change of the middle and late Neopleistocene floras — the climate of each interglacial and glacial stage was colder and more continental than that of the preceding interglacial or glacial stage. According to our data, every palaeoenvironmental cycle includes four interglacial and four glacial epochs and lasts approximately 450 ka. All interglacial periods of the younger cycle of "Kaluga cooling–the Holocene (incl.)" (MIS 10–MIS 1) are characterized by more continental climate and significantly smaller admixtures of Neogene relicts and other plants not typical of the regional floral communities than their interglacial analogues of the "Pokrovka cooling–Likhvin interglacial" (MIS 20–MIS 11) cycle.

Likhvin interglacial (MIS 11): environmental analogue for the Holocene?

At the Otkaznoye section, the Likhvin interglacial corresponds to soil complex (SC) 4 that is more than 3 m thick and can be subdivided into three sub-horizons of well-developed paleosols. In the middle reaches of the Kuma R. (north of the Terek-Kuma Lowland), the climate of the Likhvin interglacial was the warmest and driest as compared with other interglacials of the middle and late Neopleistocene. During the entire interglacial period dominant were open landscapes, primarily forest-steppe and steppe. Evolutionary changes in vegetation are recognizable through changes in structure of the main formations, namely steppe communities, broadleaf and mixed forests. Our data suggest six phases in the evolution of vegetation.

Based on the comparison of palynological data derived from the Holocene deposits of the Russian Plain with the reconstructions of the climato-phytocenotic successions during previous interglacial periods, we can infer that the evolution of the Holocene climate has only passed a thermoxerotic stage. Therefore, a thermohygrotic interglacial stage can be expected to occur in the next millennia, i.e. the climate will likely become warmer and moister than that which existed during the Atlantic optimum. Our analysis suggests that since the late Sub-Boreal

period (2.2–2.5 ^{14}C ka BP), all century-long and shorter climatic fluctuations occurred against the background of a general endothermal cooling.

As it was established above, every long-term palaeoenvironmental cycle lasts approximately 450 ka. Such is the duration of the first "Pokrovka cooling–Likhvin interglacial" (MIS 20–MIS 11) cycle. Therefore, the duration of the next "Kaluga cooling–the Holocene interglacial" cycle will also make about 450 ka (see Fig. 3 and Fig. 3) and the duration of the Holocene similarly *as its analogue* — Likhvin interglacial — will approximately be the same. From this it follows that the reconstructed evolution of the vegetation and climate during the Likhvin interglacial can be used as an environmental and temporal analogue of the present interglacial.

Conclusions

(1) The last 900 ka were characterized by 9 interglacials separated by 8 cold periods of glacial rank. (2) Two long-term palaeoenvironmental cycles were established within this period. (3) Each cycle lasted ca 450 ka covering four interglacial and four glacial stages. (4) Each of the environmental stages of the younger cycle had its counterpart in the preceding

one. (5) Likhvin interglacial (MIS 11) is the most likely palaeo-analogue of the *present one (MIS 1).*

Keywords: Neopleistocene, cyclicity, palynology, ESR-chronology, Northern Eurasia.

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BACK

MULTICENTENNIAL CLIMATIC CHANGES IN SOUTHERN SIBERIA IN THE LATE HOLOCENE

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Reconstruction of the mean Northern Hemisphere temperatures for the past two thousand years by Moberg et al. (2005) shows much larger multicentennial-scale variability than most previous multi-proxy reconstructions. According to this reconstruction, high temperatures, similar to those observed in the 20th century before 1990, occurred around 1000-900 years ago, and minimum temperatures that are about 0.7°C below the average of 1961-90 occurred about 400 years ago (Fig. 1a). This reconstruction suggests significant adjustments to the idea of the climate stability of the late Holocene (Mann and Jones 2003; Mayewsky et al. 2004; Wanner et al. 2008). This large natural variability is likely to continue in future, which makes reconstructing the Late Holocene climate essential for better understanding of climate variability, and provides necessary background knowledge for improving predictions of future climate changes.

The mountainous areas of southern Siberia (Altai, Sayan and Tuva) are a key region for the analysis of climatic changes in the Holocene due to their central location in the Eurasian continent. They reflect the long-term dynamics of the main pressure fields in the Northern Hemisphere (changes in the depth of the Icelandic Low and the strength of the Siberian anticyclone), associated with the strengthening/weakening of the Westerlies and the Asian monsoon (Majewski et al., 2004). Over the past decades, detailed data on landscape and climate changes in the Holocene have been obtained in the Altai-Sayan region and in neighboring areas of Central Asia (Blyakharchuk et al. 2004, 2007; Blyakharchuk and Chernova, 2013; Panin et al. 2012; Rudaya et al. 2009, 2016; and other). These data showed that 5.5-5.0 kyr BP a climate amelioration of the middle Holocene gave way to a cooling along with increased continentality and aridity in the region. These processes became especially pronounced after 2.0 kyr BP. They

brought about the decline of forest and a greater spread of steppe vegetation. However, data on short-term climatic oscillations in the late Holocene for this region are still scarce.

A promising method for studying landscape-climatic changes of this rank is a detailed pollen analysis of sediments with a stable accumulation regime, with high contents and good preservation of microfossils, reliably dated by radiocarbon method. As a research object, we chose a section of the lake and mire sediments at Por-Bazhin, located near the shore of the Tere-Khol' lake in the intermountain depression of the same name (50°37′N, 97°24′E, southeastern Tuva). The bottom of the Tere-Khol' depression lies at the height of about 1300 m above sea level, within the belt of mountain larch and larch-Siberian pine forests. Panin et al. (2012) studied history of the development of the Tere-Khol' lake in the Holocene. A series of radiocarbon dates from the Por-Bazhin section shows that the thickness of peat and underlying sandy loam deposits of about 80 cm accumulated for approximately 2.8 thousand years. The underlying loamy deposits with inclusions of sand, gravel and pebbles are in a frozen state. An existence of permafrost in the Tere-Khol' depression is due to average annual temperature of -6°C, severity and low snowiness of winters.

The Por-Bazhin section is located at the transition between the forest and steppe zones, near the southern boundary of the permafrost. The boundary position of the section in combination with altitudinal belts and exposure differences in vegetation associated with the mountain relief of the surrounding area lead to a distinct reflection of low-amplitude and short-term climatic variations in the composition of pollen spectra.

Based on the changes in the composition of the pollen spectra in the Por-Bazhin section, we identified six local pollen zones (LPZ) (Fig. 1b). The presence of pollen of aquatic plants typical of stagnant and weakly flowing shallow lakes (*Lemna, Myriophyllum, Potamogeton, Utricularia, Nymphaea*, etc.), algae (*Pediastrum* and *Botryococcus*), and various hygrophytes (*Typha latifolia, Sparganium, Polygonum amphibium* and other) in LPZ PB-1-3 indicates that the accumulation of sediments took place in the coastal part of the lake, which at that time had a larger area. Changes in the composition of the pollen of hydro- and hygrophytes reflect the process of shallowing and overgrowing of the marginal part of the lake and the formation of a mire, where about 1.7 kyr BP the accumulation of peat has begun.

In general, the composition of pollen and spores throughout the section reflects a predominance of mountain taiga similar to modern vegetation in this area. Changes in the abundance of pollen of the main forest-forming species (*Larix, Pinus sibirica, Picea, Betula* sect. *Albae*, etc.) in combination with pollen of microthermal shrubs (*Betula* sect. *Fruticosae, Duschekia fruticosa*, *Juniperus* spp., etc.), or more thermophilous species of trees and shrubs,

allow tracing the altitudinal shifts of the vegetation belts caused by relative warming or cooling. Among the non-arboreal pollen (NAP), there are quite high contents of Chenopodiaceae and *Artemisia*. Presence of pollen of typical xerophytes (*Ephedra, Eurotia ceratoides, Polygala*, etc.) indicate that there were mountain steppe communities on south-facing slopes. A great variety of NAP species indicates that during drier phases, meadows and meadow-steppes occupied larger part of the depression than at present. During the relatively humid phases, the participation of more mesophilous herbaceous plants in the steppe communities increased.

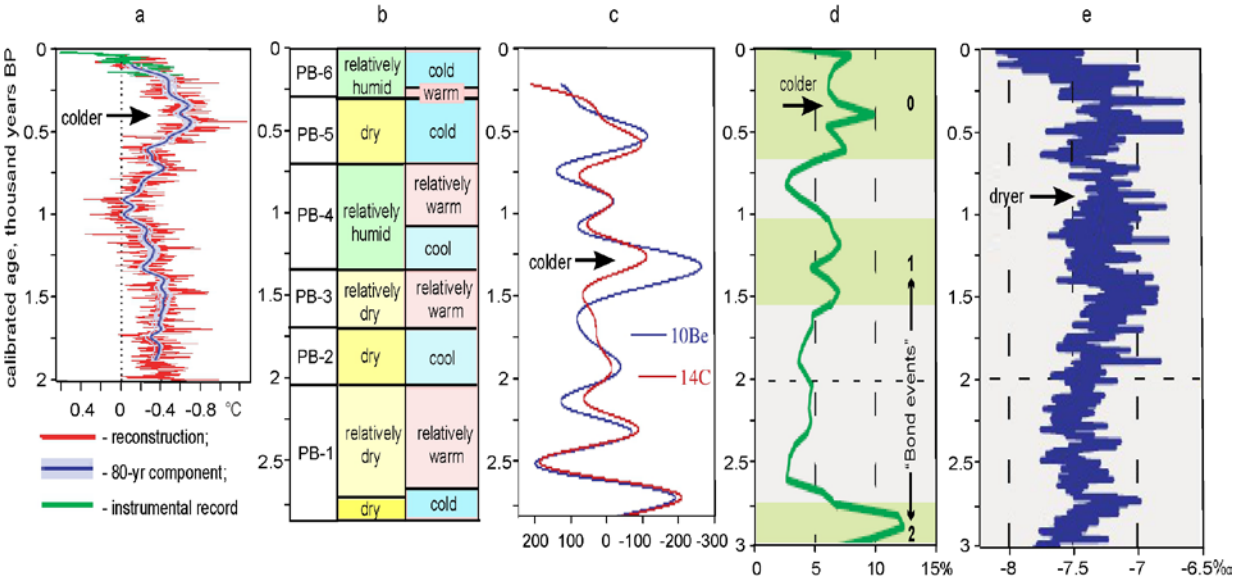

Fig. 1. Short-term climatic oscillations in the late Holocene indicated by different paleodata. a. Multi-proxy reconstruction of Northern Hemisphere mean temperature variations AD 1–1979 with its >80-yr component AD 133–1925, and the instrumental record (Moberg et al. 2005); b. Fluctuations in temperature and humidity inferred from the data of palynological studies of the Por-Bazhin section; c. Reconstructions of the solar activity (in relative units) based on ^{10}Be concentrations measured in the GRIP ice core and ^{14}C production rate (Wanner et al. 2008); d. Changes in the quantity of the ice rafted debris in North Atlantic (Bond et al. 2001); e. Oxygen isotope record from Dongge Cave speleothem in southern China (Wang et al. 2005).

According to palynological data, the formation of deposits in the lower part of the section (up to about 1350 yr BP) occurred in more arid conditions than modern ones. The drier phases several hundred years long were at the same time colder, which means an increase in the continentality of climate during these intervals. The most dry and cold conditions are reconstructed for the earliest part of the sequence (LPZ PB-1-3, 2.8-2.7 kyr BP).

At the time of peat accumulation in the upper part of the section (LPZ PB-4-6) (1350 yr BP – present), the reconstructed conditions were generally colder than during the previous part of the late Holocene. The pollen percentage of tree birch, more characteristic of the lower part

of the forest belt in the region, decreases here, while the amount of larch pollen increases. The pollen content of *Pinus sibirica*, which forms the upper treeline in the mountains of the region, also increases. In this part of the section, the pollen of *Juniperus* is constantly present. Both species of juniper, characteristic of the region (*J. sibirica* and *J. pseudosabina*), grow in subalpine Siberian pine and larch woodlands and on stony patches in high mountains.

During this period, the correspondence of the phases of cooling and drying mentioned above was altered: the cooler intervals partly corresponded to relatively moist conditions. The duration of warm and cold phases was reduced with increasing differences between them. The most pronounced dry and cold phase was from 700 to 300 yr BP (LPZ PB-5). At the transition from LPZ PB-4 to PB-5, the proportion of Cyperaceae pollen decreased sharply, and the pollen of *Artemisia* and Poaceae reached their highest abundances for the entire sequence. The proportion of Chenopodiaceae, Asteraceae, Apiaceae, Caryophyllaceae, and Ranunculaceae also increased. Pollen of typical steppe xerophytes (*Eurotia ceratoides, Bupleurum*, and *Pleurospermum*) was found here.

This interval separated two relatively warm and humid phases: from 1100 to 700 yr BP and from 300 to 150-200 yr BP. The lessening of the climate continentality at these intervals is emphasized by the largest content of *Pinus sylvestris* pollen, the increase of Cyperaceae pollen and diversity of forbs, as well as by the presence of pollen of mesophilous shrubs (*Sambucus, Frangula*, and *Ribes*) and a single pollen grain of *Tilia*. Relatively thermophile aquatic plants, such as *Nymphaea* and *Nuphar*, occurred at the site. In the last 150-200 years there has been a new cooling, although it was not accompanied by noticeable aridization. The composition of the pollen spectra in the LPZ PB-6 shows that the modern climate differs from the cryoxerotic phase at 700-300 yr BP by less seasonality and slightly higher humidity of climate.

Thus, changes in the vegetation cover in the Tere-Khol' depression and in surrounding mountains over the last 2.8 thousand years, reconstructed from the palynological data on the Por-Bazhin section, reflect the alternation of wetter and drier phases, as well as relatively warm and cool phases, that were several hundred years long, in the context of the cold dry climate of the late Holocene (see Fig. 1b).

According to the estimations of Northern Hemisphere mean temperature variations by Moberg et al. (2005), the highest temperature for the past two thousand years was reached between AD 1000 and 1100, during the so-called "Medieval Warm Period", and the greatest cooling occurred around AD 1600, during the "Little Ice Age". Based on the similarity of the paleotemperature curves and changes in the intensity of solar radiation reconstructed from the contents of ^{14}C and ^{10}Be isotopes (Wanner et al. 2008), it can be assumed that the temperature

fluctuations were mainly due to changes in solar activity (Fig. 1c). Bond et al. (2001) demonstrated that ice rafted debris (IRD) were deposited in the North Atlantic by southerly drifting icebergs. Higher IRD numbers indicate cooler time intervals, often called “Bond events” (Fig. 1d). Fluctuations in temperature, reconstructed from palynological data on the Por-Bazhin section, are similar to those described above in their direction, duration and time of manifestation, but less pronounced.

Data on changes in the isotope composition of oxygen in the calcite of stalagmite from the Dongge cave in southern China (Wang et al. 2005), which has a high (up to one-year) time resolution, show that, apart from the decrease of the monsoon strength from 7.0 to 0.5 kyr BP, separate episodes of a particularly severe fall in the Asian monsoon activity occurred in phase with the ice-rafting events in the North Atlantic (Wang et al. 2005; Wanner et al. 2008). The relatively humid/dry phases inferred from Por-Bazhin pollen record, which manifested themselves against the general background of climate aridization in the mountainous regions of

southern Siberia in the late Holocene, correspond fairly well to the phases of Asian monsoon strengthening/weakening.

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Keywords: late Holocene, short-term climate changes, palynological data, Por-Bazhin section, south-eastern Tuva.

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BACK

LATE PLEISTOCENE GLACIATION IN THE TELETSKOYE LAKE REGION, RUSSIAN ALTAI: LUMINESCENCE CHRONOLOGY OF GLACIAL-RELATED DEPOSITS

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The geomorphological structure of the basin of the Teletskoye Lake and its environs has been studied for more than a century. Most previous studies (Yakovlev 1916, Bublichenko 1939, Kaletskaia 1948, Strelkov and Vdovin 1969, Bondarenko 1971, Bogachkin 1981, Maloletko 1987, etc.), were focused on the problem of the origin of the basin. Formation of the lake was discussed by Bublichenko (1939), who estimated the lake lifetime at 36,000 years. We obtained new data on the absolute geochronology of glacio-fluvial and glacio-lacustrine deposits in a number of sections (Fig.1), which allow us to clarify the dynamics and chronology of the Late Pleistocene valley glaciation in the Teletskoye Lake region and the time of the lake formation. Optical-luminescent dating (OSL) was performed in the GADAM Centre, Institute of Physics, Silesian University, Poland.

Core at the bottom of the Biya Valley 2.7 km downstream from the Artybash village (Fig. 1) revealed clayey lacustrine sediments with a thickness of more than 50 m under modern alluvium (Bublichenko 1939). Judging by the abundance of organic remains, these are deposits of the epoch, possibly related to the Kazan interglacial. Probably, these deposits continue to the east, to the latitudinal (northern) part of the Teletskoye Lake. At modern sources of River Biya at Artybash these deposits are buried under the moraine ridge that dammed River Yogach, a small tributary of Biya. The lower part of Yogach valley is filled with horizontally layered sandy-pebble material that provided two OSL dates: 82.6 + 7.0 ka (GdTL-1715) in the base of the section, and 50.2 ± 3.3 ka (GdTL-1716) in the top (Fig. 2). Thus, the glacier blocked the

Yogach River not later than 80 ka ago, and the resumption of flow and river cutting down had occurred about 50 ka ago or somewhat later.

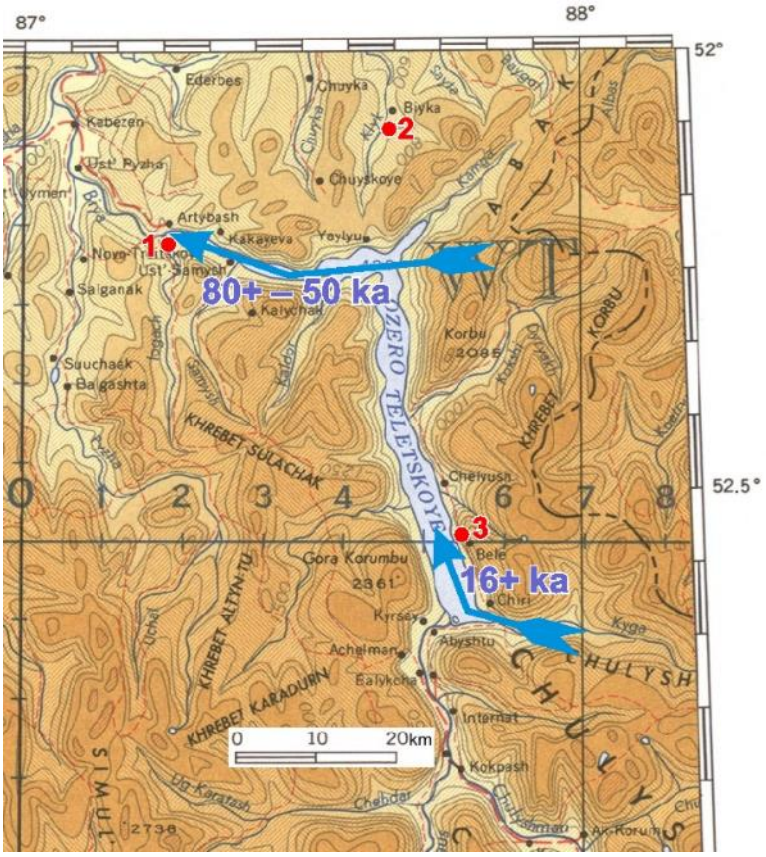

Fig. 1. Overview map of the study area. Sections described in the text: 1 – Iogach, 2 – Biyka, 3 – Bele. Blue arrows and numbers designate maximal advance of valley glaciers and their age.

Fig.2. Deposits of the glacier-dammed lake in the Yogach valley. Red numbers are OSL ages (after Baryshnikov et al. 2016).

The retreat of the glacier about 50 ka ago is documented also by the data obtained from the glacio-fluvial deposits to the north of the Teletskoye Lake, near the Bijka village (Fig. 1).

Here, two units composed of coarse clastic deposits with a total thickness of about 10 m are exposed in the quarry (Fig. 3). The upper Unit 1 5 m thick is composed of fairly well-rounded pebble-boulder material with rough horizontal stratification. According to the size of the material two subunits can be recognized. The upper subunit 1a with a thickness of 3 m is represented by a larger material - boulder-pebble (up to 0.5-0.7 m) in a gravel-small-pebble matrix. The lower sublayer 1b, 2 m thick, consists mainly of pebbles with inclusions of rare boulders, with gravel-sand matrix. At the base of the exposure lies Unit 2, composed of cross-bedding of sandy-gravel and pebble layers that dip at an angle of 30-35º to the west.

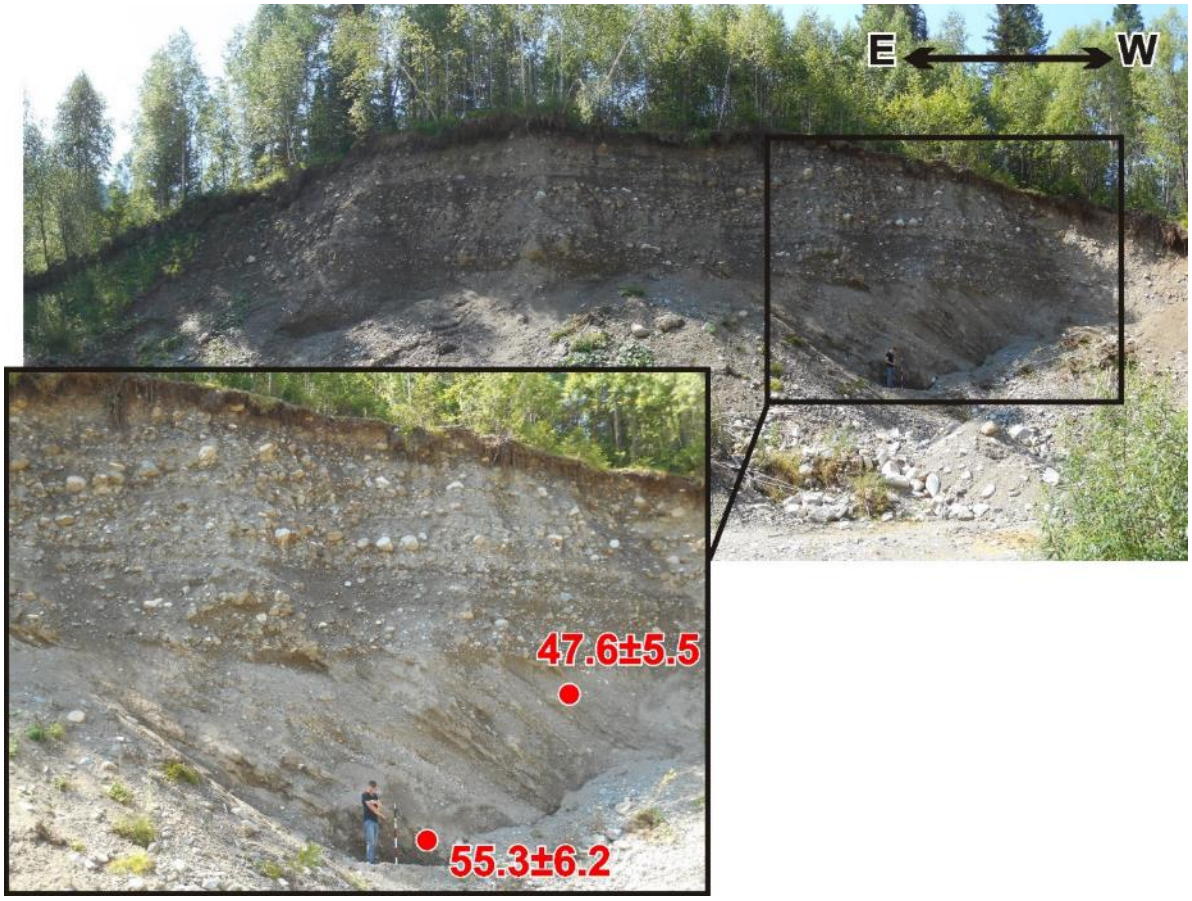

Fig. 3. Glacio-fluvial deposits at the Biyka village north from the Teletskoye Lake (Red numbers are OSL ages (this study).

The deposits exposed in the pit were interpreted as glacio-fluvial, accumulated during two phases of glacier melting. The upper pack is practically free of sand material and therefore not dated. Two dates were obtained from sand material in Unit 2: 47.6 ± 5.5 ka (GdTL-2950) from the depth of 6.3 m, and 55.3 ± 6.2 ka (GdTL-2949) from the depth of 9.2 m. Obviously, the accumulation of this cross-bedded stratum occurred geologically instantly. Both dates

intersect with their intervals of uncertainty, so to estimate the time of accumulation of the lower unit, one can take the average of the two OSL age – about 51 ka ago.

The meridional part of the lake does not bear any traces of fresh glacial erosion and does not resemble a trough valley. Four levels of terraces, apparently of fluvial genesis, with the elevations above the lake of 45, 65, 70 and 85 m are clearly expressed. Lower terraces are erosional, they are embedded into a 70-meter pebble mass. In the Izhon site (left side of the lake), a stratum consisting of well-rounded pebble fragments of light-gray two-mica granites, diorites, greenish-gray porphyrites, metamorphosed rocks, lies on greenish-gray metamorphic schists and schistose sandstones. The bedrock basement rises by 13 m above the lake. There are no large boulders here. Petrographic composition of pebbles is very similar to the alluvium of the Biya River. The mass is leaned against the bedrock side of the lake and can be traced along it for hundreds of meters.

In the sources of the lake on its right (eastern) shore is developed the so-called Belene terrace (named after the small farm of Bele located there). The terrace has a height of about 120 m above the lake. Up to an altitude of about 25 m above the lake, it is composed of thin-layered sandy-silt lacustrine sediments. Above they pass into fluvial pebbles, and then into boulder mudflow deposits. From a height of some 70 m, moraine begins composed of a large angular blocks. The glacial origin of the terrace is also proved by the uneven surface topography abounding of closed depressions, apparently glaciocarstic.

More than 30 years ago, one of the authors of this work discovered a fragment of a terrace composed of thinly layered sediments, apparently of lake origin (Fig. 4). The terrace was located at an altitude of 420 m from the lake, on a steep eastern slope near the Belene terrace. Probably, it was a lake, dammed by a valley glacier – located between the glacier body and the steep slope of the lake trough. In 2015 we visited this site again, sampled the exposure and obtained the following OSL dates: 14.0 ± 0.9 ka (GdTL-2947), 15.7 ± 1.1 ka (GdTL-2946) and 19.5 ± 1.3 ka (GdTL-2948). The average from the three dates of *ca.* 16.5 ka may be regarded as the time of the maximum spread of the valley glacier in the upper reaches of the Teletskoye Lake.

Discussion and conclusion.

The results obtained allow us to propose a new interpretation of the late Pleistocene glacial history of the Teletskoye Lake region (Fig. 1). The most part of the meridional section of the lake was not occupied by glaciers in the late Pleistocene. Morainic and glacier-related fluvial and lacustrine complexes in the area of Biika and Artybash were formed by a glacier descending, most likely, from the eastern slope of Teletskoye Lake, which was first proposed

by Kaletskaya (1948). Based on the OSL dating, this glacier operated in the Zyryan epoch about 80-50 thousand years ago (late MIS 5 – MIS 4 – early MIS 3). After the degradation of this glacier (about 50 thousand years ago), the morainic dam in the area of Artybash still existed for some time. As shown in (Baryshnikov et al. 2016), it was breached between 35-40 thousand years ago, and from this time one can count down the modern history of the Teletskoye Lake, which confirms the long-standing assessment of Bublichenko (1939).

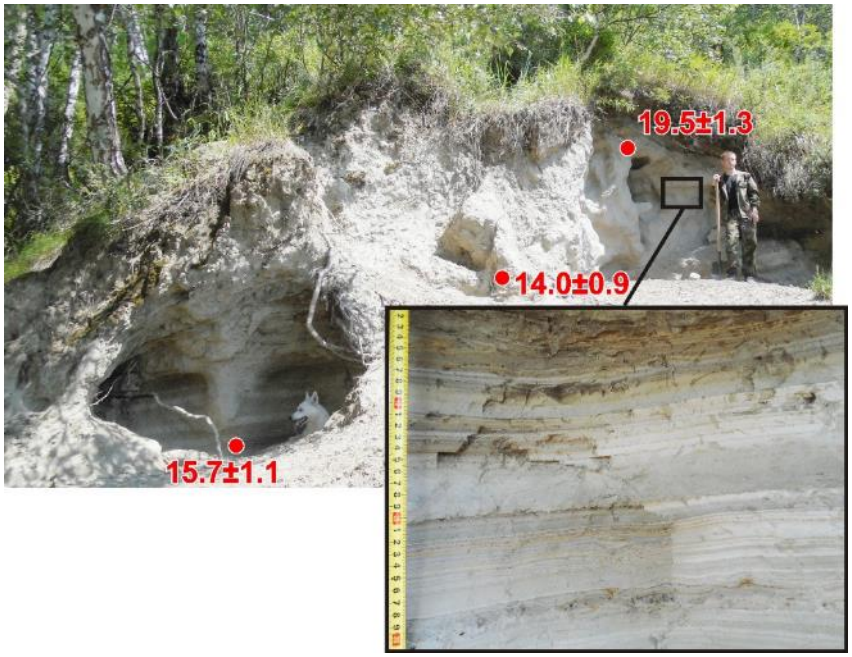

Fig. 4. Glacio-lacustrine terrace at the elevation od 420 m above the Teletskoye Lake (Red numbers are OSL ages (this study).

In the Sartan epoch (MIS 2), the glacier occupied only the upper reaches of the Teletskoye Lake (Fig. 1). Some researchers (Butvilovsky 1993) assumed that the glacier descended along the valley of River Chulyshman. However, there are no traces of glacial activity in the lower reaches of Chulyshman. Clear glacial landforms and deposits are found only in the Karasuk valley upstream from the mouth of Bashkaus (left tributary of Chulyshman), 50 km from the mouth of Chulyshman. We propose that the Sartan glacier reached from the Kyga valley (the southeastern tributary of the lake – see Fig.1) and pressed

against the western side of the Teletskoye Lake, which allowed to preserve the lacustrine-alluvial basement of the Belene terrace.

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Keywords: glacial history, valley glaciers, Last Glacial Maximum, glacio-fluvial deposits, moraine, dammed lakes, OSL dating.

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BACK

SOIL RECORD OF HOLOCENE ENVIRONMENTAL CHANGE IN MOUNTAIN ALTAI

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As far as the Altai is the ultracontinental mountain area with strongly differentiated climatic and landscape conditions, environmental changes here are not only time-, but also strongly space-dependant. Specific of soil body as a recording system is that of an each soil body records the information about surrounding local environment *in situ*, unlike sedimentary systems keeping generalized environmental information on the area of their sedimentation basins. Therefore soils, being environmental archive with high space-resolution (Targulian, Goryachkin, 2008) (if to compare with sedimentary records which can have very good time resolution at nearly always low space- resolution) have certain preferences in paleoenvironmental reconstructions, especially in the areas with high spatial variability of environments.

Besides paleoenvironmental meaning, soils can be used as a source of dating material, and as a chronostratigraphic marker, especially taking in account the deficit of appropriate dating material in sediments of the studied area. Soil development in basins and valleys of the mountain Altai has started after the drainage of dammed lakes existed there in the Late Pleistocene (Rudoy and Baker 1993; Butvilovsky 1993; Herget 2005 and many others). The oldest dates obtained from buried and surface polygenetic soils could be regarded as a low limit of subaerial phase and soil formation.

Both surface polygenetic soils (survived at least ones an environmental change resulted in changing direction of soil formation) and buried paleosols of soil-sedimentary sequences located in big river valleys and small intermountain basins of Altai Mountains, between 1400 and 2500 a.s.l. were studied as markers of landscape stability and sources of

paleoenvironmental information. Pedolithostratigraphy and soil morphology was studied at the field stage. Further micrmorphological diagnostics of pedogenic processes was accomplished in thin sections, under a polarizing Nikon E200 Pol microscope. Morphological results were supported by analytical data (humus content and composition, content of carbonates, particle size distribution, etc.), obtained by standard soil methodology. 14C dates were obtained in buried soils for 2-3 cm at a roof of humus horizons (approximate date of burial) and 2-3 cm at a lower boundary of humus horizon (minimal "0"-time of pedogesis – start of the soil formation); or for a bulk sample if a horizon is thin (first centimeters), and presumably did not get considerable 14C before burial. Several dates were obtained for carbonates and humus of layered pendants skinned off coarse fragments within contemporary soils.

As based on calibration intervals of 14C dates obtained for buried humus horizons (11 buried soils in 6 studied soil-sedimentary sequences) and some dates from pendants of contemporary soils, following stages of pedogenesis were recorded in studied soil-sedimentary systems and surface soils (Fig. 1): 6,4 – 11,5 ky cal BP (4 buried soils, carbonates of pendants); about 4,9-5,3 cal BP (1 buried soil); 2,5-3,8 cal BP (4 buried soils, humus of pendants); 0,6 – 1.2 cal BP (2 soils). All studied surface soils in the basins nowadays develop in water deficit conditions: those are Kastanozems Cambic, Cambisols Protocalcic and Cambic Calcisols. All buried soils, are well developed, and differentiated. All these soils were formed in permafrost effected steppe, meadow-steppe and forest-steppe landscapes. All profiles have features related to 'wet" cryogenesis (turbations, glossic boundaries of A hor., frost sorting etc.); dark, rich in humus mollic horizons (topsoils); abundant, secondary carbonates below topsoil, sometimes accumulated from ground-waters; redoximorphic features testifying on short over-moistening periods. The oldest of those soils located at the highest position above a contemporary timberline have profile differentiation and features of clay redistribution testifying on former forest vegetation. As can be seen from the above, all studied buried soils were formed at milder environmental conditions, and less (if any) water deficit comparatively to surface contemporary soils, in more favorable environment for intra-soil biological activity. Two humid stages can be discriminated basing on soil data: 1. humid and relatively warm period about 8-11 ky ca BP of pedogenic textural differentiation, which is clearly imprinted only in one soil-sedimentary sequences located at the highest position (2400 a.s.l.); 2.two humid and cold sub-stages between 2,5 and 3,8 ky cal BP: 3,6-3,8 and earlier than 2,5-2,9 ky BP – Al-Fe-humus migration and

accumulation of humus (Fe) layers in multilayered pendants (Fig. 1, 2). The last stage is also most clearly recorded at the highest levels: 2200-2400 a.s.l.

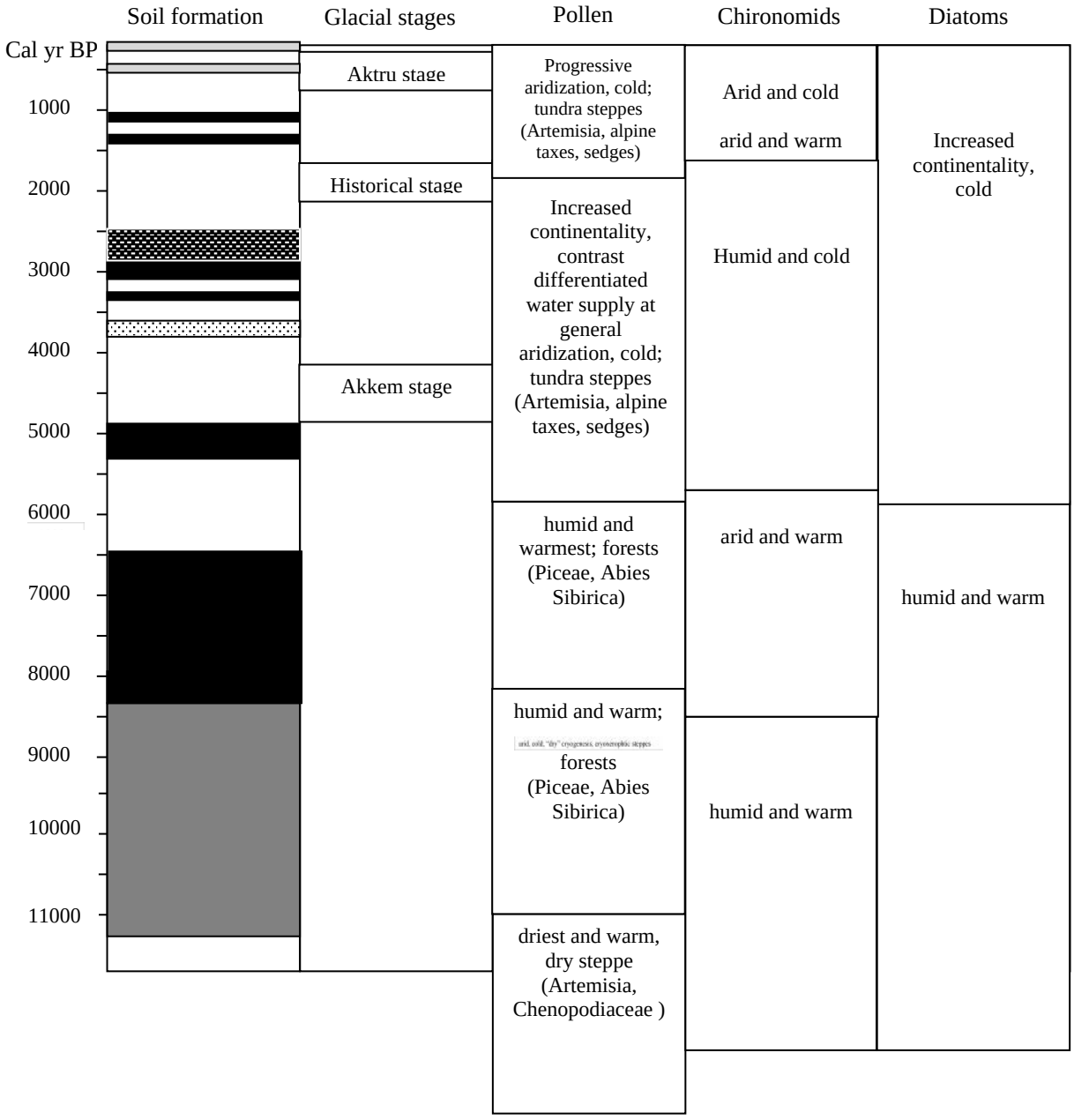

Fig. 1. Correlation of soil record and other paleoenvironmental archives. Compiled basing on own data, and published data: Ilyashul B.P., Ilyaashuk E.A., 2006; Westover et al., 2006; Blaycharchuk et al., 2007; Agatova et al., 2014.

- - Arid, cold; cryoxerophtic steppes, - Water balanced, warmer, steppes and meadow, steppes, - Humid, cold; tundra, or alpine, - Humid, cold; tundra or

alpine features superimposed on soil formed at water balanced steppe/meadow steppe conditions stepp co, [redacted] - Humid, relatively warm; larch (?) forests.

Wide spread cryogenic features in buried soils are mostly due to their better water supply before freezing comparatively to surface soils rather than more severe temperature regimes. The most extreme stage of Holocene reflected in soil-sedimentary sequences is contemporary surface soils. It combines ultracontinental conditions, permafrost, low temperatures and approximately corresponds to the last millennium.

Layered carbonate/humus pendants on rock fragment, being widely spread pedofeatures in soils of cryo-xerophytic steppes occupying vast areas within intra-mountain basins and those slopes in wide range of absolute heights, are regarded as a key intra-soil indicator of Holocene environmental change for the region. Those pendants could be considered as intra-soil microsedimentary systems which layer by layer records soil forming conditions. Multilayered pendants were studied in a number of soil profiles at different absolute heights, have the same set of layers differing in composition and morphology (morphotypes), and similar sequences of morphotypes in all studied soils. These sequences have recorded following generalized phases of soil evolution: 1). semiarid, groundwater-affected (successive phases of high standing, and seasonally fluctuating waters); 2). semiarid, not influenced by ground waters; 3). well drained humid; 4). resumption of semiarid conditions (Fig. 2). First phase is related to initial soil formation after dammed lakes drainage. Following changes in pedogenesis were due to progressive drop of water level in residual lake/river basins; others are explained by fluctuations of climatic humidity. For now the only humid phase was dated by 14C of humus (about 4 ky cal BP), and general minimal age of pendants (about 8 ky cal BP) was estimated for one of studied soils. Multilayered pendants have great future potential as a paleoenvironmental indicator and dating tool. Further studies those features in surface soils of different locations will yield new data on chronology of subaerial phase started after ice melting or drainage of dammed lakes in the mountain basins, as well as on time frames of climatically conditioned changes of soils and landscapes.

As a generalization of obtained data on surface soils and soil sedimentary sequence following conclusions could be resumed. The initial soil formation could start at different ages in basins with different a.s.l.;low limit of the initial soil formation could be estimated as 11-8 kyr cal BP. Soil, and soil-sedimentary systems have recorded general trends of on-spot soil

formation, including the initial stages. These trends testify that the most extreme conditions of soil formation within Holocene were within the last 1-2 kyr.

All buried soils were formed in better conditions, more balanced in water, rather active biologically, mostly within steppe or forest-steppe landscapes. Meanwhile cryogenic features had been insisting all over the Holocene till nowadays, so that the region still was permafrost affected, and climatically rather severe (with long, cold winters). “Wet” cryogenic features demanding satisfactory water supply, are met in buried soils up to the age of 1-2 ky cal BP, in the last millennia ones gave way to “dry” features, such as simple fissures, frost sorting, and shattering.

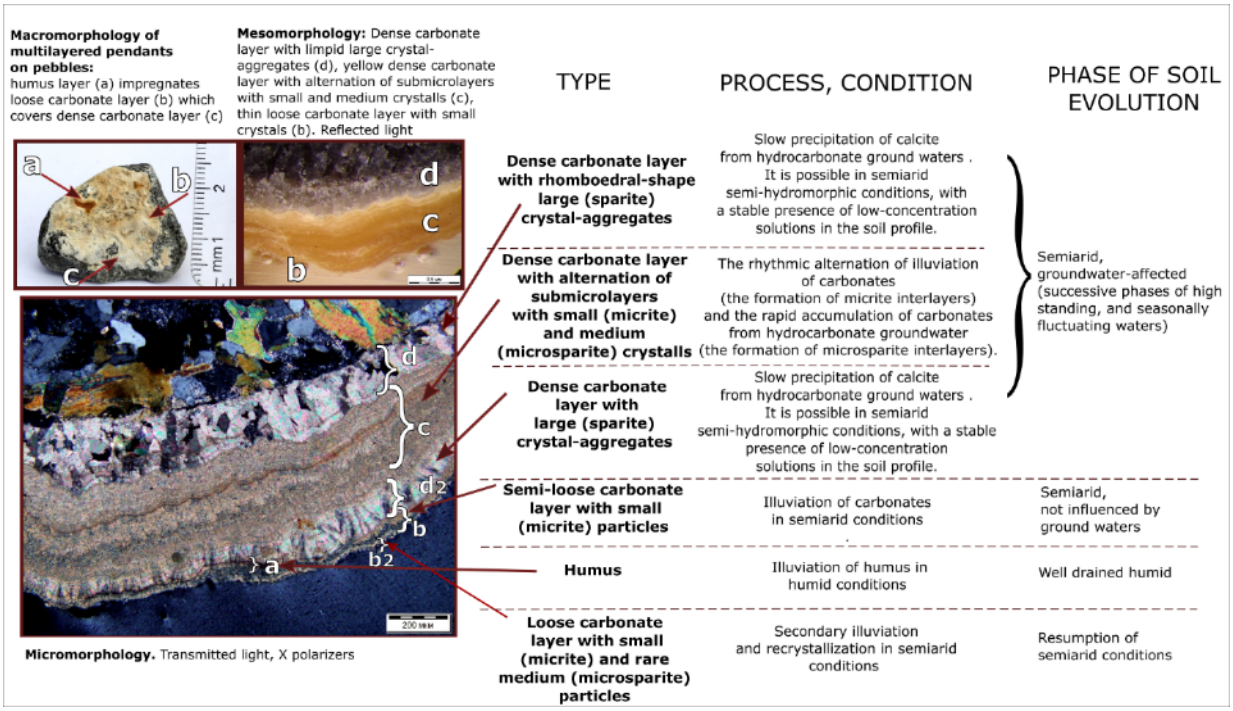

Fig. 2. Phases of soil evolution as based on morphotype sequences in pendants.

At lower levels (Kuraiskaya basin) more or less arid cold steppe conditions insisted within the most part of Holocene (means fluctuations of climate possibly were not that sharp in the low valleys). Initial stages of soil formation were often ground water affected, or at least shortly waterlogged. At the highest positions humid and relatively warm Early Holocene stage of forest pedogenesis is recorded for the beginning of Holocene, and a Late Holocene (last 3-4 kyr) cold humid phase, presumably under mountain tundra and/or alpines. Microsedimentary intra-soil record in carbonate-humus pendants imprints fine fluctuations of soil water regime at initial stages of soil formation, controlled by local topography, and climatic changes in the second half of Holocene. General trends of environmental changes in the region recorded in

soil and soil sedimentary systems are in well correspondence with other records of paleonvironment (Fig. 1, compiled basing on B.P. Ilyashuk, E.A. Ilyashuk, 2006; Westover et al., 2006, Blyakharchuk et al., 2007; Agatova et al., 2014). Soil record much better reflects local specific of environmental change, differences in chronology between localities. Discrepancies between different types of records are due to different level of generalization of the collected materials, different sensitivity, reflectability, response time and other specific characteristics of recording systems (soils, sediments, glaciers etc.), and single indicators (pendants, pollen, diatoms etc.). Careful analysis of all these record- and indicator-dependant discrepancies in order to combine better different paleoenvironmental records in a single, not contradictory, so to say, purified picture promise to be fruitful.

Aknowledgements.

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Keywords: paleoenvironmental records, soil-sedimentary sequences, multilayered pendants.

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BACK

ICE-RICH PERMAFROST AND FEATURES OF THE LATE PALEOLITHIC CULTURAL LAYERS FORMATION IN THE CENTRAL REGIONS OF THE EAST EUROPEAN PLAIN

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The problems of cryogenic process development on the East European Plain in the Late Pleistocene are considered with a special reference to the Late Paleolithic sites on permafrost; particular attention has been given to typical forms of cryogenic disturbances and to their possible impact on living conditions of the Early man in Eastern Europe at the maximum of the Valday glaciation and the beginning of Late Glacial.

The early stages of the man history were marked by major changes in landscapes and climates that would necessarily exert an influence on the mode of human existence. It is those periods of radical changes in climates and the entire landscape system restructuring that the initial human colonization of the East European Plain falls on. The considerable alterations in the climates and environments required certain changes in human adaptation practice; among the latter are changes in the economy orientation which made it possible to colonize regions with highly diversified environments. The colonization proceeded against a background of a considerable instability of natural zonality, so that the communities of the Early man had to overcome considerable difficulties. Among the latter, a prominent place was occupied by cryogenic processes having reached the maximum intensity at the time of human dispersal over the East European Plain; considerable efforts must have been made by the early men to adapt themselves to the life in those environments.

Paleolithic sites found in abundance on the East European Plain are mostly confined to the drainage basins of large rivers (the Dniester, Don, Dnieper, Pechora) and their tributaries. The earliest Late Paleolithic sites appear in the valleys of the Don (the Kostenki group) and Pechora (Mamontovaya Kurya).

The earliest radiocarbon dates obtained on the Late Paleolithic sites fall closely to the middle of the inter-Valday megainterstadial: Kostenki 1 – 37 900±2800/2100 (GrA-5245);

Kostenki 12 – 36 280±360/350 (GrA-5551), Kostenki 17 – 36 780±1700/1400 (GrN-12596), etc. (Sinitsyn et al. 1998). The northernmost site known in Europe up to now – Mamontovaya Kurya in the lower reaches of the Pechora R. – is dated at 34 360±630 (T-11504), 37 360±970 (LU-400) (Pavlov, Indrelid, 2000). A great number of Paleolithic sites are known from the Dnieper drainage basin.

By today's data, the Late Paleolithic man inhabited the East European Plain at the time of the most severe climate and inhospitable environments recorded during the entire Pleistocene history. That is proved by the permafrost occurrence and cryogenic processes having left distinct traces within the plain boundaries. The cryolithozone was spread over a major portion of the plain. There are abundant traces of cryoturbations recorded in cultural layers of Late Paleolithic sites. They are typical of many sites within the limits of cryolithozone and could significantly affect the lifestyle of the Paleolithic humans, particularly their living space organization and migration routes. Below are given some results of paleo-cryogenic studies performed on a few sites belonging to the Desna group (the upper Dnieper drainage basin) and on the Zaraisk site in the Moscow Region.

The oldest site in the region is **Khotylevo II** dated by radiocarbon to 24–22 ka BP. It occurs at the base of a thick series of the Valday loess-like sandy loam on the interfluve surface. The series lies above a horizon of complicated cryogenic deformations comprising humus matter of a paleosol. There are large ice-wedge pseudomorphs more than 3 m thick forming a polygonal network in the loess overlying the cultural layer. That suggests the frozen ground existence since the end of the Bryansk interval including the period of the site functioning.

A younger site – **Eliseevichi I** (17–12.5 ka BP) is positioned on the 2nd terrace of the Sudost River (tributary of the Desna R.). The cultural layer is rather complicated in structure due to the presence of household constructions and storage pits, as well as to subsequent deformations (in process of the layer burial and permafrost thawing). The permafrost left distinct traces in the form of large wedge-like structures arranged in a system of polygons 20–30 m wide (Velichko et al., 1997).

The **Yudinovo** site on the 1st terrace of the Sudost was functioning at the Late Glacial time (^{14}C dates are 15 to 12 ka BP). The settlement was on a slightly projected river bank between two gently sloping linear hollows. The surface is marked with small-size depressions, presumably thermokarst in origin, dated to the Late Pleistocene. The findings are confined to a layer bearing poorly pronounced traces of a soil formation. In the lower part of the layer there

is a fine polygonal structure identifiable; it is formed by wedge-like fissures 2 to 3 cm wide. Their origin could be related to the patterned ground development within the active layer.

The site of **Zaraisk** is in the center of a town of the same name, immediately at its walls and within the kremlin (fortress) of Zaraisk, at a level of an interfluve plateau cut with a large balka at a ~40 m elevation above the Osetr River channel. The site estimated age is close to the time of the Last Glacial Maximum (^{14}C age is 23 to 16 ka BP). The site includes several cultural layers, slightly disturbed, presumably by cryogenic processes. In the process of excavation there have been identified two systems of quasi-polygonal formations, the oldest one represented by ditch-like structures ~1 m wide and 1 m deep, while the younger formations are similar to the above in outlines, though smaller in size (0.1-0.2 m wide and up to 0.5 m deep) (Amirkhanov 2000). The structures occurring between the cultural layers are of considerable significance, both for natural history and cryostratigraphy. Apart from those, there are horizons of small polygons on the Zaraisk A and Zaraisk B sites, with cells 0.2–0.3 m in size, – most probably, remains of spot medallions.

So, there are deformations in the deposits both including cultural layers and overlying them; most of the deformations may be attributed to cryogenic processes. The most important among the latter are frost cracking and the development of originally ground veins or ice wedges transformed later into pseudomorphs. Patterned grounds are most often found in the active layer, along with traces of thermokarst processes and debris freezing out. All the processes of that group resulted in changes of the geological context, including initial occurrence of the cultural layers and of the artifact position within them.

Evidently, the sites of the Paleolithic humans existed within the limits of the permafrost. However, we still do not know for certain whether they settled on polygonal grounds subjected to active frost fissuring, or they preferred adjacent localities. It is not inconceivable that the cultural layers were disturbed by cryogenic processes after people had left the cultivated area. Most likely the ground breaking by fissures into small polygons did not have a pronounced effect on the human activities; the same is true of the slope processes under cryoarid conditions

(at least on the plain). The issue of the practical use of cryogenic microrelief is still insufficiently studied and calls for further investigations.

Acknowledgements:

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Keywords: Paleolithic, environments, human dispersals, adaptations, permafrost, settlement, glaciers, cryogenic.

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BACK

PALEOGEOGRAPHIC ARCHIVES OF THE EASTERN CAUCASUS

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The Eastern Caucasus is a specific mountainous region. As part of the Caucasus, it occupies a boundary position between the predominantly mountainous areas of South-West Asia and the plains of Eastern Europe. At the same time, the Eastern Caucasus, in contrast to the Central and especially Western, is characterized by a much more arid climate. For a number of schemes of regionalization, the Eastern Caucasus draws closer to the arid regions of South-West Asia. The features of the distribution of the snow line in different parts of the Caucasus are indicative. If in the west it is located at 2500-3000m, then in the east it rises above 4000m. It is also indicative of the difference in the forest cover of different parts of the Caucasus. In the highlands and mid-mountains of the Western Caucasus forests occupy more than 50% of the area, and in the Eastern Caucasus less than 10%. Geologically, the Eastern Caucasus is characterized by a significant expansion of the mountains to 200 km (Fig. 1). In this case, the whole territory is composed only of sedimentary rocks of Jurassic, Cretaceous, Paleogene and Neogene. The high-mountain part is composed of mudstones (clay shales) and sandstones of the Jurassic and in the literature is known as Shale Dagestan. The maximum height is 4.0-4.5 km.

The middle mountains part is divided into two subregions. The northwest is occupied mainly by limestones of the Upper Jurassic, Cretaceous and Paleogene and is called the Limestone Dagestan.

The relative small excess of the maximum heights in the region above the snow line significantly limits the area of the glaciation. Accordingly, a slight rise in the snow line to the first hundred meters can lead to the complete disappearance of the glaciation of the Eastern Caucasus. According to a number of scientific research, modern warming leads to a significantly higher melting rate of the Eastern Caucasus glaciation, in compared with other parts of it. Accordingly, it can be assumed that glaciers in the eastern Caucasus exist

intermittently and took a limited time, especially in compared with the glaciers of the western and central Caucasus. In conditions of absolute domination of shales in the high mountains of the Eastern Caucasus, conditions for the formation and preservation of well-developed glacial forms are also extremely limited.

Fig. 1. Geographical position of Limestone Dagestan. Schematic division of the Caucasus into parts (Western, Central, Eastern)

The study of the paleogeography of the mountain regions has its important methodological specifics, which can be characterized as follows: "The views on the history of glaciation and the climate of the Late Glacial and Holocene in the Caucasus are based mainly on geomorphological descriptions of moraines and biostratigraphic data" (Solomina et al., 2013).

As noted above, such archives of paleogeographic information associated with glacial processes in the Eastern Caucasus are limited. During our research, it was necessary to identify new natural objects, which are archives of paleogeographic information.

To date, we have obtained certain results that will significantly expand the actual base of potentially suitable objects for paleogeographic research in the region. Some of the identified

groups of archives are also distributed in other mountainous regions and their research will help significantly expand the possibilities of paleogeographic research.

The first group of paleoarchives is agricultural terraces. A specific form of economic development of the Eastern Caucasus is the wide spread of terraced farming here. In this regard, the region is on a par with the mountains of Central and South America, South-East and South Asia, the Mediterranean. According to the overwhelming majority of research, agricultural terraces in the mountains were created during the minimum of the entire Bronze Age, for the eastern Caucasus it is more than 5 thousand years. This is due to the proximity of the region to the centers of the emergence of the manufacturing economy of south-west Asia in the area of influence of archaeological cultures which almost always included the region under study. According to the results of research in agricultural terraces (Borisov, Korobov, 2013; Gracheva et al., 2017; Borisov et al., 2018), palaeogeographic archives are almost always contained. In the vast majority of the terraces, buried soils were identified, and for many of them a series of buried soils. For example, in one of these terraces next to the Neolithic Tchokh settlement (Amirkhanov, 1987), we identified four paleosoils (Fig. 2). These paleosoils characterize both

the different state of the natural environment and the closely related dynamics of the development of terraced fields.

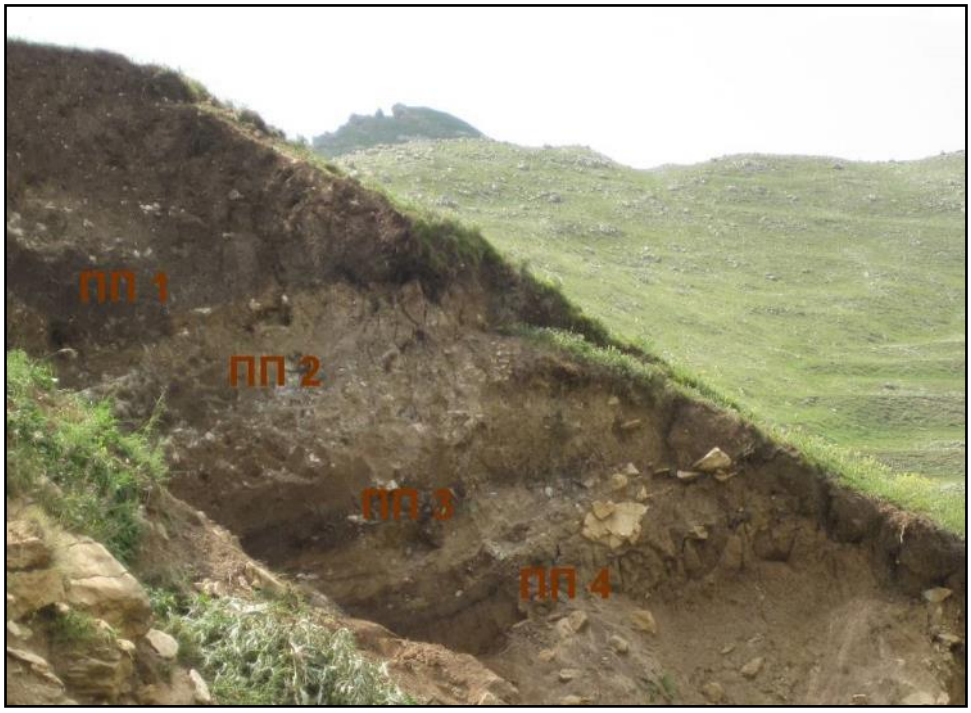

Fig. 2. Paleosoils in a section of the agricultural terrace

The second group of paleoarchives is the swamp sediments of the mountainous part of the region. According to research conducted in 2016-2017, preliminary in the Eastern Caucasus four types of swamp can be distinguished (Ryabogina et al., 2018).

The first type. Swamps formed in tectonically conditioned forms of relief, confined to the practically flat surfaces of large plateaus. Peat thickness up to 2 m. Occur in the middle zone. According to preliminary data, they are also developed in other parts of the Caucasus, in particular in the Central Caucasus. An example is the Schotot swamp (Fig. 3-1). Probably

formed during most of the Holocene. During their history, they had no connection with the glacial forms.

Fig. 3. Different types of swamp in the Eastern Caucasus.

The second type. Dam lakes, which after the accumulation of considerable thickness of lake sediments were transformed into swamp. As a rule, they are bogged down in the alloy type, have distinct sides, in some cases the open water remains in the center and the peat alloy is separated from the lower lake part of the sediments by a water lens. The thickness of the sediments is up to 10 m and more. They occur both in the mid-mountain and in the high-mountain zone. An example is the swamp of the Shara (with a water lens) (Fig. 3-2), Balkhar. Such swamps and primary lakes for them could exist both in the Holocene and at the end of the Pleistocene.

The third type. Swamps in the transition zones from wide flat-bottomed valleys to adjoining ridges. Genesis of the valleys is different. Similar swamps are common in the highland zone. They are similar to the swamps of the highlands of the Western and Central Caucasus. An example is the Bortnykh swamp (Fig. 3-3). Similar swamps were studied in other parts of the Caucasus (Serebryanyi et al., 1980). The peculiarity of such swamps is a great

dependence on the dynamics of glacial processes and probably their small youth. They can cover only the late part of the Holocene.

The fourth type. Swamps in karst funnels. They occur in complexes with lakes and are characterized by small dimensions (up to 200 m) and rounded shape and well-marked sides. The marshes of this group are developed in different parts of Limestone Dagestan, for example, on the Araksmeer and Andiiskij ridge (Fig. 3-4). The data of these swamps were not previously described and probably can exist during the Holocene - the late Pleistocene.

The third group is lake sediments. They are connected with the wide development of the dam landslide lakes in the region. Specific natural conditions of the Eastern Caucasus: alternation in the section of thick strata lithologically different rocks; high-amplitude folding; great depth of erosion dismemberment; neotectonic activity and relative youth of the relief directly determine the wide development of various landslides and associated lakes here (Idrisov, 2013, 2014).

For example, the largest lake in the Caucasus - Goluboye (Kazenoyam, Alkhar, Bolshoe Andiyskoye), was created as a result of overlap by a landslide of a small valley. The modern depth of the lake is about 80 m, the area is 1.8 km2. According to the underwater studies and reconstruction of the primary relief, the initial depth of the lake could reach 100 m. Most of the basin in the lower reaches of the rivers flowing into it is filled with deposits and is represented by flat plains. If the pond lake is completely filled with sediments and in the relief is expressed only by a flat plain, such objects are described by us as "paleolake" (Idrisov, 2014). In particular, for the paleolake Ameterkmachi, the thickness of such deposits, discovered by the subsequent erosion of the river reaches 110 m, for the paleolake Balkhar is more than 50 m, for the paleolake Tsanatl is about 70 m (Fig. 4). The probable lifetime of the majority of such lakes in the Holocene region is the end of the late Pleistocene.

The study of these groups of paleoarchives in the Eastern Caucasus will allow us to reconstruct in detail the paleogeography of the region, especially for the Holocene. At the same time, such research must be in close connection with research of the "traditional" for mountain regions of river terraces and glacial sediments. The establishment of specific climatic changes and exogenous processes in the region, taking into account the reconstruction of the general evolution of the natural environment in the late Pleistocene-Holocene, will enable us to solve a

wide range of problems for a large number of related disciplines at a high scientific and methodological level.

Fig. 4. Lacustrine deposits of the paleolake Tsanatl.

Keywords: holocene, swamps, agricultural terraces, lakes, Caucasus.

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BACK

EVOLUTION OF BORISOGLEBSK UPLAND INTERFLUVES OVER LAST 150,000 YEARS (MARGINAL ZONE OF MOSCOW GLACIATION, CENTRAL PART OF RUSSIAN PLAIN)

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The Upper Volga region is one of the main stratigraphic references for reconstructing geomorphic evolution of northern part of the Russian Plain since termination of the last Middle Pleistocene glaciation (Moscow – Saalian, MIS6) thanks to a large number (>20) of reference sections described in details (Razrezyi..., 1977; Oledeneniya…, 2001). At the same time, interpretation and correlation of these numerous sections still remains controversial for the two main reasons: i) different backgrounds and basic concepts adopted by research groups studying the same set of sections (Novskiy 1975; Kvasov 1975; Gey et al. 2001; Sudakova 2012; Rusakov et al. 2015; Astakhov et al. 2016 etc.); ii) lack of absolute dating. It is generally accepted that since the Moscow glaciation degradation, prominent geomorphological events at its marginal zone have concentrated largely within the fluvial network. Hence, most of the landscape development reconstructions have been strongly biased towards understanding the fluvial landforms, sediment sequences and corresponding incision-widening-infill cycles (Panin et al. 2009). However, thorough understanding of clearly notable fluvial activity cycles creating the existing complex hydrographic network does not shed sufficient light on much slower and lower-amplitude evolution of interfluves characterized by a variety of genetic and morphological types (i.e. typical moraine ridges or hills, dead-ice moraine knob-and-kettle topography, glacial melt-water channels and outwash plains, glaciolacustrine depressions, etc.). The latter for a long time have remained poorly investigated.

The case study area of the Borisoglebsk Upland adjoins long-existing tectonic depression with inherited subsidence trend since Pre-Quaternary (Fig 1). Its central part is occupied by the Nero Lake providing continuous and prolonged sedimentary record for the

basin area. The existing palaeolandscape reconstructions for the surroundings are based entirely on integration of the lake sedimentary sequence, valley infills and correlated geoarcheological sites (Novskiy 1975; Gey et al. 2001; Sudakova 2014; Rusakov et al. 2015), reflecting local confined conditions. However, deciphering another part of the environmental change history carved into the interfluve morphology and surface sediments (Eyles 1979, Kaszycki 1987) has a great potential to support reliable extrapolation to regional-scale generalizations. In addition, in most of the studies interfluve surfaces are considered as relatively simply arranged geomorphic, lithogenic and pedogenic background. Nevertheless relic components such as remnants of periglacial microtopgraphic features and ancient fluvial network are observed almost everywhere in the landscape and soil cover structure (Eremenko et al. 2010; Novskiy 1975; Clayton 1964; Andrieux et al. 2016), testifying presence of fundamentally different environmental conditions during their formation. Origin of texturally differentiated sod-podzolic soils (albeluvisols, or retisols) of the region is also a matter of ongoing debate (Glushankova 2008). Contribution and relative importance of surface gleyization, lessivage and

podzolization, on one hand, and sedimentation features, on the other, into their formation and evolution has not yet been determined (Targulian 1974).

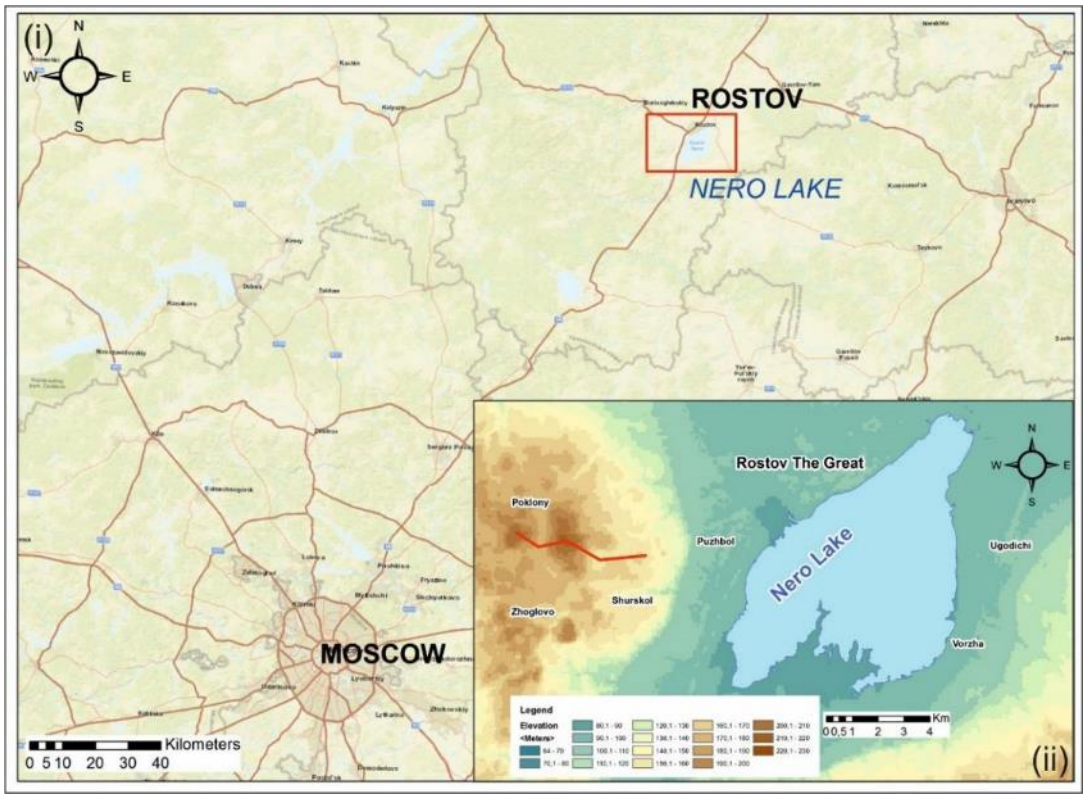

Fig. 1. (i) Case study area at central part of the Russian Plain (source: Google global topography, infrustructure and settlements); (ii) the Lake Nero depression and eastern slope of the Borisoglebsk Upland. Red line marks transect along the main reference sections and cores (source: ALOS 3D 30 m)

In order to decipher this natural archive, almost devoid of traditional palaeoenvironmental proxies, interdisciplinary research of interfluve surfaces and slopes geomorphic structure, lithology, textures and pedogenic properties of surface sediments has been carried out. It involved combination of several independent approaches including detailed geomorphic descriptions, DGPS-profiling, topographic maps and remote sensing data analysis (open source satellite imagery, global satellite DEMs, aerial photography using unmanned aerial vehicle), thorough description and sampling of one open geological section on the hilltop (4 m deep) and more than 20 cores up to 9 m deep along the selected transects. Integrating the available results, we propose a detailed scenario of the interfluve landscape evolution over the last ca. 150 ka for the Moscow glaciation marginal zone. It includes stages of ice cover degradation and successive glaciofluvial-glaciolacustrine transformation during the end of the

Middle Pleistocene, morpholithogenic evolution with continuous polygenic soil formation and superimposed cryogenic periods during the Late Pleistocene and Holocene.

Main morphologically distinctive types of interfluves can be determined considering the Borisoglebsk Upland general ridge-hilly glacial topography (Fig 2). Large (up to 1-2 km wide at base) elevated (214-160 m ASL, 25-50 m relative) flat-topped hills with several steps on comparatively steep (up to 15-20°) slopes dominate upper interfluve level of the area. The lower level (160-140 m ASL) is represented by less prominent but much more widespread smaller isometric typical moraine hills (relative elevation about 10 m, base diameter up to 500 m).

Fig 2. Two main types of interfluves of Borisoglebsk Upland: i) large elevated flat-topped hills and ii) less prominent smaller typical moraine hills

The two highest neighboring hills separated by deep dry valley headwaters have been investigated directly by cores and one large open geological section. Both hills expose similar geological composition with the Moscow till core overlain by thick (4->9 m) glaciolacustrine deposits. Relatively flat surface of the moraine at about 195-200 m ASL is overlain by 1->6 m stratified unit represented by thick (0.5-1 m) silty-sandy loams interbedded with thin stripes (3-15 cm) of fine sands. Upward, it is gradually replaced by 1-1.2-m layer of finely laminated silts and loams. The lower unit corresponds to accumulation in glacial lake environment with highly contrast sedimentary conditions. The upper unit reflects a shift to less dynamic sedimentary environment, most likely in shallow residual lakes with significant aeolian sediment input.

Comparative analyses and geological correlation based on detailed description, grain size analysis and DGPS-topography survey data led us to conclusion that glaciolacustrine unit topping both hills represent a remnant of a supraglacial (and probably transformed later into dammed proglacial) lake 4-4.5x2 km formed during the early stages of Moscow deglaciation.

Its bottom deposits were superimposed on the till surface during the non-uniform ice melting and thermokarst.

Several more or less distinctive leveled surfaces are found on the interfluve hillsides below 200 m ASL. Wider flattened fragments are covered by well-sorted glaciofluvial sands while gently inclined ones are presumably cut directly into the glacial deposits and reveal evidences of dominant erosion. Both types of interfluves are separated by gently outlined linear (open) or more isometric (closed) depressions apparently inherited from the glacial meltwater channels (the former) or dead-ice moraine kettles (the latter), later infilled by lacustrine, alluvial and colluvial deposits.

Moraine knob-and-kettle topography and sequences of distinctive leveled units at different elevations on interfluve hillsides (Fig 3) suggest that large blocks of dead-ice were likely to survive in the terrain depressions during the Moscow glacier ongoing degradation. Promoting formation of ice-dammed proglacial lakes and temporary base levels for local erosion (i.e. meltwater channels) they either slowly melted or caused sudden outbursts. These processes in general led to leveling of the landscape, though at places also left several over-deepened (>10 m) depressions at the foothills. Lake outbursts caused formation of the primarily melt-water channels network. It has the greatest extent, stretches mostly from N toS and from W to E and displays clear evidences of several headwaters interceptions. Nowadays it is partly inherited by the modern small river valleys. Incisions of smaller and steeper radial hollows on the upper interfluve hillsides was associated with less intensive erosion under conditions of surface runoff base levels relatively stabilized on higher levels than the present valley and depression bottoms. Thus, fans of those former gullies are bound to the differently elevated base levels (marking the stages of water-table decline) and now are hanging on sides of the later infilled depressions. As a result, the modern fluvial network generally inheriting the ancient one is clearly separated into two parts with upper reaches practically disconnected from the main fluvial network by the infilled lake or dead-ice depressions.

Such a tentative reconstruction of events makes it unnecessary to involve the unrealistic hypothesis of dramatic rise of the Middle Pleistocene Nero Lake level up to 190-140 m (100 m above its present level) to explain formation of high terrace-like surfaces. Such an extreme stage of the Nero Lake evolution was proposed by several authors (Trudyi... 1958; Kvasov 1975) as a part of the great glacial lake chain supposedly developed in the Middle-Late Pleistocene in the entire Upper Volga River basin as a combination of a series of moraine dams and glacioisostatic uplift. However, careful estimations of the available water sources and dam sizes do not support such enormous waterbody existence. The ultimate decay of glacial ice within

the Nero depression was immediately followed by the first and deepest fluvial incision stage (up to 25 m) at the end of the Late Moscow glacial (MIS6). The successive prolonged period of landscape stability was mainly marked by pedogenesis which left fragments of texturally differentiated soil profile (presumably of the Early Mikulino – Early Eemian – age, MIS5e) found in cores on top of the eroded Moscow till surface.

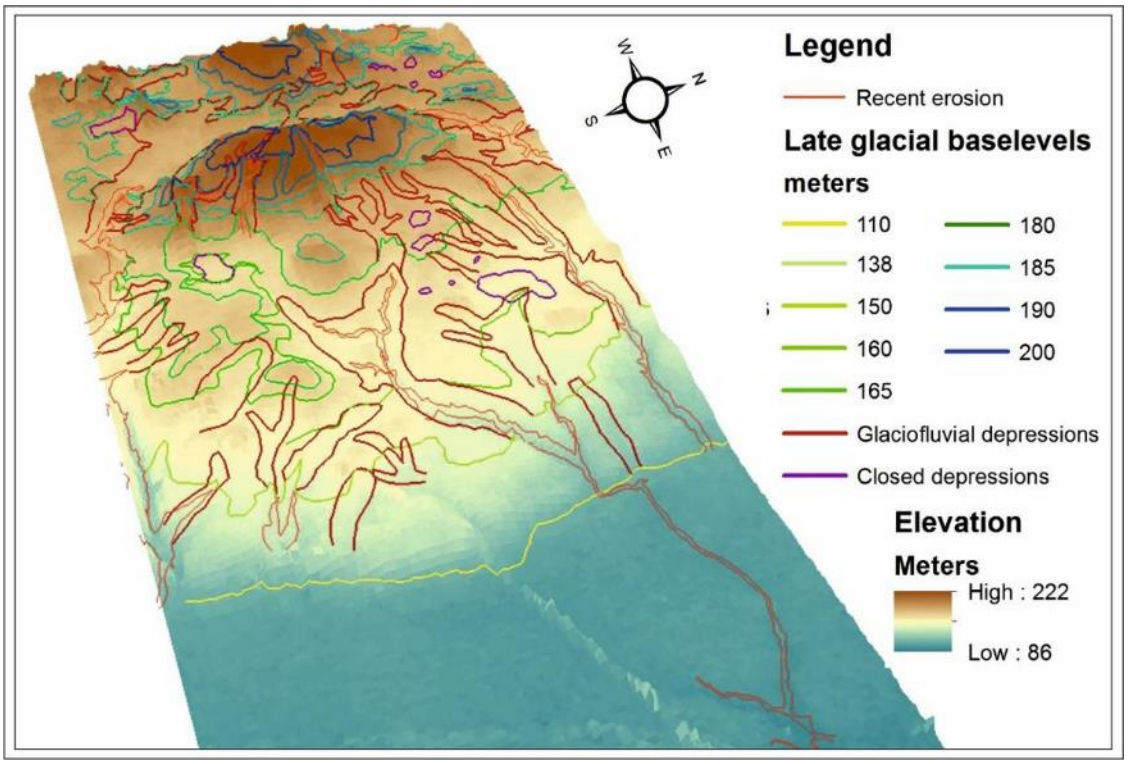

Fig 3. Late Pleistocene relict geomorphic features in the modern landscapes of case study area, the eastern slope of Borisoglebsk Upland (source: ALOS 3D 30 m).

Summits and slopes of both upper and lower interfluve levels are overlain by relatively thin (2.1-3.2 m) heterogenic cover of non-laminated mantle loams possessing strong traces of complex reworking by cryogenic, pedogenic and slope processes. Cryogenic textures have been found in several layers from small-scale cryoturbations along the upper contact of glaciolacustrine units to large (>2 m) frost mound and ice wedge formations involving both lake (or glaciofluvial) and mantle loams and superimposed small-scale polygonal nets in the upper part of cover loams only. This sequence of cryogenic deformations most likely reflects gradual drying trend of hilltops conditions probably due to draining of watershed lakes and puddles and generally lower moisture content of surface sediments towards the end of Late Pleistocene. Pedogenic features show, at least, two generations of texturally differentiated soils developed on surfaces of various ages and elevations. Structural and grain size properties also suggest that the two layers of cover loams can be distinguished. The lower one has complex

structure and is characterized by more sandy composition and limited presence in cores and outcrops. The upper one is homogenous and covers not only all the interfluve surfaces and slopes but also the Nero Lake terraces higher levels. Therefore, we consider the lower layer to be deposited during the final stages of Moscow deglaciation (MIS6) and serve as a parent material for the Mikulino pedogenesis (MIS5e). It was substantially disturbed during one of the successive Late Pleistocene cold periods, presumably Early-Middle Valdai periglacial (Weichselian). Thus, the Middle Valdai period (MIS3) could be associated with formation of frost mounds landscapes in warmer, wetter, but yet relatively cool conditions. Those were followed by one of the coldest periods of Quaternary history – the Late Valdai periglacial (Last Glacial Maximum – MIS2) – when the upper stratum of mantle loams have emerged due to the aeolian deposition and was cracked by the polygonal nets due to permafrost development under extremely dry conditions. Afterwards texturally differentiated sod-podzolic soil have developed superimposed on those sediments and cryostructures over the Holocene.

The present-day fluvial network often inherits the ancient meltwater channels of the Late Moscow age, but does not penetrate as far into the most elevated parts of interfluves (Fig 3). However, cores obtained from the Late Pleistocene infills of glacial depressions (up to 7-8 m thick) show a number of alluvial layers (from coarse sands to laminated loams with humic layers) above or within thick lake sediments (silts and silty loams with peat lenses). It indicates that fluvial incision and infill of more limited amplitude have been active here at least once during the Late Pleistocene (probably in MIS3) and were interrupted or slowly shifted to stagnant waterlogged basin conditions by increasing colluvial sedimentation (transition to MIS2). The overlying loamy deposits show patterns typical for colluvial material corresponding to the widespread permafrost with apparently thick active layer during the LGM and end of the Late Pleistocene (second part of MIS2, probably correlated to the time of polygonal net formation on the hilltops). The main Early Holocene fluvial incision stage and the following minor erosion episodes have not spread further up than the lower interfluve level. Only a few of small radial gullies drainig the upper interfluve hillsides exhibit noticeable signs of modern incision whereas the larger ones in the main modern valleys headwaters presently remain complitely stable. Most likely it can be explained by combination of insufficient runoff discharges and domination of generally forested catchments.

It can be concluded that the interfluve landscapes and environmental conditions at the Moscow glaciation marginal zone have experienced distinctive evolutionary changes over the last ca. 150 ka. Several stages of ice cover decay and consequential glaciofluvial-glaciolacustrine transformation could be distinguished during the end of the Middle Pleistocene

when initially supraglacial and later moraine-dammed proglacial lakes and dead-ice masses strongly controlled rates and distribution of erosion and sedimentation. Later on, those were followed by relatively slow morpholithogenic evolution of the hilltops with continuous polygenic soil formation and superimposed cryogenic disturbances periods. Simultaneously, upper parts of glacial depressions (meltwater channels and dead-ice moraine kettles) have been gradually incised, infilled and flattened by lacustrine, alluvial and colluvial deposits with at least one distinctive period of fluvial incision during the Late Pleistocene. The present-day fluvial network takes over the ancient meltwater paths only at the lower interfluve level, leaving the Late Pleistocene exterior of the higher elevated parts almost unchanged.

The study was funded by RFBR project № 18-05-01118 and GM AAAA-A16-11632810089-5.

Keywords: Interfluves evolution, glaciation, Pleistocene, pedogenic, cryogenic.

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BACK

HOLOCENE FIRE REGIMES IN THE EAST EUROPEAN PLAIN: CLIMATE CHANGE OR HUMAN IMPACT?

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Fire frequency was reconstructed on the base of macro- and micro-charcoal concentration in peat cores from five key areas, located in different landscape zone of European Russia: Ustijanskoe plateau in Archangelsk region (middle taiga), southern part of Valdai Hills (the Central Forest Biosphere Reserve, south taiga), Meshchera lowlands and Mordovia State Natural Reserve (Polessie-type landscape, mixed coniferous-broadleaf forests) and Mid-Russian Uplands (Kaluzhskie Zaseki State Natural Reserve, broadleaf forests). The obtained results showed that the beginning of human occupation of the areas is clearly marked by increased fire activity. However, in the Polesie-type landscapes (Meshchera lowlands, Mordovia) periods of increased fire activity occurred prior to the occupation of these areas by human, when the influence of anthropogenic factor was minimal. The highest frequency of fires in key areas of "Meshchersky" and "Mordovia" is determined for a period 9000-6000 cal. years BP and 3500 – 2500 cal. years BP, and about 1000 cal. years BP, when fire-free interval ranged from 15- 20 to 120 years. In the landscapes of moraine and moraine-fluvioglacial plains covered by taiga spruce forests or mixed spruce-deciduous forest fires were extremely rare until the economic development in the Historical time (the last 300-500 years). For example, in the area of the Central Forest Biosphere Reserve only three severe fires were revealed between 7000 and 500 cal. years BP. In the "Ustjansky" area fires were detected only at the beginning of the 20th century. In the key area "Kaluzhskie Zaseki", located in the broadleaved forest vegetation zone a significant increase in fire frequency was revealed around 2000 cal. years BP (Early Iron

Age) and the maximum frequency of fires (8 fires per 1000 years) was reconstructed for the last millennium.

This study was supported by the Russian Science Foundation (Grant 16-17-10045).

Keywords: Holocene, Fire History, European Russia, human impact.

BACK

THE TRANSITION FROM INTERGLACIAL TO GLACIATION IN THE LOESS-PALEO-SOIL MEMORY AS THE ANALOG OF THE MODERN CLIMATIC ERA

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Frontier 117-115 thousand years ago was the transition from the previous interglacial (MIS 5e) interglacial MIS 5e to the last glacial to the glaciation (MIS 5d). It can be considered as a model of the modern era – the transition from the Holocene to the subsequent glaciation. Modern interglacial climate era is over. The last completed interglacial period was warmer than Holocene, but was characterized by repeated sharp drops in temperature. The markers of natural events can be identify in the loess-paleosoil sections: 1. Buried soils and soil-like formation (pedoliths, pedosediments, etc.). 2. Buried geomorphological forms, surfaces, erosion lines, disagreement of bedding layer. 3. Lithological layers with characteristic textural features: pyrogenic, volcanic ash, basal, biotic (peat and wood layers, bone clusters etc.), cultural layers of the settelments, etc. 4. Postcryogenic deformations (the features of seasonal perennial frost) cracks, wedges, pseudomorphs, cryoturbations, solifluctions, postcryogenic textures. 5. Traces of a sharp change of hydrothermal, gravity and tectonic conditions.

Paleogeosystem components responsible for the different phases of climatic rhythm. Soils are the markers of warming. They reflect the phases the most favorable for biota during the interglacials, interstadials, interphasials. Rocks (especially with cryogenic features) are the markers of cooling. They form during the least favorable phases for biota: glaciations, stadials, phasials. Landforms, high rates of sedimentation characterize unstable, transitional phases, also unfavorable for the development of the biota and soils. The ratio of the three factors determines the basic structure of the climatic rhythm. The structure of Interglacial - Glaciation rhythm can be determined according to the role of leading environmental (pedo- and morpholithogenic) processes. Relief-forming processes prevail during glacial to interglacial transition and vice versa: aeolian and slope sedimentation, cryogenesis, cutting, aggregation of forms and relief planation. The leading soil forming processes during the warm half-cycle are: humification, textural differentiation and gleyization. Pyrogenic layer in the top of Last interglacial Ryshkovo soil (MIS 5e) the evidence of a catastrophic fire at the end.

BACK

CORRELATION OF THE PALEOGEOGRAPHICAL EVENTS IN THE CASPIAN SEA AND ON THE EAST EUROPEAN PLAIN DURING THE LAST GLACIAL EPOCH

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The problem of correlation between transgressive-regressive oscillations in the Caspian and glacial events on the East European Plain is of great importance in Pleistocene paleogeography. There is no unequivocal opinion on the correlation scheme. The authors have carried out complex paleogeographic analyses of the boreholes cores from the Northern Caspian Sea. Paleogeographic evidence on events on the Plain is based on published data. The conclusion is made the events during the last glacial epoch (MIS 2) left their distinguishable imprint on the Caspian Sea environment evolution. As follows from the analysis of seismic-acoustic profiles and drilling data, the stages of glacial epoch development are quite distinguishable in the sedimentary sequence. Before the LGM the development of the interstadial warming led to increase in the surface runoff from the catchment of the Caspian and resulted in the rising of the lake level (Atelian) and the onset of the first stage of the Khvalynian transgression. The level rising was interrupted during maximum cooling and aridization at MIS 2 (Late Valdai) and resumed when the ice sheet was decaying. The events known as warm phases of Bølling and Allerød promoted the ice sheet melting along with thawing of permafrost, the latter having been widespread in the Volga drainage basin. All the above contributed to the Khvalynian transgression. The ‘chocolate’ clays were accumulated in the Volga estuary and in depressions in the Pre-Khvalynian relief. Phases of a cooling known as the Oldest, Older and Younger Dryas marked by a decrease in the runoff volume from the Caspian drainage basin are correlatable with regressive stages in the Khvalynian basin history. The best pronounced of them corresponded to the Younger Dryas. The Khvalynian came to its end at the first sharp warming that resulted in the rise of the Caspian level and is generally taken as marking the Pleistocene/Holocene boundary. The Mangyshlakian regression is dated to the

Holocene and was essentially a response to the increase in the climate continentality. The work is supported by the RSF (Grant 16-17-10103).

Keywords: Last glacial epoch, Caspian Sea, East European Plain, events, correlation.

BACK

LATE GLACIAL AND HOLOCENE VEGETATION AND CLIMATE HISTORY OF THE EASTERN SAYAN MOUNTAINS (SOUTHEASTERN SIBERIA)

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The central parts of the Asian subcontinent is particularly sensitive to climatic changes, for these areas far removed from the influence of oceans, and therefore have continental climate with large amplitudes of daily and seasonal temperatures. Any moderate strengthening or weakening of these types of air circulation may have pronounced effects on adjacent areas.

The lava flows and volcanoes in the Zhom-Bolok River valley in the Eastern Sayan Mountains are unique, because they are the largest manifestations of the Late Pleistocene-Holocene eruptions in the Central Asia Region. The chronology of volcanic events is still poorly investigated. It is only known that lava outpourings were multiphase here, began in the postglacial time, and continued through the last millennium. The volcanic events were accompanied by the formation of large dammed lakes. In the headwater of the Zhom-Bolok River valley, some such water reservoirs are observed even today. Mountain lakes are commonly undisturbed or slightly disturbed ecosystems readily responding to natural changes in their basins. That is why the sediments of such lakes are used as valuable archives to reconstruct the paleoenvironment. The main objective of our research was to study changes in the natural environment of the Zhom-Bolok volcanic region recorded in the sediments of lava-dammed Khara-Nur Lake (absolute altitude 1651 m) and proglacial Kaskadnoe Lake (absolute

altitude 2080 m) and to explain their causes in connection with global/regional climate changes and volcanic activity over the last 14300 calibrated years.

The work has been done under the support of the Russian Science Foundation (Grant No 16-17-10079).

Keywords: lacustrine sediments, pollen and geochemical records, climate change, volcanic activity, vegetation response, Late Glacial, Holocene.

BACK

ANALYSIS OF LATE HOLOCENE NATURAL DISASTERS ON THE SOUTH FAR EAST COASTS FOR THE PROGNOSIS PURPOSES

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The analysis of natural disaster manifestations, identification of their scales and frequency on the base of paleodata is one of the tasks for the land use strategy on marine coasts. The most of Far Eastern coasts are tsunami-hazardous. Paleotsunami records were constructed for South Far East, which allowed to establish age, repeatability and parameters of strong events. Late-Holocene strong tsunami were larger events than those of XX century. In the Southern Kurils frequency of strongest tsunami over the past 2500 years is about 300 years, vertical run-up exceeded 8-10 m, flooding areas were hundreds meters. For the Sea of Japan paleotsunami records for the last 3550 years suggest that major tsunami occur every 200 years. The run-up heights can reach 5-7 m, the inundation zone usually up to 300 m, in rare cases – up to 800 m. Strong tsunami are accompanied by intensive erosion that altered the coastline. Sand sheets on coastal lowlands (up to tens cm) can radically change the ecological situation. Tsunamis even with small run-ups can endanger tourists and temporary structures located on the coasts, which must be considered in the development of recreational land use planning. Large effect on coasts development will exacerbate the storms caused by intensification of cyclonic during global warming. Extreme storms, whose impact on the coast exceeds the ordinary storms influence zone, can lead to significant changes of coastal zone, for example extreme storms on Southern Kurils in 2006-2007. In the south Far East, catastrophic floods occur periodically, which can lead to river mouths zones changes. The periods of intensification of floods in last 2.2 ka are established. The most severe floods occurred in the Medieval Warm Period and warm phases of Little Ice Age. Modern analogue is the changes in climatic regime at 21st century, which is characterized by drop in surface atmospheric pressure, increased cyclonic activity, the frequency of extreme cyclones that produce strong rains. Strong floods

began last 210 years in the conditions of trend to warming. Reduction of flood activity, as a rule, occurred in coolings. Grant VAST-18-010.

Keywords: natural disasters, tsunami, storms, floods, Holocene, Russian Far East.

BACK

ENEOLITHIC SETTLEMENT TURGANIK IN THE STEPPE CIS-URALS – FUNCTIONING UNDER CHANGING CLIMATIC CONDITIONS IN THE SECOND PART OF THE HOLOCENE

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The multi-layered settlement Turganik in the Tok River valley (steppe region west of the Urals) has been studied using paleopedological and paleobotanical methods. The early humans lived there in the Eneolithic epoch (the 5th millennium BC) and in the Early Bronze Age (the 4th millennium BC). The cultural layers attributable to the Atlantic period of the Holocene developed under conditions of a rather dry climate, the landscapes being dominated by the grass and herb steppe. The settlement area was above the flood water level and was suitable for habitation. The soils in its vicinities met the criteria for the Kastanozems (Endosalic Protosodic). The final stages of the cultural layer formation bear traces of strong (though short-term) floods, the deposits of the latter partly concealed traces of the preceding long-term arid phase. The maximum of aridity falls on the final interval of the Atlantic period. The Subboreal and Subatlantic periods were noted for meadow-chernozem soil formation (Luvic Chernozems (Stagnic)) and an increasing proportion of arboreal species in the pollen assemblages. Some phytoliths of aquatic plants were found in the assemblages dominated by those of meadow grasses. The climate was more humid and cool, though short episodes of aridity could occur.

This study was supported by the Russian Science Foundation, project no. 16-17-10280.

Keywords: Eneolithic settlement, cultural layers, paleopedological method, paleoenvironmental reconstructions, mid-to late Holocene.

BACK

LAND USE RECONSTRUCTION BASED ON HISTORICAL DATA: CASE STUDY – MESHCHERA LOWLANDS IN 16-18 CENTURY

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Historical materials are an important data for the reconstruction of long-term landscape changes. In our study we made a reconstruction of the land use for the key area located in the Ryazan region at the junction of two landscapes: a low, largely swamped, with poor sandy substrate and high, better drained, with loamy soils. Basic materials for reconstruction were scribe books ("piscovie knigi") of the 16th century. They contain text information about the types of land use and their areas that belonged to a particular village. They were also accompanied by the characteristics of boundaries of landholdings in the form of text descriptions. General Land Survey materials (18th century) and modern landscape maps were used to accurately allocate land use form scribe books. The reconstruction was carried out using a model based on logistic regression. The model was trained on the spatial distribution of land use obtained from General Land Survey maps, depending on natural and socio-economic factors. "Natural factors" meant the relief, quality and moisture of soils, etc. "Socio-economic" – population density, distance to rivers, villages, roads, etc. Then we changed in the model input data: population density and other socio-economic features according to scribe books, plus the share of the land use, which was required to obtain as a result of modelling. Thus, the reconstruction of lands for the mid-16th century was carried out. Results showed that although the proportion of arable land was somewhat less than in the 18th century, the spatial distribution remained restricted by natural factors. In addition, the relationship between the population density and the share of arable land was not linear, which must be taken into account in reconstructions based on the assertion that the population density is related to agricultural development.

The study was supported by Russian Science Foundation, grant № 16-17-10045.

Keywords: land use reconstruction, General Land Survey, scribe books, modelling.

BACK

LOW RIVER TERRACES IN SELENGA RIVER BASIN: STRUCTURE, STAGES OF FORMATION AND SEDIMENTATION

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The analysis of published materials on morphology and structure of low terraces is carried out. New data about covering and alluvial deposits age of terraces, the phases of penetration and filling of valleys with sediments, stages of exogenous processes activation and pedogenesis in drainage basins and river valleys were obtained (Konstantinov et al., 2016; Ryzhov et al., 2016; Ryzhov, Golubtsov, 2017).

In the Selenga river basin are allocated to low (1-2 m) and high flood-plain, three low terraces, respectively, 5-7, 7-9, and 10-12 m (Bazarov, 1986), 6, 9-11, 14-16 м (Konstantinov, 1994).. First terrace alluvium lies at altitudes up to 4 m above low flow line, has Holocene (11.7-3.4 cyr BP) age, and covering deposits before 2 m (Ust-Menza-1, Studenoye-1, Tarbagataika-1). Alluvium of the second terraces lies on heights - 4-7 m and were formed in the Late Pleistocene and Early Holocene, (Ust-Menza-2, Studenoye-2, Tarbagataika-2). The third terraces (10-16 m) are distributed locally in the Western Transbaikalia. Terraces consist of covering deposits, small thickness sandy alluvium (MIS 4 - first half of MIS 3 ages), have high gravel position. Buried soils lie in bottom of covering sediments have ages <35 cyr BP (Ust-Menza-13, Chitkan, Melnichnoye, Fomichevo).

In terrace sections are distinguished relatively short cutting phases and longer stages of sediment accumulation. Flood-plain and covering deposits were alternated with soil layers. Low (I-III) river terraces have the Late Pleistocene and Holocene ages. Third terrace erosion scarps are formed in the second half of MIS 3 (35-30 cyr BP), second terraces - in Late Pleistocene and Holocene (14-10 cyr BP), first terraces - 8-3.4 cyr BP.

BACK

THE RESPONSE OF SMALL TRANSBAIKALIAN RIVER SYSTEMS TO ENVIRONMENTAL CHANGES DURING THE LATE GLACIAL AND HOLOCENE

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Detailed studies of Late Glacial and Holocene sediments of the slopes, valleys of temporary streams in the Selenga Middle Mountains has allowed to identify nine periods of activation of exogenous processes and of sedimentation and the eight phases of intense pedogenesis during the last 15 thousand years. (Ryzhov et al., 2016). The study of sediments of the first and second terraces of the Tarbagataika river and radioisotope dating milestones different water flow, accumulation of alluvial and covering deposits, soil formation, river incisions.

The most dramatic changes were observed in Late Glacial period (14,6-11,7 cyr BP). During interstadial warming (14.6-12.9 cyr) polygenetic deposits were accumulated in river valleys, on the slopes. Periodically, they were affected by soil formation (Golubtsov et al., 2017). In the conditions of growth of winter and summer air temperatures and precipitation (Bezrukova et al., 2011) process of permafrost degradation, fluvial, erosion-accumulative, piping, thermokarst were activated (Ryzhov et al., 2015).

In stadial (12,9-11,7 cyr. BP) climate became cool and dry. Cryogenic, aeolian and deluvial processes dominated in drainage basins. In deposits were allocated 1-3 cryogenic layers (Ryzhov, Golubtsov, 2018).

Early Holocene warming caused the change from mineragenic to organogenic deposits. The permafrost degradation of in the Early Holocene caused an activation of pedogenesis, erosion, piping, thermoerosion and thermokarst processes (Ryzhov et al, 2015). During this time stackable floodplains were formed in river valleys (Geology..., 1982).

Changes in climate in the middle and late Holocene are reflected in the soil-sedimentary sequences (Golubtsov et al., 2017). Soil and sediment layers alternation indicate environmental changes. The last 1000 years for the Selenga river basin are characterized by progressive increase of anthropogenic press, grazing and overgrazing. The last 250 years were growth of croplands, erosion and accumulation accelerates.

BACK

MARIAN ONE GEOGRAPHY OR COMPLEX OF EARTH SCIENCES-STUDYING CHANGES OF EARTH SURFACE IN SPACE AND IN TIME

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Geography is a science about the earth's natural environment, which man manages. It is the science about circulation of matter and energy exchange that are spatially differentiated and that control diversity of ecosystems. Today, elements of the environment are subject of study of independent sciences branches (like geomorphology, pedology, hydrology, etc.) that are enrooted in geography. On the other hand, social-economic geography examines the effects of human activity in the environment — it should bridge the gap between the earth sciences, economy and social sciences.The other basic issue next to spatial distribution is time. Its role is revealed through monitoring of processes, by paleogeographic examinations and historical research. Therefore, in forecasting, a special role belongs to sciences that emerged from geography. To be able to face these boosted changes combined with the degradation of environmental resources, it is necessary to extend the range of research with a better engagement of physics, chemistry and biology. It is the aim of "global science" including monitoring of all processes in global scale. The changes in atmospheric systems' and water circulation lead to shifting the boundaries of climatic zones and to degradation of geoecosystems. To meet this challenge, we must think about creating interdisciplinary problem teams. We must activate existing organizational structures of science, in particular geographic sciences, drawing upon research centres that conduct studies at different spatial scales yet in conjunction with global programmes. Such a center is the Institute of Geography of the Russian Academy of Sciences which developed interdisciplinary methods in palaeogeographic research of several climatic zones with diverse landscapes. Geography of the future should draw upon knowledge of scholars of various specialties investigating ever-changing nature, seeking

solutions to situations that require intervention both on a global and regional scale. We must make the society aware of these issues.

Keywords: global changes, earth sciences, place of geography.

BACK

POSTER

PALEOGEOGRAPHIC ANALYSIS OF THE VALLEY OF THE RIVERS SUKHONA AND KUBENA WITH GIS

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The relevance of research paleorelief and paleobasins of south-eastern part of the Scandinavian glaciation predestined by insufficient knowledge. Surface of the study region qualified by high diversity of modern and paleo landforms forming peculiar geomorphological and hydrological systems, the analysis of which allows to refine the development of the reference territory of the glacial marginal zone.

The rivers Sukhona and Kubena belong to the basin of the Northern Dvina and were formed after deglaciation in the southeast periphery of the Scandinavian glacier. Analysis of the valleys of the rivers Sukhona and Kubena includes two stages. At the first, a database of baseline data is created on the basis of paleogeographic, geological, geomorphological and hydrological sources. The features of the longitudinal profile of rivers are revealed, the valleys of rivers are classified according to the features of the relief and lithology of the Quaternary rocks. Areas with the maximum and minimum cut in the bed of the rivers, slopes and places of flow of the river along the paleozoic basins are identified. In the second stage, longitudinal vertical river profiles were obtained based on the DEM and the Arcmap program and 3D Analyst Tool tools and their paleogeographic zoning was carried out. Conclusions: the modern valleys of the Sukhona and Kubena rivers are represented by different genetic sites; the sections

on which there was a change in the direction of flow and changes in the pattern of the hydrographic network were identified; Key sites for sampling for dating have been identified.

The results will be used to expand the paleoreconstruction in the basins of the rivers of Kubena and Sukhona.

Keywords: GIS, paleolakes, River Sukhona, River Kubena.

BACK

HYDROCLIMATIC RECONSTRUCTIONS FOR THE EAST EUROPEAN PART OF THE BLACK SEA BASIN IN THE BOREAL PERIOD OF THE HOLOCENE

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Reconstruction of the climate and water runoff from the territory of the East European Plain in the early Holocene is of key importance for testing the hypothesis of catastrophic flooding of the Black Sea basin in the Holocene (Ryan et al. 1997). According to this hypothesis, up to the end of the Boreal period of the Holocene, the level of the Black Sea stood at 100 m below sea level and then geologically instantaneously climbed to minus 40 – 30 m as a result of the overflow of the World Ocean waters through the Bosporus sill. Preservation of low levels of the Black Sea was possible only with a deficit of the incoming part of the water balance, the bulk of which is composed of river runoff from the catchment area. Palynological data on the sections located in the basins of the Don and Dnieper rivers and in the adjacent territories dated by the radiocarbon method, allow us to reconstruct the state of vegetation and climate in this part of the Black Sea basin in the Boreal, 9.3-8 kyr ^{14}C BP (10.5-8.8 kyr BP calibrated). These data make it possible to assess the probability of the existence of dry conditions postulated in a number of works that caused a decrease in the Black Sea level below the Bosporus sill.

The composition of the pollen spectra of the Boreal time reflects the predominant distribution of birch forests or, in areas of extensive development of sandy soils, pine-birch forests. North of 50-53°N in the undergrowth of these forests cryophilous shrubs (*Betula humilis*, *B. nana*, *Alnaster fruticosus*) occurred. A significant proportion of the non-arboreal pollen in the spectra and the presence of xerophyte pollen (*Ephedra* spp., *Cannabis*) indicates a sparse nature of these forests and the significant role of open grassy formations in the vegetation cover. Throughout the Boreal, the participation of cryo- and xerophytic elements, inherited from the periglacial vegetation of the Late Glacial, gradually decreased. In the south of the forest zone in the second half of the Boreal, pollen of mesophilous and relatively thermophilic elements, in particular broad-leaved species of oak forest (*Quercus*, *Ulmus*, *Tilia,*

Corylus), appeared in the spectra. In the south-west of the territory under consideration, in the basin of the Southern Bug, broadleaf forests have already been developed in the Boreal period. As in Western Europe, the maximum of *Corylus* pollen, marking their formation, there corresponds to the Boreal. South of the forest area, there was a strip of birch forest-steppe with broad-leaved species in the west, on the right bank of the Dnieper, and with considerable participation of pine on the interfluve of the Dnieper and the Don. The steppe zone occupied the lower reaches of the Dnieper basin and almost the entire Don basin. In comparison with the current situation, the sub-zone of the forest-steppe expanded; in the Don basin, its boundary passed 200-300 km further to the north than at the present time. Within the steppe zone, pollen of broadleaf species is present in the spectra throughout the entire Boreal period, and its amount gradually increases with time. This reflects the process of the increasing role of 'bairak' and floodplain forests in the steppe zone.

For the reconstruction of the main climatic parameters of the Boreal using the palynological data, we applied two methods, complementing each other.

The first method, developed by V.P. Grichuk (1969), is based on the study of the composition of fossil floras (the so-called method of arealograms). The basis of this method is the assumption that the ecological and climatic requirements of plant species remained unchanged, at least during the Late Pleistocene. If the boundaries of the range of a plant are determined primarily by its requirements for heat and moisture, then the climatic conditions in the territory, where most of the species of a fossil flora (the so-called region-analogue) now grow together, must correspond to the climatic conditions of the place and time of this fossil flora formation. The location of the current concentration of species of a fossil flora (CCS) is determined by overlapping the modern ranges of plants that make up this flora. Using the method of arealograms, reconstructions of the main climatic indices necessary for calculating the annual runoff layer (the sum of the positive mean monthly temperatures and the annual precipitation sum) were performed for four fossil floras (Fig. 1). Their Boreal age was established by radiocarbon dating of corresponding sediments. The climatic indices in the locations of the studied sections and in the CCS of fossil floras are determined from the digital maps from the Agroecological Atlas of Russia (Afonin et al. 2008).

The second method used is close to the "zonal analogues" approach proposed by Savina and Khotinski (1982). They established the limits of variations of the main climatic parameters characteristic of each vegetation zone; vegetation at the zonal level was reconstructed according to palynological data (the general composition of spectra – the ratio of arboreal pollen, non-arboreal pollen, and spores – and the contents of the main taxa). To determine the nearest

modern analogues of the vegetation of the Boreal more precisely, at the level of subzone (for example, the northern, middle and southern taiga), or of the groups of formations (such as pine forests with the participation of oak and of other broad-leaved species, birch forest-steppe, etc.), we also took into account the most informative minor components of the pollen spectra. For example, the presence of pollen and spores of Arctic and sub-Arctic species of herbaceous plants and of microthermal shrubs allows us to use the forest-tundra rather than the northern taiga as a modern analogue, in spite of very similar composition of the main components of the pollen spectra typical for these zones. The difficulties encountered in the reconstruction of the paleoclimate of the Boreal period of the Holocene by statistical methods based on the composition of the pollen spectra are primarily related to the important role of pioneer tree species (birch and pine) in the Early Holocene vegetation. At that time, under conditions of rapid warming, the forest zone formed on the East European Plain. On the one hand, fluctuations in the content of pollen of pine and birch, which have an extremely high pollen productivity, mask the changes in the content of pollen and spores of other plants. On the other hand, the widespread development of secondary birch forests in the modern (anthropogenically altered) vegetation cover of this territory makes it difficult to find modern analogues of such spectra. Direct analogues of some plant communities of the Boreal (for example, primary, indigenous birch forests) on the East European Plain are absent.

Analogues of the vegetation of Boreal time were determined for eight sections located on the East European Plain, studied in detail and dated by radiocarbon method (see Fig. 1). For these modern "zonal" analogues, the mean values of mean monthly temperature sums above zero and annual precipitation were calculated using maps from the electronic Agroecological Atlas of Russia (Afonin et al. 2008). The reconstructed climatic indexes of the Boreal were then compared with the corresponding modern climatic indexes at the studied sites. The sections used for reconstruction are located in different climatic conditions, from the steppes to the northern taiga forests. Comparison of modern and reconstructed by the two methods described above climatic parameters shows that the climatic conditions of the Boreal differed from modern ones mainly by lower winter temperatures (by 3-5°C lower than the modern ones), while the summer was warm (mean July temperatures 0.5–1°C below the modern ones). The annual amount of precipitation was close to the present-day one (10% less on average). Thus,

the climate of the Boreal was characterized by greater seasonal contrast (continentality) compared with the modern one.

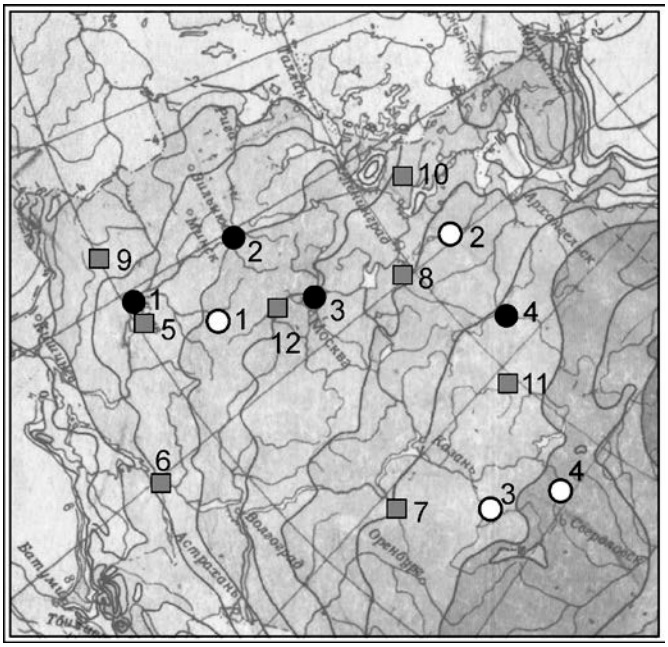

Fig. 1. The sites with palynological data used for reconstructions with the method of arealograms (1-4 – the sections and their corresponding CCS – empty circles) and with the method of vegetation analogues (5-12). 1 – Kikolovo (Borisova 1994); 2 – Ponizovye (Borisova 1994); 3 – Dolgoye (Kremenetski et al. 2000); 4 – Baika (Borisova 2002); 5 – Gelmyazevskoye (Bezusko et al. 1988); 6 – Rakushechny Yar (Borisova 2011); 7 – Pobochnoye (Kremenetski et al. 1999); 8 – Galich Lake (Velichko et al. 2001); 9 – Starniki (Bezusko et al. 1988); 10 – Gotnavolok (Jelina 1985); 11 – Chus (Pakhomov et al. 2004); 12 – Butovka (Borisova 2005).

Based on the comparison of modern and reconstructed climatic parameters, transfer functions were developed for the transition from the present sum of mean monthly air temperatures above 0°C and the annual amount of precipitation to the corresponding indicators of the Boreal. Based on the assumption of a principle similarity of the general geographic patterns of the Holocene climates, maps of the main climatic indices for the Boreal period were designed. They were subsequently used to calculate the mean annual runoff depth for the East European Plain in the Boreal. For the calculation of the mean annual runoff depth, a generally accepted method of water balance in the form:

$$\boldsymbol{X = P\text{-}E} \qquad (1),$$

where *X*, *P*, *E* are the mean long-term values of the runoff depth (mm per year), precipitation and evaporation. The approach proposed by V.M. Evstigneyev (Kislov et al. 2008) for

conditions of limited initial information, when only values of precipitation and air temperature are available.

In this approach, the calculation of the evaporation E is reduced to estimates by the equation $E = f(P, E_0)$, where E_0 is potential evaporation. Potential evaporation, in turn, is found from empirical relation with the sum of the mean monthly air temperatures above zero T_0. According to the data for river basins of the East European Plain,

$$E_0 = 6.72 T_0 \qquad (2).$$

To approximate empirical equations of the form $E = E(P, E_0)$, the Mezentsev function (Mezentsev and Karnatsevich 1969) is used in the form of

$$e = I\left(1 + I^n\right)^{-1/n} \qquad (3),$$

where $I = E_0/P$, $e = E/P$. The parameter n is obtained by the method of ordinary least squares. For the East European Plain, n = 3.8.

The map of the runoff depth for the territory of the East European Plain in the Boreal period of the Holocene, calculated on the basis of the sum of the positive mean monthly air temperatures and the annual sum of precipitation, is shown in Fig. 2.

Fig. 2. The mean annual runoff depth in the Boreal period of the Holocene (mm).

The calculations show that in the Boreal the total runoff from the Dnieper River basin was approximately equal to the modern one, in the Don basin the runoff exceeded the modern

one by 9%, and in the Volga basin by 5%. Thus, there is no reason to assume that the climate in the Boreal could lead to a significant reduction in river flow from the East European Plain and to a drop of the Black Sea level below the Bosporus sill.

This study contributes to the Russian Academy of Sciences Fundamental Research Program, paragraph 127 (State Task 0148-2018-0002, Registration Number 01201352492) (O. Borisova and A. Panin) and to the Russian Federation Program "The Evolution and Transformation of Erosion–Channel Systems under Changing Environment and Human impact" (A. Sidorchuk).

Keywords: vegetation and climate reconstructions, runoff depth, East European Plain, Boreal, Holocene.

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BACK

CHARACTERISTICS OF BOTTOM SEDIMENTS FROM THE LAKE HUKO (CAUCASUS) AS INDICATORS OF LOCAL AND REGIONAL CHANGES IN ENVIRONMENTAL CONDITIONS IN THE HOLOCENE

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In this paper, the results of analyzes of bottom sediments from Lake Khuko (the Caucasus) are presented. Lake Khuko is located at the border between Adygea and Krasnodar Region at an altitude of 1,744 m. According to preliminary data, the sedimentary record from this lake covers the entire Holocene. Spore-pollen, elemental, granulometric, and mineralogical analyzes were performed within the framework of comprehensive analytical work, and magnetic susceptibility, pH and loss on ignition (550, 950°C) were determined. On the basis of data on elements obtained by X-ray fluorescence analysis using synchrotron radiation, periodic regularities have been revealed and the contrast in the variability of various elements have been shown previously (Grachev et al., 2018). Here, a comparison of the data of the nineteen measured elements with other measured characteristics is given.

Based on the analysis of spore-pollen data of Lake Khuko deposits, the main pollen zones were identified reflecting the successive stages of the changes in plant communities during the investigaed time period. Spore-pollen data on Lake Huko are compared with the palynological data obtained earlier for the deposits of Lake Karakel (Chepurnaya, 2014). The conclusion is made that within the studied period, the boundaries of high-altitude belts of vegetation have been changing. The composition of plant communities has been changing as well. Also, the regime of accumulation of terrigenous and biogenic elements in the reservoir has been changing. The results of comprehensive study of the deposits of Lake Huko allow establishing the main trend of changing climatic conditions throughout the time interval of this study, and also to determine the values of some climatic parameters.

This work was carried out within the framework of the RFBR project 17-05-01170 A (lead by O.N. Solomina).

BACK

NEW DATA ABOUT THE FORMATION OF SUKHOE SWAMP (PSKOV REGION, RUSSIA)

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Sukhoe Swamp is situated on the bottom of buried paleo-incision near Izborsk (Pskov region, Russia). Obdekh paleovalley is one of the paleo-incisions which widely distributed on the north-west of the East European Plane (Krotova-Putintseva and Verbitskiy 2012). Reconstruction of formation and development of Sukhoe Swamp allows to judge about evolution of buried erosion network during the Lateglacial time and the Holocene. The problem have studied much worse in contrast to other problems connected with buried paleo-incision especially in the Russian Federation.

Interfluves, elements of Obdekh paleovalley were drilled in field. There are 45 boreholes. The key section Su-1 was drilled into Sukhoe Swamp, the depth of borehole is 11.65 m. It revealed peat (2.32 m), lacustrine sediments (3.47 m), limnoglacial clays - varves (5.35 m) divided the layer of sandy-silt, and deepened into the underlying sandy-gravel sediments. Thanks to the results of palynological analysis, measuring of varves and 14C AMS we can distinguish five stages in the history of the upper part of Obdekh palleovalley: 1 - ice reservoir (Older Dryas - Allerod), 2 - local proglacial lakes (Allerod - Younger Dryas), 3 - common proglacial lake (Younger Dryas - Preboreal), 4 - lake basin (Preboreal), 5 - modern lakes (Gorodishchenskoye and Malskoe) and Sukhoe Swamps (Boreal - present time).

The separation between Gorodishchenskoye and Malskoe lakes and formation of swamp Sukhoe is connected with activation erosion processes on the slopes of the Obdekh valley. Probably it was started at the end of the Late glacial time. The evidences of it conclude into the similar structure of upper part sediments of the key section and boreholes which were drilled on the alluvial fan. The upper part is peat (stage 5), under layer of peat - lacustrine lime (stage

4). Alluvial fans of balks blocked some parts of the common lake (stage 3). The middle part is Sukhoe Swamp was shallow and was filled by sediments easy.

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Keywords: buried paleo-incisions, the Scandinavian Ice Sheet, deglaciation, proglacial lakes, swamp, varves, palynologic analysis, AMS.

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BACK

GLACIATION OF PUTORANA PLATEAU (NORTH-WEST OF SIBERIA) IN THE LITTLE ICE AGE

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Recent paleoglaciological studies indicate that mountain valley glaciers developed on the Putorana Plateau in the Late Pleistocene and Holocene. Early Holocene climatic warming led to the complete disappearance of glaciers. The last cooling, corresponding to the Little Ice Age (LIA) occurred in the late Holocene and led to the emergence of new glaciers that filled the ancient cirques. Based on the study of superlong tree-ring chronologies in the area, it was found that the greatest cooling of the late Holocene occurred in the last millennium and had several phases. Using local tree-ring chronologies, it was established that, from the second half of the 17th century and until the end of the 19th century, the annual wood increment was minimal, i.e. summer seasons, corresponding to the ablation period, were cold. At that time, cirque and cirque-valley glaciers developed in the upper parts of the cirques and did not spread beyond them. LIA moraine cover eroded sediment deposited by former glaciers. They are characterized by a certain freshness of forms, low roundness of boulder material (the dominant class of roundness – first class), weak turfness and distinct morphological limits. Moraine boulders are devoid of lichens. The glaciers reached a length of up to 1.5 km. Their moraines rise above the modern glaciers surface at 30-45 m. The relief of these moraines are well defined transverse rampart formed at the edge of the glacial front. These formations well record the glacier stagnation states which allowed to accumulate moraine material. In total, up to 6 states of stagnation in LIA can be identified. At present, LIA glaciers have turned into niche and rock glaciers.

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Keywords: Little Ice Age, glaciations, moraines, tree rings.

BACK

THE ORIGIN OF THE HOLLOW SYSTEM AT THE INTERFLUVE AREAS OF THE EASTERN PART OF THE AZOV REGION

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The interfluve areas of the Eastern part of the Azov region are widely covered with the hollows - negative linear forms with smooth trough-shaped cross-section, indistinct edges and the inside seams. These hollows are not significantly expressed in the relief. They are hardly recognizable at the terrain. Usually the hollows form treelike systems which are located at the riverheads. Curiously the spread of the hollows has no connection with the field borders, forest belt system or auto roads. Its localization and plane pattern follows only the configuration of the drainage area and the common direction of the slope of the surface. The hollow system has the typical fluvial plane structure but the modern fluvial activity is barely detected (gullies, scours, stream forms, etc). All these morphological features let us suppose the relict origin of the hollows.

The geological structure of three treelike hollow systems on the interfluve areas of the Eastern part of the Azov region was analyzed by studying the coastal cuts and the drillhole cores. It was determined that the age of the primary relict gully system that was partially covered with the slope deposits is the Late Neopleistocene (Late Weichselian, MIS 2). According to pedostratigraphic analysis and texture specificity the phase of intensive erosion by climate causes can be identified at that time. The phase of accumulation mostly occurred at the late glacial period and Holocene. The filling mainly was delivered from the adjacent slopes by the prosesses of diluvial wash, solifluction and creep.

Among the probable reasons that have caused the intensive erosion of the interfluves areas at the Late Weichselian are: 1) the overall growth of the surface flow and its irregularity during the late glacial period (Panin at al., 2013); 2) the specific cryoarid climate conditions of the Late Weichselian which caused the decrease of the stability of the substrate by sparse vegetation and deep seasonal freezing (Konstantinov, Velichko, 2013); 3) a deep drop of the

basis of erosion (Azov-Black sea basin) which increased the regressive growth of the erosion system (Alekseyev, Chistyakov, Shcherbakov, 1986).

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Keywords: relict gullies, loess, paleosols, glacial-interglacial cycles, late Pleistocene.

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BACK

MIDDLE PLEISTOCENE SMALL MAMMAL FAUNAS OF EUROPE

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The paper is concerned with the small mammal fauna evolution in Europe in the Middle Pleistocene. The information on the faunas of the end of the Early Pleistocene have been also taken into consideration. The data available made possible identifying several stages in the small mammal evolution. Not all intervals within the Middle Pleistocene are provided with sufficient information for recognizing individual stages; that is particularly true for the cold periods of the Middle Pleistocene – the Donian and the Okian glaciations (=Elsterian, =Anglian). The stages of evolution of the East European faunas have been correlated with those of Western Europe. Based on the studies of small mammal localities, the biostratigraphic scheme has been developed; the principal phylogenetic lineages of Arvicolinae were traced.

Problems of evolution of the European Middle Pleistocene small mammals and the synchronization of the principal stages of their evolution with geological and climatic events have been examined in many previous publications of European palaeontologists from the beginning of XX century. In this paper we try to analyze the main stages in the evolution of the European small mammal fauna referring to the period from the Jaramillo paleomagnetic event (the end of the Early Pleistocene 1.07 – 0.99 Ma, ~MIS 26-30) till the end of the Middle Pleistocene – till the beginning of Eemian (=Mikulino) Interglacial (MIS 5e) (~ 0,30 Ma). The ages of the temporal intervals were given according to oxygen isotope curve (Lisiecki and Raymo 2005). A significant number of global climatic events, glaciations and interglacials, correspond to this period. We tried to recognize the response of the small mammal faunas to the different climatic events during the Middle Pleistocene, to synchronize the faunas of Eastern Europe with those of Western Europe, to examine the principal evolutional changes in the different phylogenetic lineages of Arvicolinae during the Middle Pleistocene.

On the Russian Plain most of localities are found in great geological sequences studied not only paleontologically, but also by several methods including paleomagnetic stratigraphy. Those supplementary data help to determine the stratigraphic position of mammal faunas. A

relatively large part of localities in Western Europe are related to karst caves and fissures. In such localities faunal remains of different age are often found to be mixed, and paleomagnetic analysis data are also not quite reliable. There are, however, a number of multilayered localities (Kärlich, Shöningen, Sima del Elephante, Grand Dolina, Colle Curti, Castagnone, the localities related to the different Themes River terraces, and some others) where multidisciplinary studies were performed.

Every phase in the evolution of small mammals is identifiable not only by appearance of new taxa, but also by the prevalence of certain morphotypes within a taxon. The main evolutionary transformations within the phylogenetic lineages resulted from anagenesis; several "paleontological" species were identified on the basis of the dominant tooth morphotypes.

Principal stages of middle pleistocene small mammal faunas

The end of the Early Pleistocene – the beginning of the Middle Pleistocene. The analysis of small mammal faunal data from Eastern and Western Europe dated to the interval from the Jaramillo paleomagnetic event to the beginning of the early Middle

Pleistocene (1.07-0.7 Ma) provided evidence for several phases in the small mammal evolution recognizable within this interval. It is established that the boundary between large mammal fauna stages corresponds to those of Tamanian and Tiraspolian mammal assemblages in Eastern Europe, Early/Late Galerian in Italy, and MNQ 20/MNQ 21 zones (Masini and Sala 2011; Vislobokova and Tesakov 2013). A more detailed picture was revealed in the evolution of small mammal faunas during the regarded interval; the phases are distinguishable by changes in the species composition, first occurrences of new species, and evolutionary changes in a few phylogenetic lineages of Arvicolidae (Markova 2007, Maul and Markova 2007). Every phase in the evolution of small mammals is identifiable not only by appearance of new taxa, but also by the prevalence of certain morphotypes within a taxon.

Small mammal faunas related to Jaramillo normal polarity event

Small mammal faunas confidently correlated with the Jaramillo normal polarity event contain remains of *Mimomys savini, M. pusillus, Clethrionomys sokolovi*, advanced *Allophaiomys, Borsodia fejervaryi, Prolagurus pannonicus, Lagurodon arankae, Eolagurus argyropuloi* (Masini and Sala 2011; Siori and Sala 2007; Markova 2007). Characteristic for the Iberian faunas is the presence of archaic representatives of the endemic *Iberomys* genus *(I. huescarensis*), voles of the *Ungaromys* genus and surprisingly finds of the water vole *Arvicola jacobensis* found together with *Allophaiomys lavocati* (Cuenca-Bescos et al. 2013). It is noteworthy that no voles of *Terricola, Stenocranius* and *Pallasiinus* subgenera have been recorded in faunas correlatable with the Jaramillo event. In Eastern Europe such faunas had

been earlier identified as **Kairian (=Ostrogozhskian**) (Markova 1990, 2007, Shik 2014). In Western Europe they have been correlated with Biharian faunas, with those of the "Colle Curti stage" (Colle Curti F.U.) in Italy and the "Allophaiomys lavocati" phase in Spain, etc. (Fig. 1, 2).

Small mammal faunas related to post-Jaramillo interval, but located before Brunhes - Matuama paleomagnetic boundary

The next step in the small mammal evolution is represented by faunas with the first documented representatives of *Microtus (Stenocranius) hintoni* and *Microtus (Terricola*) sp. *Mimomys savini, M. pusillus, Allophaiomys pliocaenicus nutiensis*, *Prolagurus pannonicus* are also present in these faunas. Those faunas were identified as the **Morozovkian** small mammal assemblage (Alexandrova 1976; Markova 1990) and fall within the Matuyama reversed polarity zone (Fig.1, 2).

More advanced faunas are identified by the first occurrence of *Microtus* ex gr. *oeconomus* (= *M. protooeconomus, =M. ratticepoides*). The bulk of the fauna is formed by *Prolagurus pannonicus* and *Eolagurus argyropuloi*; remains of *Mimomys savini* and *Allophaiomys pliocaenicus nutiensis* are present in small number. According to paleomagnetic data, they are correlated to the end of the Matuyama epoch. The faunas at that stage of evolution are recognized as **Petropavlovkian** assemblage of small mammals in Eastern Europe (Alexandrova 1976; Markova 1998) (Fig. 1, 2).

The faunas marked by the first appearance of *Microtus arvalinus* and *Prolagurus posterius* (Shamin locality) occur in inversely magnetized deposits and are dated to the very end of the Matuyama epoch. The presence of the above named species makes the faunas closer to the **Early Tiraspolian** ones. In the localities pertaining to the beginning of the Brunhes epoch the rooted voles of *Mimomys* genus still persist. Steppe lemmings are represented mostly by *Prolagurus posterius*, though remains displaying the *Prolagurus pannonicus* morphotype were presented long enough (up to the end of the Don glacial epoch). The genus *Microtus* became more diversified at that time.

New species appeared in Western and Eastern Europe more or less simultaneously. The variability in the morphology of the genus *Allophaiomys* teeth often used by European specialists as a basis for their biostratigraphical conclusions is undoubtedly extremely important.

First half of the Middle Pleistocene (MIS 18 – 12). The main intervals of the first half of the Middle Pleistocene include: Ilyinian interglacial complex (MIS 18 and 17), that apparently corresponds to the glacial A of the Cromerian complex and interglacial Cromer II;

the Donian glaciation (MIS16) = glaciation B of the Cromerian complex; the Muchkapian interglacial complex =Cromer III (MIS 15). The Muchkapian interglacial stage (by the data from Eastern Europe) includes Glazov and Konakhov warm phases and the cool interval (Podrudnyansky) separating them (MIS 15). The Navlinian cooling (MIS 14) and the later Ikoretskian warming (MIS13) follow it. The Navlinian cooling probably corresponds to the cooling (glaciation) C of the Cromerian complex, the Ikoretskian interglacial corresponds to Cromer IV (MIS 13) and the Okian glaciation (=Anglian = Elsterian glaciation) (MIS 12) (Shik 2014) (Fig.1,2).

Ilyinian complicated interglacial = glacial A of the Cromerian complex and Cromer II interglacial (MIS 18 and MIS 17, ~0.780 Ma - 0.676 Ma). The faunas of this interval are characterized by the presence of rhizodont voles *Mimomys pusillus, M. savini, Pliomys episcopalis*, steppe lemmings *Prolagurus pannonicus, P. posterius* (dominating), *Lagurus transiens,* voles *Microtus (Stenocranius) gregaloides, M.(Terricola) arvalidens, Microtus arvalinus, Microtus* ex gr. *oeconomus,* and *Microtus hyperboreus.* Insectivores are represented by *Sorex runtonensis* and *S. (Drepanosorex) savini.* Voles of *Allophaiomys* genus are absent from these faunas (Agadjanian 2009, Markova 2007) (Fig. 1, 2).

Donian glaciation (MIS 16, ~0,676 -~0,621 Ma). The Donian faunas differ from the earlier ones by the presence of cold-adapted species: *Dicrostonyx* ex gr. *simplicior* and *Lemmus* sp. Rhizodont voles of *Mimomys (M. savini)* and *Pliomys* genera are parts of these faunas, as well as *Prolagurus posterius, Lagurus transiens, Microtus (Stenocranius) gregaloides. M. (Terricola) arvalidens, M. arvalinus, M. oeconomus* (= M. *ratticepoides),* and *M. hyperboreus* also are present in these faunas (Markova 1990, Agadjanian 2009) (Fig. 1, 2).

Muchkapian interglacial (MIS 15, Cromer III, ~0,621 = ~0,563 Ma). The Eastern European faunas are characterized by the presence of rhizodont voles *Mimomys savini*, steppe lemmings *Prolagurus posterius* and *Lagurus transiens*, voles *M.(Terricola) arvalidens, M. arvalinus*, and *M. oeconomus*. The first appearance of *M. (S.) gregalis* distinguishes these faunas from the previous ones. In Western Europe at the beginning of this interglacial, the fauna with *Mimomys savini* was described (Pakiefild) (Stuart and Lister 2001). In the second part of this interglacial, the first *Arvicola* was distinguished in West Europe (Kolfschoten and Turner 1996) (Fig. 1, 2). Thus, there is a significant difference in the first *Arvicola* appearance (FAD) in Eastern and Western Europe.

Ikoretskian Interglacial (=Cromer IV, MIS 13, 0,533-0,478 Ma). In the localities attributed to the Ikoretskian interglacial in Eastern Europe (Cromer IV) the first appearance of the archaic water voles *Arvicola cantianus* is recorded. Rhizodont voles of *Mimomys* genera

are not detected in these faunas (Iosifova et al. 2006). In West-European faunas of that age *Sorex runtonensis, Drepanosorex savini, Arvicola cantianus, Microtus arvalinus, M. agrestis,* and *M. oeconomus* have been found.

Okian (=Elsterian, = Anglian) glaciation (MIS 12; ~0,478 - ~0,424 Ma). In these faunas *Lemmus* sp., *Dicrostonyx simplicior okaensis, Lagurus transiens,* and *Microtus (Stenocranius) gregalis* have been described in Eastern Europe (Agadjanian 2009). *Spermophilus* sp., *Allocricetus bursae, Lemmus lemmus, Arvicola cantianus,* and *Microtus (Stenocranius) gregalis* have been described for this period in Western Europe. The European small mammal data reflect the drastic cooling and aridification during this glaciation (Fig. 1, 2).

The second half of the Middle Pleistocene (MIS 11 - MIS 6). *Likhvinian (= Holsteinian, = Hoxnian) interglacial (MIS 11, 0,424 – 0,374 Ma).* More than ten localities of this age were found in Eastern Europe (Markova 2006). Several very important localities were found in Western Europe. Among them, there is the famous Barnfield Pit locality in Great Britain in the south of the Thames drainage basin (Schreve 2004) and the Kärlich H locality (Germany) (Kolfschoten and Turner 1996). The small mammal faunas of this interglacial are characterized by archaic water voles *Arvicola cantianus, Lagurus transiens, Microtus gregalis, M. arvalis, M. oeconomus*. The rhizodont voles of *Mimomys* and *Pliomys* genus are absent from these faunas. The SDQ index of *Arvicola* enamel indicates the "mimomys" structure of the teeth. *Lagurus transiens* (progressive type) was typical for this interval.

Borisoglebskian cooling (MIS 10, 0,374 – 0,337 Ma). The only locality with small mammals, Topka locality (the Don R. drainage basin), was discovered in the deposits overlying those of the Likhvinian Interglacial (Krasnenkov and Kazantseva, 1993). The locality yielded remains of *Arvicola chosaricus*, but no voles of the "*Terricola= Pitymys*" subgenus typical for Pre-Okaian faunas have been found at the Topka. No small mammal localities of that age are known in Western Europe (Fig. 1, 2).

Kamenkian =Reinsdorf= Parfleet Interglacial (MIS 9)(0,337-0,300 Ma)

The most characteristic to this interval are *Lagurus* ex gr. *transiens – lagurus* (*=L. chosaricus*), *Arvicola chosaricus, Microtus gregalis, Microtus arvalis, Microtus oeconomus*. In steppe lemmings of the *Lagurus* genus the 'lagurus' morphotype is dominant in faunas of the Khozarian type. The locality of Schöningen 13-II, Layers 13-II-2, II-3, II-4 includes *Arvicola terrestris cantianus, Microtus (Terricola) subterraneus, M. arvalis, M. agrestis, M. oeconomus, M. (Stenocranius) gregalis, Apodemus sylvaticus* and others. Geological data and the Arvicolinae morphological characteristics gave grounds for dating the fauna to an interglacial younger than Holsteinian – to **Reinsdorf** one correlatable with MIS 9 (van Kolfschoten 2014)

(Fig. 1, 2). Purfleet locality (Great Britain) is also correlated with MIS 9 and includes *Sorex araneus, S. minutus, Arvicola terrestris cantiana, Microtus agrestis, M. arvalis, Apodemus sylvaticus* and others (Schreve 2004).

Orchikian cooling (MIS 8, 0,300-0,243 Ma). The Kamenka (=Purfleet, =Reinsdorf) interglacial was followed by a new cooling, which was named after the name of loess horizon distributed on the Russian Plain (Velichko et al. 1992). The faunas of this age are absent from Eastern Europe. In Western Europe the Harnham locality was discovered in the south of Great Britain and dated by OSL to approximately 250 ka BP (Bates et al. 2014). It yielded *Apodemus* sp., *Clethrionomys* sp. *Microtus oeconomus*, *Microtus* sp. (Fig.1, 2). In Poland the fauna of this age discovered in Biśnic cave (layer 19) and includes cold-tolerant, steppe, aquatic, and forest species (Socha 2014).

*Romnian, = Schöningen, = Sandy Lane interglacial (0,243-0,191 Ma).*The fauna found in Matveevka locality on the Sula R. may be assigned to the end of the Romnian warming (MIS 7). It includes *Lagurus lagurus, Eolagurus* sp., *Arvicola chosaricus, Microtus arvalidens, M. arvalis, Microtus (Stenocranius*) *gregalis, M. oeconomus* et al. The Lion Pit locality in the lower reaches of the Thames yielded *Apodemus sylvaticus, Mammuthus trogontherii, Palaeoloxodon antiquus, Equus ferus, Stepanorhinus kirchbergensis,* and others (Schreve 2004)(Fig. 1, 2). The Aveley locality, Great Britain, was exposed in a sand quarry; the fauna includes *Arvicola terrestris cantianus, Microtus agrestis* or *Microtus arvalis, Apodemus sylvaticus*, and others (Parfitt 1998, Schreve 2004). In Central Europe several faunas were correlated with MIS 7. The Wageningen - Fransche Kamp 1 locality (the Netherlands) includes *Arvicola cantianus, Microtus arvalis/agrestis, Apodemus sylvaticus, A. maastrichensis* and undoubtedly corresponds to a warm interval (MIS 7), preceding the Saale glaciation and was correlated with **Shöningen Interglacial** (Van Kolfschoten 2014) (Fig. 1, 2). A close fauna was described in Maastrichte-Belvédère, layers 3-4. A rich locality of Weimar-Ehringsdorf (Lower Travertine)

contains *Arvicola cantianus*, *Microtus oeconomus*, *M. subterraneus*, *M. gregalis* et al. (Maul 2000, 2002).

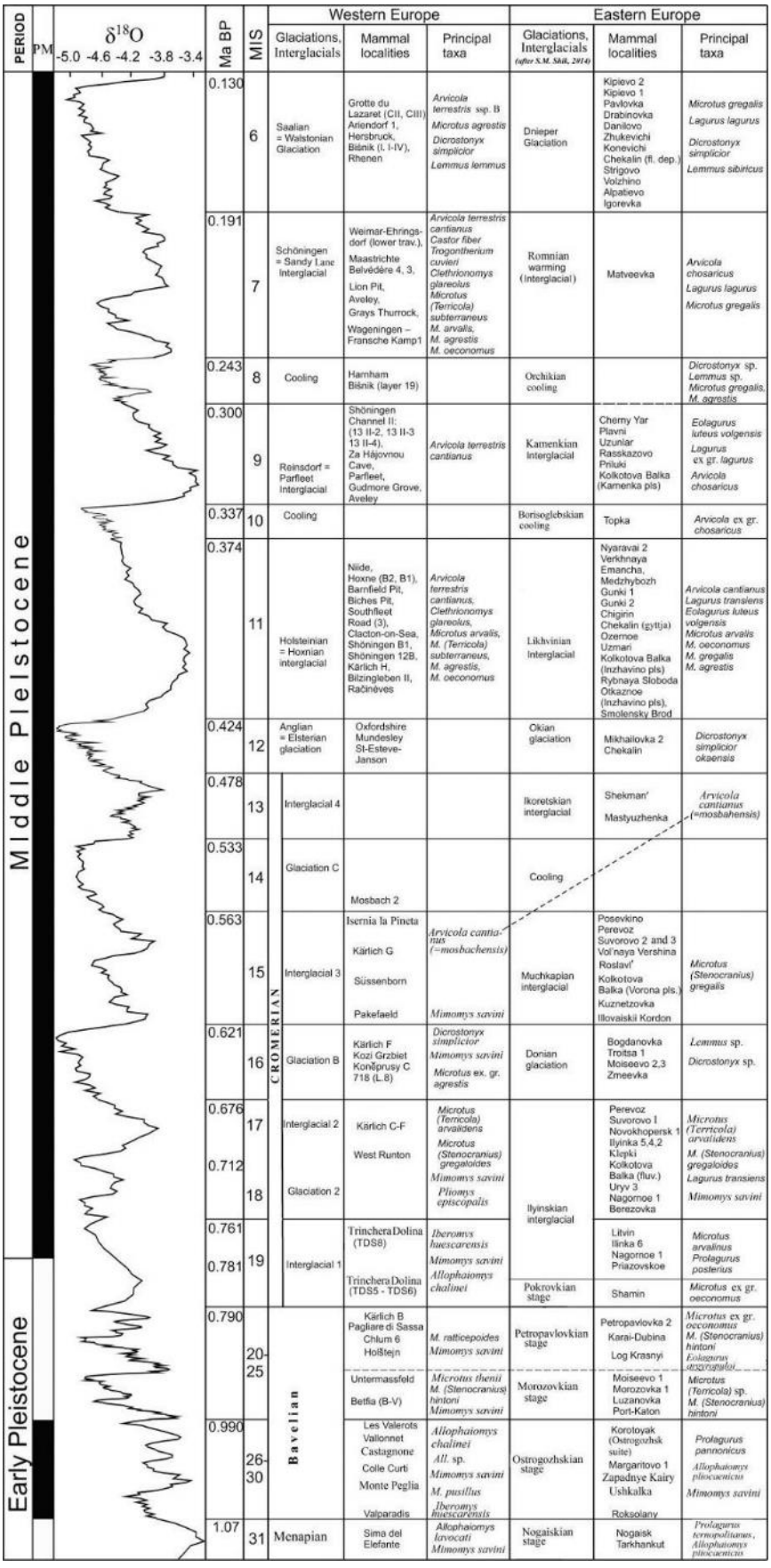

Fig.1. Biostratigraphical scheme of the Middle Pleistocene by small mammal data from Western and Eastern Europe

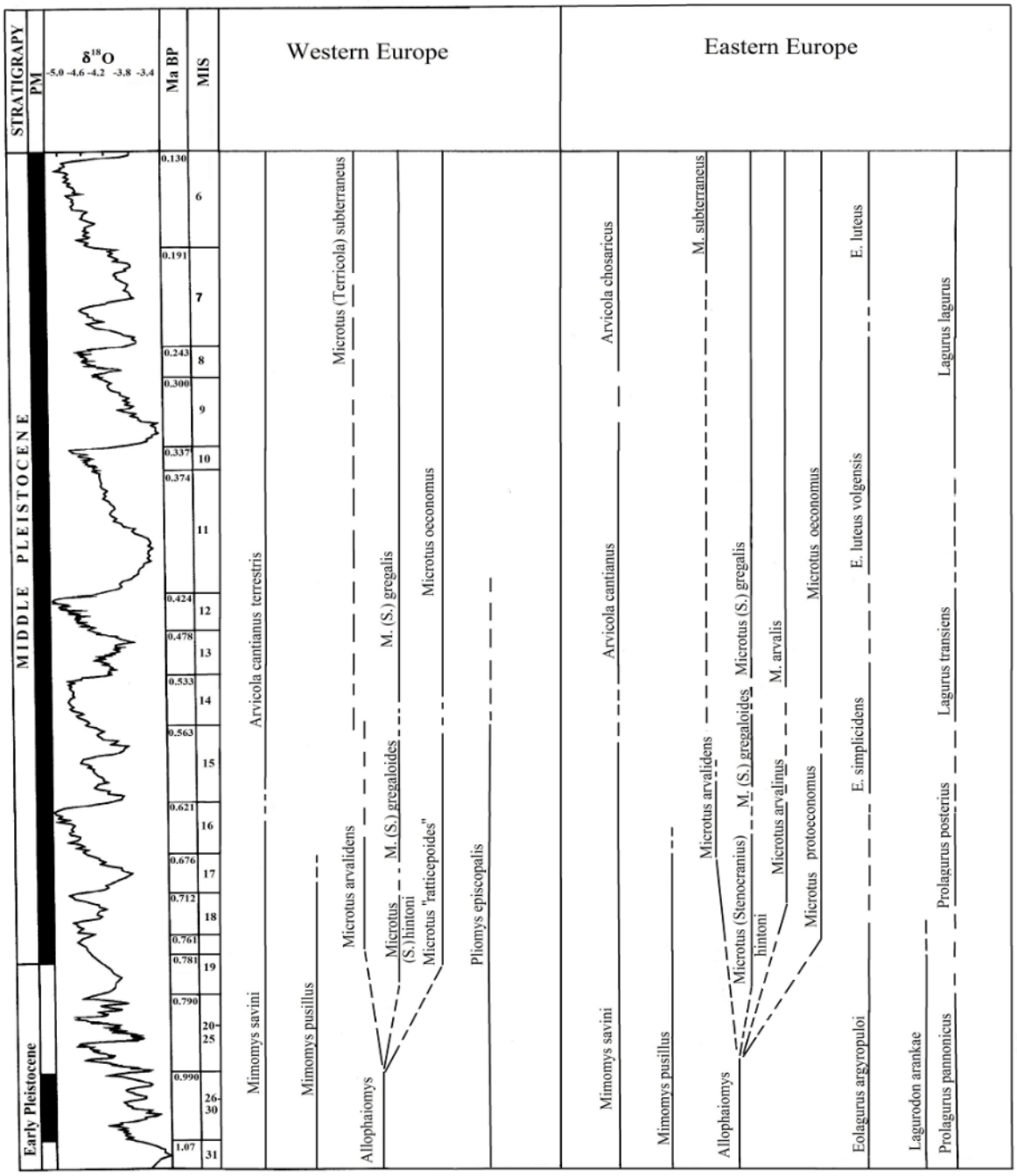

Fig. 2. Arvicolinae phylogenetic lines during the Middle Pleistocene by the materials from European localities

Summary

The principal trends in the small mammal evolutionary changes during the very end of the Early Pleistocene and the Middle Pleistocene have been revealed, and the East European and West European faunas were compared (Fig.1, 2). An integrated analysis of theriological, geological, and geochronological data available from the Middle Pleistocene localities in Europe has shown marked changes in the small mammal fauna through the period under

consideration and provided information on the climate and environments at different time intervals. The changes in Arvicolinae phyletic lines made possible a correlation between the West European and East European mammal localities. The biostratigraphic scheme of the Middle Pleistocene has been developed (Fig. 1, 2).

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Keywords: small mammals, Middle Pleistocene, Europe, taxonomy, evolution.

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BACK

SMALL MAMMAL FAUNA FROM THE MIDDLE PALAEOLITHIC SITE BETOVO (DESNA RIVER BASIN)

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Betovo Palaeolithic site is situated near the Betovo village in the Desna drainage basin (Briansk province (53º 20′ 56″ N, 34º 00′30″E). This site was open and investigated by L.M. Tarasov (1974, 1977). He attributed Betovo site to the Middle Palaeolithic. Dr. A.K. Ocherednoy excavates this site during the last years (2008). E.V. Voskresenskaya (Institute of Geography RAS) investigated the geology of Betovo. She described the Late Pleistocene loess-like deposits with Trubchevsk paleosol which cover the layer with the interlaying sands and loams with the artifacts and the mammal bones (Voskresenskaya and Ocherednoy 2012). The numerous radiocarbon dates on mammal bones were received for the cultural layer. They fall in the interval 28 500 – 36 000 yr ca (Vishniatsky et al. 2015). So, it is a contradiction between the relatively young dates and the Middle Palaeolithic culture. The investigators suggested that the Middle Palaeolithic culture survived longer in this region than in other parts of the Russian plain (Vishniatsky et al. 2015). The palynological data from the cultural layer indicate the tundra-forest condition during the existing of the site (Tarasov, 1989).

The small mammal bones from the cultural layer 2 (11 geological layer) was collected by the team of A.K. Ochrednoy during 2016 yr and was given to author of this paper for identification. The bone material has a good preservation, has a yellowish color. The angles of teeth are not broken, there are not traces of re-deposition.

The small mammal determination was carried out with a help of SMC4, ASKANEA binocular. The analysis of bone materials were carried out according to the each archaeological square.

All the small mammal species from Betovo belong to tundra and the steppe ones. The collared lemming, narrow-skull vole and steppe lemming dominate in the Betovo fauna.

Thus, small mammal fauna discovered from the cultural layer 2 of Betovo is the perfect indicator the environmental situation during 36-28 th. cal BP. This fauna reflects the strong cooling, which cause the whole disappearance of the forest zone in the center of the Russian

Plain and the distribution of the open cold tundra-steppe, so called the “mammoth steppe” which hasn’t analogues in recent time. The similar reconstructions were received earlier by

mammal materials from the other Palaeolithic sites of the Upper Dnieper basin, and for the Russian Plain in a whole (Markova et al. 1995, 2008, Rekovets, 1978).

Table 1. Small mammals from the Betovo site (cultural layer 2).

Species	Squares																		
	А-5	А-3	А-4	А-Б	А, В,Г,-4, 5 and Г- 3	В-3	В-4	В-5	В-4	Г-3	Г-4	Д-3	Д-3,4	Д-5	Е-4	Е-5-	Ж-3	Ж-5	Unindicted squares
Ochotona sp.										1						1			
Lepus sp.														1					
Marmota bobac			2																
Spermophilus sp.								1			1								
Dicrostonyx guilielmi	85	1	8	38	9		119	1	12	24	8	4	11	69	4	27	5	11	9
Lemmus sibiricus							2			1									
Eolagurus luteus					3									6	1	2			
Lagurus lagurus		2		8	3	6	2		1			1		9	4	16	2	1	3
Lasiopodomys gregalis		1	21	12	11	6	10		2	20	2	1	1	7	5		2	7	4
Microtus sp.				3															

The united list of small mammals from the all squares of Betovo site (cultural layer 2)

Lagomorpha:

1. *Ochotona pusilla* Pallas (small or steppe pica) – 2
2. *Lepus* sp. (lepus) – 1

Rodentia:

3. *Marmota bobac* Müller, 1776 (bobac marmot) – 2
4. *Spermophilus* sp. (ground squirrel) – 2
5. *Dicrostonyx guilielmi* Sanford, 1840 (collared lemming) – 461

6. *Lemmus sibiricus* (Kerr, 1792) (Siberian lemming) – 3
7. *Eolagurus luteus* (Eversmann, 1840) (yellow steppe lemming) – 12
8. *Lagurus lagurus* (Pallas, 1773) (steppe lemming) – 58
9. *Lasiopodomys (Stenocranius) gregalis* (Pallas, 1779) (narrow skull vole) – 112
10. *Microtus* sp. – 3 (vole)

Total - 657 identified bones

It is also important to note the low species diversity of Betovo small mammal fauna. This indicator reflect the unfavorable conditions of environment, when only the several species dominated in the fauna, and other ones presented in small amount of remnants. The 28 species presented in the modern fauna of small mammals of this region, most of which distributed in the forest environments, but only 9 species of small mammals were found in Betovo.

So, all received data indicate the extreme severity of the climatic and environmental conditions in the end of MIS 3 – the beginning of MIS 2 in the Desna River basin – the conditions of the cold tundra-steppe which was widely distributed during the Valdai Glaciation in Eastern Europe.

Acknowledgments

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Holocene: taxonomy, diversity and evolution". Its also was supported by RFBS grant No 18-05-00076.

Keywords: small mammals, Middle Palaeolithic, Betovo site, Upper Desna River basin, reconstructions

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BACK

VEGETATION AND CLIMATE CHANGES DURING THE GLACIAL/INTERGLACIAL TRANSITION: NEW PALYNOLOGICAL DATA FROM UPPER VOLGA REGION

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Among many studied sections of the Last (Mikulino = Eemian) interglacial in the central Russian Plain only a few allow to reconstruct the changes in plant communities during the Moscow (Warta) late glacial and the earliest phases of the interglacial. Recently new palynological data on this interval were obtained on two sections of alluvial, lacustrine and peat deposits in the valleys of two small rivers in the Upper Volga basin: Bolshaya and Malaya Kosha.

Pollen analysis of sediments from these sections shows that during the final stage of the Moscow glaciation in the periglacial zone northern taiga, forest-tundra, forest-steppe and tundra communities were widespread in the Upper Volga region. At the beginning of the late Pleistocene, during the early part of the thermoxerotic phase of the Mikulino interglacial, open periglacial forest-steppe landscapes still dominated the area. The vegetation cover combined birch and pine forests with steppe elements, spruce-larch-birch open woodlands, willow-sedge-brown moss tundra, and tundra-steppe phytocoenoses. The climate was much colder and more continental than the modern one. The presence of pollen of subarctic species in the spectra may indicate the preservation of island permafrost in the Upper Volga region. Further warming led to a succession of phases of forest vegetation: (1) taiga forests, (2) southern taiga forests with a large proportion of deciduous species, and (3) broadleaved forests. The composition of tree pollen reveals changes in the broadleaved forest formations: oak and elm pollen prevails in the earlier part of the optimum, while the pollen contents of hornbeam and linden increase in its

later part, after the maximum of hazel and alder pollen. During the optimum of the Mikulino interglacial, hornbeam became one of the major forest-forming species in the region.

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Keywords: pollen analysis, vegetation and climate reconstruction, Upper Volga region, Pleistocene.

BACK

FEATURES OF LANDSCAPE EVOLUTION IN THE FOREST ZONE OF THE RUSSIAN PLAIN

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Rhythmic variations in climate had crucial importance in the evolution of the landscapes, leading to repeated shifts of their types (zones). The specific pattern of allocation of landscapes of the largest rank as well as the local level is determined by the action of a group of the structural and geomorphological factors. For the territory of Moscow glaciation the distinctive feature is limited diversity of the morphological structure of landscapes as compared to the area of the Valdai glaciation with smaller landscape complexes of the local level, predefined significant "variety" of the forms of micro- and meso- relief. The landscapes of the mixed forests during the Holocene changed their typology four times (taiga - mixed forests - deciduous forests - mixed forests) and changed six subtypes of landscapes. The southern taiga landscapes and northern taiga landscapes changed four types of zones with five to eleven shifts of subtypes of zones, respectively.

Starting from the Subboreal period (Bronze Age) the anthropogenic transformation of landscapes begins, which dramatically increased only in the last 300-400 years in the area of Moscow glaciation and in the last 200-300 years in the area of Valdai glaciation. At the zonal-provincial level several basic types of economic development of landscapes have developed which presented spatial pattern of combinations of natural and man-made landscape complexes. The southern and middle taiga landscapes of Valdai glaciation are characterized by small-focal (dot) type of economic development due to the fact that small arrays of developed lands are confined to high-drained sites - moraine hills and kame hills or remnants of the "flush moraine relief." There are common linear and threaded subtypes of drawings inherent to valley type of development. The combination of the small-focal and linear subtypes is typical for the areas of terminal moraine ridges. The mosaic type of development with approximately equal mix of forest and treeless territory is more typical for landscapes of mixed forests of the Moscow

glaciation. More uniform spatial pattern of economic development is inherent to the background type for the economic development with the watershed type of settlement, distributed mainly in the deciduous zone.

Keywords: Landscape evolution, forest zone, Russian plain.

BACK

LANDSCAPE FEATURES OF THE «KALUZHSKIE ZASEKI" NATURAL RESERVE

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A distinctive feature of the reserve is high preservation of large arrays of broad-leaved forests that existed since the Zaokskaya forest boundary of the Moscow State, as well as its boundary landscape and geographical position. A landscape map was drawn up for the southern part of the reserve. The landscape structure is typical for the marginal (North-Western) part of the Central Russian geographical province, but it also has a number of typical features of neighbouring outwash and moraine-outwash landscapes of the Dnieper-Desninskaya and moraine Smolensk-Moscow provinces. Interfluves are represented by dominant tracts of erosive flat and flat-sloping plains of different degrees of subdivision. The subdominant tracts are damp and moist catchment lowlands and hollowed upper reaches of small erosion forms. Rare tracts are flat-topped moraine hills with a cover of loess-like loams. Single tracts are swamping ancient lake basins with marsh and peaty soils and damp through valleys that are small troughs of the glacial water flow. The erosion network is represented by: the valleys of small rivers with steep and slanting indigenous slopes, segment and belt floodplains and fragments of low floodplain terraces, valleys of streams of girder type, moist and wet beams, and ravines. Along the rivers Dubenka and Moshok and some of their tributaries, fragments of outwash valleys are traced. The water-accumulative landscape complexes (lake-glacial and outwash) have the most simple structure. Moraine complexes are characterized by a small type diversity. They are characterized by low coefficients of individual complexity and tortuosity of outlines. This is explained by the relatively simple rounded form of the tracts of morainic hills and swamped inter-morennial lowlands. Erosion plains are characterized by increased complexity of the structure, and have the highest coefficient of tortuosity of outlines and individual complexity. However, they have a rather low coefficient of type complexity due to the fact that the same number of types regularly repeats over a large area. The tracts of moraine-

outwash plains have the same level of complexity. In a small area, morainic, erosional and outwash tracts often intertwine with each other, forming a complex mosaic.

This study was supported by a grant from the Russian Science Foundation (Grant 16-17-10045).

Keywords: Kaluga forest reserve, landscape structure, tracts, Dubenka and Moshok.

BACK

FEATURES OF THE FORMATION OF THE MIDDLE AND LATE PLEISTOCENE PALEOSOLS IN THE CENTRAL PART OF THE EAST EUROPEAN PLAIN

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The central part of the East European Plain is known as one of the main loess regions (Velichko et al. 2006). In the sequences loess series alternate with paleosols. Principal phases of the paleosol formation fall on interglacials; later on, as the climate became cooler, vegetation changed accordingly and interstadial soils developed (Velichko et al. 2007). The soil formation process practically stopped during the ice ages, and the loess accumulated on the soil surface. The object of the paper is to consider the characteristics of paleosols developed in the Middle and Late Pleistocene; to trace changes in the soil characteristics from north to south; to find out changes in the soil in their morphology and micro-morphological structure; to estimate the trend in the soil cover variations with time from the Middle Pleistocene to the present days; and to make a comparison between soil-forming processes in paleosols and their modern analogs. Having analyzed and summarized results obtained from eleven sections studied by the paper authors and using numerous data available from literature, we made an attempt at reconstructing soil cover that existed during the Likhvin, Kamenka, and Mikulino interglacials and at comparing them with the soil cover of today.

The present work is based on the materials on the Middle and Late Pleistocene paleosols studied in comparison with the today's soils existing in the central East European Plain. Among the studied sections there are following (Figure 1): №1. Suvorotino (Dlussky 2001; Panin 2007); №2. Bogolyubovo (Velichko et al. 1996); №3. Gololobovo (Dlussky 2001; Panin 2007); №4. Mikhnevo and №5. Ozherelye (Panin 2007); №6. Likhvin (Dlussky 2001; Little et al. 2002), №7. Bryansk and №8. Arapovichi (Velichko and Morozova 1963; Morozova 1981); №9. Korostelyovo (Dlussky 2001; Velichko 2002); №10. Sebryakovo-Mikhailovka (Dlussky 2001; Velichko et al., 2006); №11. Strelitsa and №12. Gun'ki (Velichko et al. 1997).

The sections are exposed in the brickyard quarries or cut in steep valley slopes where some modern soils are present – gray forest and chernozems, typical and southern. The modern soils in many quarries have been stripped away; some sections in valley scarps are often devoid

of the upper humus horizons (sections Bogolyubovo and Gololobovo). Loess-soil formations include several PC of the Late and Middle Pleistocene age. The greatest assortment of paleosols (besides the modern soil) was found in the Korostelyovo section in the south of the East European Plain. There have been recorded a well pronounced Bryansk and Romny paleosol, as well as Mezin, Kamenka, Inzhavino, and Voronskiy PC. In the Bogolyubovo section (northern part of the loess zone) there are found the Bryansk paleosol and Mezin PC only.

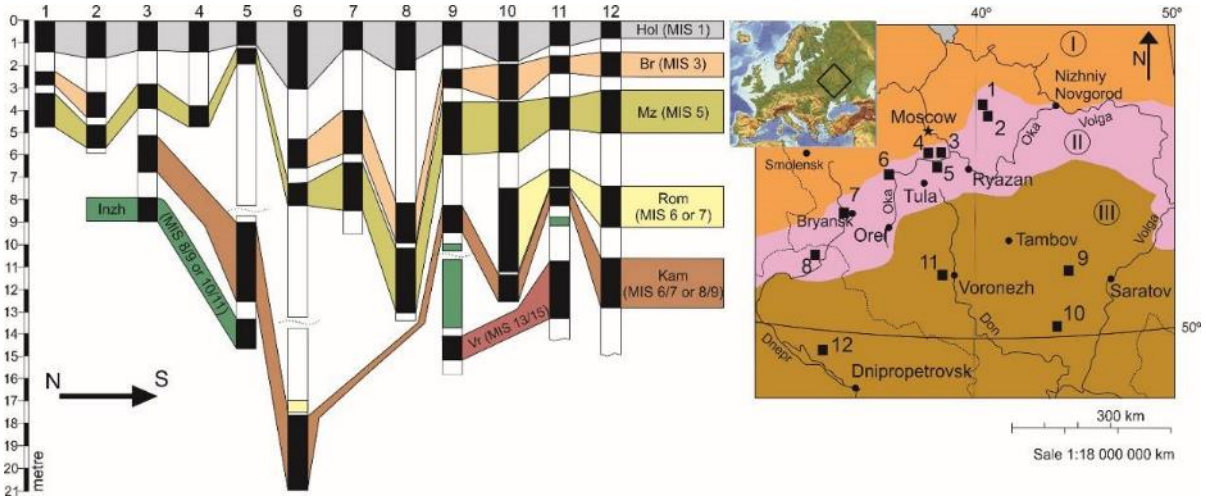

Fig. 1. The correlation of the loess-paleosol sequences exposed in the main sections. The units distinguished in the sections are: Hol – modern soil (map on the right side: I – sod-podzolic soils; II – gray forest soils; III – chernozem complex); Br – Bryansk interstadial paleosol; Rom - Romny interstadial paleosol; Mz – Mezin PC; Kam – Kamenka PC; Inzh – Inzhavino PC; Vr – Vorona PC. The names of the sections with numbers are given above.

In this paper our attention is concentrated on the soil morpho- and microstructure, as well as on the humus and clay fraction content; some data on the amorphous and crystallized iron content and on carbonates and other constituents will be given in order to make easier the interpretation of the soil-forming processes.

The paleosol microstructure was studied in thin sections (30 μm thick) impregnated with polysynthetic resin. In describing thin sections and interpreting the soil formation processes we

followed the techniques described in literature (Gerasimova et al. 1992). Thin sections were photographed on the polarized-light microscopes Motic BA310Pol at 4X/0.1 magnification.

Micromorphology of the Middle and Late Pleistocene paleosols is represented in the Figure 2.

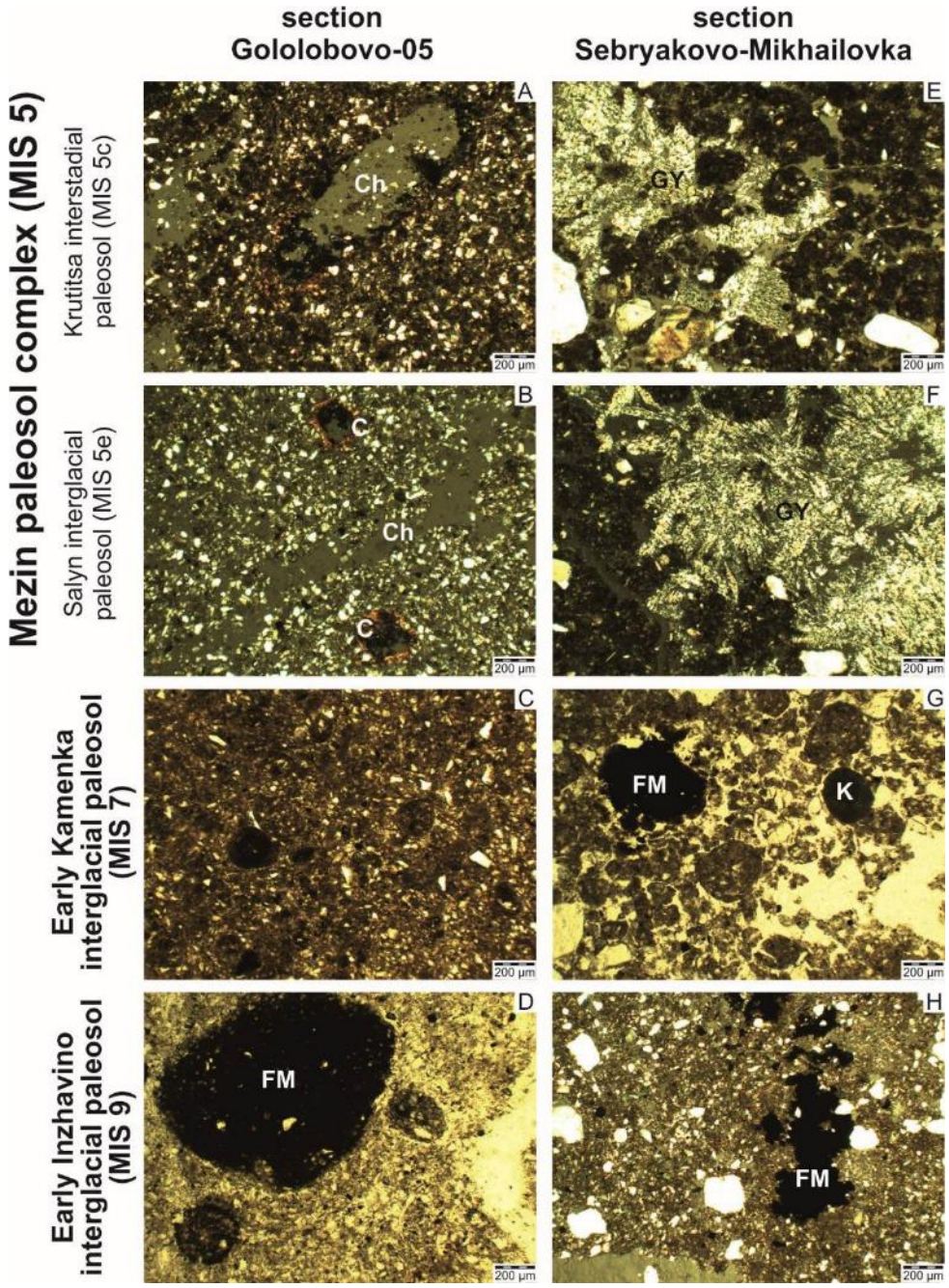

Fig. 2. Symbols in the figures: Ch – channel, FM – Fe-Mn nodules, GY – gypsum pedofeatures, K – carbonate pedofeature, C - clayey coating.

Late Pleistocene Mezin paleosol complex

The Krutitsa interstadial paleosol has been described in 12 loess-paleosol sections, three of them located within the modern Chernozem zone (sections Korostelyovo, Sebryakovo-Mikhailovka, Gun'ki) and the rest in the northern part of the gray forest soil zone.

The interstadial paleosol microstructure (sections Gololobovo, Ozherelye, Suvorotino, Bogolyubovo, a.o.), there are illuviation coatings, mostly humus-clayey in composition, compact, dark brown. They are confined to pores and does not occur in the groundmass. The latter is dark brown, essentially silty-clay in composition. In the Suvorotino section there are iron concretions indicative of wetting and stagnation of water at that level (Gerasimova et al. 1992). The presence of humus-clayey coatings of illuviation in those paleosols, suggests a leading role of humus accumulation with some illuvialtion processes also taking part in the Krutitsa soil development. Taking into consideration the small thickness of their profile (0.42 m), the listed characteristics suggest a certain similarity of those paleosols to modern imperfectly developed meadow-chernozem-like soils (Panin 2007).

In southern sections (Korostelyovo, Sebryakovo-Mikhailovka, Gun'ki) the microstructure of interstadial paleosols is distinct for large regularly shaped gypsum crystals; according to Gerasimova et al. (1992), such crystals may develop under conditions of continuous, or long-term, presence of water in the soil, which makes possible the crystal growth. The soil profile is 0.66 m thick on average. The main soil forming processes here are humus accumulation; carbonate redistribution by eluvial and illuvial processes; and gypsum accumulation. The considered soils may be classified with immature chestnut soils and dark chestnut soils, or with imperfectly developed ordinary chernozems.

The Salyn paleosol formed during the Mikulino Interglacial. In its microstructure there is a clearly traceable eluvial horizon that contains Fe-Mn nodules (Bogolyubovo, Suvorotino sections). There are clayey coatings of illuviation, undoubtedly indicative of lessivage (transportation of clay matter). The soil profile is of a considerable thickness (1.08 m). The maximum proportion of clay particles is in the illuvial horizon and minimum – in the eluvial one. The described characteristics permit the soil to be classified with texture-differentiated soils dominated by eluvial-illuvial processes. So, one can safely assume the following processes taking part if the Salyn paleosol formation: leaf litter formation, humus accumulation, acid hydrolysis of minerals, surface gleying. The considered soils may be attributed to gray forest soils in combination with podsolic and sod-podsolics soils.

As follows from the data obtained on the southern sections (Sebryakovo-Mikhailovka, Korostelyovo, and Gun'ki), quite different soil-forming processes were prevalent there in the Salyn paleosol during the Mikulino. The soil microstructure studies revealed the presence of

large rhomb-shaped pedofeatures of gypsum and carbonates. Similar forms of gypsum were described in the Salyn paleosol in the Azov Sea region (Velichko et al. 2017); that gives ground for suggestion on a similarity in the soil-forming processes all over the south of the East European Plain. Gypsum is present in the soil as a concentration of small and larger crystals. Presumably, its could be related to fluctuations of the humidity, when the soil profile was repeatedly dried up (Minashina and Shishov 2002). Taking into consideration the presence of gypsum and carbonates in the soil and well aggregated humus-clayey groundmass, one may safely suggest that the paleosol development followed the chernozem type. The following soil-forming processes were dominant: humus accumulation; carbonate illuviation resulting in accumulative horizon; gypsum accumulation. The considered soils may be compared, therefore, with modern ordinary chernozems or southern chernozems, in combination with meadow-chernozem-like soils. According to Glushankova (2012), soils at the Korostelyovo section vicinities at the Mikulino Interglacial were represented by a combination of forest and meadow-chernozem-likes soils.

The Middle Pleistocene Kamenka paleosol complex.

The interstadial paleosol known as late Kamenka has much in common in its genesis with the Krutitsa interstadial paleosol. In the northern sections (Gololobovo, Ozherelye, Mikhnevo) studies of the soil microstructure revealed humus-clayey coatings of illuviation, along with ferruginous concretions and nodules. There are traces of cryoturbations recognizable in the paleosol profile. In common with the Krutitsa paleosol, there are carbonate pedofeatures here. It may be concluded that the Kamenka interstadial paleosols are practically identical to those of Krutitsa genetically. In the north of the studied region the paleosols are comparable with imperfectly developed modern meadow-chernozem-like soils (Panin 2007). Paleosols of the southern areas are attributed to imperfectly developed chestnut and dark chestnuts soil type, or to imperfectly developed meadow-chernozem-like.

The Kamenka interglacial was marked by the early Kamenka paleosol development. Studied in sections Gololobovo, Ozherelye, Mikhnevo, and Likhvin, it is typically noted for a thick profile (1.33 m, on average), bright brawn color. The interglacial soil profile consists primarily of horizons ABt@-Bt and AE-EBt-Bt or Btg, which suggests different soil-forming processes. The groundmass is speckled and striated b-fabric. In the uppermost parts of paleosols there are signs of active humus accumulation of humus and clay particles, proportion of both notably decreasing downwards. The microstructure displays iron-manganese pedofeatures, ferruginous concretions and coatings indicative of abundant wetting of the upper horizons. The whitish eluvial horizon does not stand out morphologically; at micro-level the plasma does not

look leached and mainly is brown or light brown in color. It may be attributed to the presence of clayey or silty-clayey coatings; the latter filling completely pores and preventing iron compounds from penetration deeper, so that the eluvial horizon turns brown due to the iron presence. The main soil-forming processes that took part in the paleosol profile development are lessivage, clayization, humus accumulation and illuviation. As follows from the micro-biomorphic analysis, the early Kamenka interglacial paleosol developed under broadleaf forests. Those paleosols may be classified as brown forest lessivé soils bearing traces of clayization and lessivage.

In the Sebryakovo-Mikhailovka and Korostelyovo sections, the early Kamenka interglacial paleosol is aggregated in microstructure; unlike the northern regions, there are pedofeatures of carbonates and iron concretions found, indicative of warm and wet climate at the time of soil development. The groundmass is well aggregated, with granular structure, the soil profile thickness is 1.08 on average. The soil-forming processes having taken part in the soil profile development may be listed as follows: humus accumulation; clayization; carbonate illuviation; biogenic aggregation. Based on those characteristics, the soil may be placed in the group of brownish-gray soils combined with chernozem-like soils and chernozems.

Middle Pleistocene Inzhavino paleosol complex.

Microstructure studies performed on the late Inzhavino interstadial paleosol exposed in Gololobovo and Ozherelye sections revealed the dominance of humus-clayey and iron-clayey coatings, and the presence of iron concretions. The plasma composition is silty-humus-clayey. Coatings are mostly laminated and confined to voids. In the Gololobovo section a coating of humus-clay composition fills a pore 1mm in diameter; the coating displays a kind of layering – the humus layers are found in the central part of the pore filled with clay matter. Such inner structure may be attributed to a cyclic character of the soil-forming processes, when clay particles were illuviated first and humus – later. The main soil-forming processes that account for the soil appearance are humus accumulation, lessivage, and surficial gleying. Hence the interstadial paleosols may be classified as meadow-chernozem-like distinct for active process of clay fraction illuviation and some evidence of surficial gleying.

There are morphologically distinct humus horizons in the interstadial paleosols of the Korostelyovo and Sebryakovo-Mikhailovka sections bearing recognizable traces of cryogenic processes. Ooidal aggregates are seen in their microstructure, along with carbonate pedofeatures and gleying noticeable in the horizons. The processes that have taken part in the paleosol formation are the active humus accumulation, surficial gleying, bioturbation, and illuviation of carbonates. Unlike interstadial paleosols of the Mezin and Kamenka PC, gypsum

pedofeatures are practically absent from the paleosol, which suggests a wetter climate than that of the subsequent interstadials. Meadow-chernozem carbonate soils, with some evidence of shallow gleying, developed under meadow steppe may be taken as the modern analogs of that paleosol.

The early Inzhavino paleosol is dated to the Likhvin Interglacial. Its profile is 1.5 m thick on the average. A whitish eluvial horizon is clearly seen in the soil profile. In common with other interglacial paleosols, there are numerous coatings (clayey, silty-clayey, and ferruginous ones) in the Inzhavino paleosol microstructure. The plasma is silty-clayey, bright brown in color. Our data gave grounds to assign the soil to texture-differentiated group, their development following eluvial-illuvial type, with processes of lessivage playing a noticeable role, and surficial gleying or podzolization being of considerable importance. Among the modern soils, the podzolic superficially-gleyed soils in combination with brown lessivé ones may be considered as their analogs.

In the Korostelyovo and Sebryakovo-Mikhailovka sections the early Inzhavino soil profile is, on average, 0.66 m thick. The microstructure features carbonates, the plasma is well aggregated, silty-clayey in composition, contains iron-manganese nodules. The Likhvin interglacial paleosols in the region may be classed with chernozem-like ones. The present-day analogs of the paleosols are leached chernozems, mycelial carbonate under meadow steppe.

Conclusions

The following conclusions may be drawn from the above described studies of paleosols dated to the Middle and Late Pleistocene on the East European Plain.

1. In the northern part of the East European Plain interglacial paleosols of the Mikulino and Inzhavino age had a texture-differentiated profile, while paleosols dated to the Kamenka interglacial lacked eluvial horizon. In the southern regions the profile of the interglacial paleosols feature carbonate is of humus-accumulative type.

2. During interstadials of the Late and Middle Pleistocene the latitudinal zonality was fairly well pronounced, two zones being distinguished within the considered region. Interglacial paleosols – Mikulino and Inzhavino – permitted to identify three zones, the Kamenka interglacial soils were also distributed over three zones, if we count a small linear area dominated by brownish-gray soils north of the Chernozem zone .

3. Both during interstadials and interglacials, including the present-day epoch, the humus content in soils and the clay fraction proportion increases southwards. As to the soil profile thickness, it was growing in the interstadials in the same direction. The present-day soil

thickness, however, in common with interglacial soils, decreases towards the south, probably due to more active soil erosion related to increasing rainfalls.

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Keywords: paleosols, loess, Pleistocene, interstadial, interglacial.

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Velichko AA. editor (2002). Dinamika komponentov nazemnogo landshafta i vnutrennikh morskikh basseynov Severnoy Yevrazii za posledniye 130000 let (Dynamics of terrestrial landscape components and inner marine basins of Northern Eurasia during the last 130000 years). Atlas-monography «Evolution of landscapes and climates of Northern Eurasia. Late Pleistocene – Holocene – elements of prognosis. II. General paleogeography». Moscow: GEOS.

BACK

SUBFOSSIL SPORE-POLLEN SPECTRA OF DIFFERENT GENETIC TYPES OF SEDIMENTS IN THE UPPER VOLGA REGION

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The best analogs method is one of the main methods used to reconstruct the vegetation and climate from pollen data. Its essence is that phytoclimatic features of the identified modern best analogs are transferred to the characteristics of paleolandscapes. Therefore, one of the important tasks of palynologists is to study pollen spectra of resent sediments in order to replenish the database of subfossil pollen spectra.

The study area is located in the basins of the Bolshaya Kosha and Malaya Kosha rivers (tributaries of the Volga river) and in the coastal zone of the Seliger and Sig lakes, Tver region. It is situated in the taiga area on the border with the mixed forest zone. We conducted pollen analysis of 20 samples of recent sediments: 11 samples were taken from the upper horizons of soils, 7 from alluvial sediments, 2 from lacustrine ones. According to the results of pollen analysis, we drew the following conclusions.

1. Subfossil pollen spectra of soils are diverse in structure. There is a clear dependence of spectra on the vegetation near the sampling site. Thus, Pinus dominates in spectra of samples taken in a pine forest. A variety of non-arboreal pollen is typical for samples from open weakly-forested interfluves and high floodplains. Nevertheless, the predominance of arboreal pollen and the presence of broadleaf species pollen in all spectra indicate their good averaging. In this way, pollen spectra of soils in afforested areas are reliable indicators of vegetation at zonal level. Local vegetation is manifested in the non-arboreal pollen and spores.

2. Pollen spectra of the coastal lacustrine sediments differ in percentage of arboreal pollen. These differences can be related with local vegetation or slope processes in the coastal zone of lakes.

3. Spectra of alluvial sediments are the most similar to each other both in structure and in palynoflora. The role of local vegetation increases in pollen spectra of alluvium in small

rivers. However, spectra of alluvial sediments in middle-sized rivers adequately reflect zonal vegetation. It is the basis for the reconstruction of paleolandscapes by the best analogs method.

Acknowledgements.

This study contributes to the Russian Academy of Sciences Fundamental Research Program, paragraph 127 (State Task 0148-2018-0002, Registration Number 01201352492).

Keywords: pollen analysis, subfossil pollen spectra, the Upper Volga region.

BACK

PALEOENVIRONMENT OF THE PALEOLITHIC SOCIETIES IN THE UPPER DESNA RIVER BASIN (KHOTYLEVO AND BETOVO SITES)

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Desna River basin was one of the dense populated areas in the East-European plain during the Middle and Upper Paleolithic. Sediments exposed in excavation of Khotylevo and Betovo group of sites are composed of loess-soil and alluvium series accumulated during the last Interglacial-Glacial cycle. The present studies were focused on detail lithostratigraphy of the Late Pleistocene deposits enclosing the Paleolithic cultural layers. The bedrock on the right bank of the Desna River was formed by the Upper Cretaceous limestone containing black flint concretions which served as the primary source of raw material for Paleolithic people. The stratigraphic position and morphological characteristics of deposits enclosing the Paleolithic cultural layers supported by available radiocarbon data, suggested that the period of human occupation of this area occurred from the first half of the Middle Valdai Interstadial (Khotylevo I, 2-4 horizons) to the terminate of Middle Valdai time (Khotylevo I, 1 horizon, Khotylevo 6, Betovo) and initial stage of the Late Valdai Glacial epoch (Betovo, Khotylevo 2). In the upperstream section of Khotylevo I Middle Paleolithic site extended about 800 m along the Desna River riverbed a series of four cultural horizons has exposed. These cultural layers were associated with alluvial and slope sediments with paleosol differing in the degree of their post-depositional dislocation. The lowermost cultural horizon underlay by Cretaceous Cenomanian sands bedrock while the uppermost cultural horizon was associated with pedosediments apparently correlated with the Bryansk buried soil. The Betovo Middle Paleolithic and Khotylevo-6 and Khotylevo-2 Late Paleolithic sites are situated of the promontories rising above the Desna flood plain about 15-20 m. The enclosing sediments of Betovo Middle Paleolithic sites were associated with the Late Middle Valdai – Early Late Valdai loess-paleosols series lied on Cretaceous bedrock. The deposits enclosing the Betovo cultural layers are represented by pedosediment of weakly developed paleosol displaced due post-depositional creep. The cultural layer of the early late Paleolithic site Khotylevo-6 were contained in the upper part of Bryansk paleosol. The cultural layer of Khotylevo-2 late Paleolithic site consist

of the weak developed initial soil in the lower part of the Desna loess horizon (early phase of the late Valdai glacial epoch).

This study contributes to the Russian Academy of Sciences Fundamental Research Program, paragraph 127 (State Task 0148-2018-0002, Registration Number 01201352492).

BACK

EVOLUTION AND GENESIS OF HUGE BASINS IN EASTERN AZOV REGION

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Flat eastern Azov lowlands have been complicated by huge oval shaped depressions we call basins. The problem of their origin was not solved yet. There are some hypotheses of their genesis: paleo thermokarst, suffosive erosion, loess subsidence, paleo firth. Those hypotheses were not refuted or confirmed. That's the problem of low grade geological study of basins structure.

We performed a morphological analysis of Yeisk peninsula basins range. The most basins have their axis azimuth about 330°. All of them have soft shape and mirror-like flat bottoms. The average area of basins is about 4 km^2, the depth depends on their area and varies from 2 to 20 m. Extremely large depressions have ridges which complicates western slopes. Geological structure of basins was studied in natural expositions. There are three basic layers the structure of basins consists of. The first layer situated in the bottom of cross-section. It is the sub-aquatic sediments of elder terrace. The depth of the layer is about 5 m below sea level. The second layer is the loess-paleosol consequence, which covers the elder terraces. The third layer consists of the sediments of basins ridge-hollow relief, which origin is unknown. Basins are enclosed in loess stratum and not affect the sub-aquatic layer. The stratigraphic unconformities discovered in the loess-paleosol consequence. The thickness of loess stratum in flat interfluves is greater than in basins, and the number of paleo-sols decreases too. But there are no erosion boundaries between paleosols. We explain it by deflation. Aeolian processes were greater in glacial ages, especially in dry steppe conditions, so the upper soil horizons could be eroded. In favor of aeolian genesis are the soft shape and the axis orientation of most basins. The features have regional spread as the attribute of deflation.

The research was supported by RFBR projects 16-35-60069 and 16-35-00345.

Keywords: flat bottom depressions, rainwater basins, Pleistocene, loess, paleosol.

BACK

HOLOCENE CARPOLOGICAL ASSEMBLAGES FROM THE OKA RIVER BASIN (EUROPEAN RUSSIA)

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Holocene plant macrofossils records were obtained from the sections located in the Oka River basin. In the sections "Ugra" and "Kaluzhskie Zaseki", Holocene deposits are represented by peaty sediments of the oxbow lakes in the Ugra River valley and Vytebet' River valley respectively . The 5 m peat core was extracted from the Istochek peatland, a small forest fen on a slope of the watershed between Voronka River and Upa River. The complex palaeogeographical investigations showed that the most diverse carpological assemblages in the studied sections are associated with the climatic optimum of the Holocene. According to the results of radiocarbon dating of peat, these assemblages were formed during the period 6000 - 6500 cal. yr BP.

Local carpological assemblages (LCA) from "Ugra" and "Kaluzhskie a Zaseki" sections have many common features. Both assemblages are dominated by *Tilia cordata* and *Alnus glutinosa* fruits. The fragments of *Acer platanoides* and *Corylus avellana* fruits were also identified. Among the shrub species the endocarps of *Rubus idaeus*, *Viburnum opulus* and *V. lantana* were noted. Species typical of wet meadows were represented by remains of *Filipendula ulmaria*, *Lycopus europaeus*, *Solanum dulcamara*. Fruits and seeds of aquatic and wetland plants (*Nuphar lutea*, *Stratiotes aloides*, *Potamogeton natans*, *Sagittaria sagittifolia*) were recorded.

LCA from "Istochek" section is featured by domination of aquatic and wetland plants remains (*Nuphar lutea*, *Potamogeton natans*, *Alisma plantago-aquatica*, *Typha latifolia*, *Carex* sp. div.). The remains of species typical of wet meadows and peatlands were also abundant. Fruits of *Potentilla supina*, *Persicaria lapathifolia* and *Chenopodium* sp. were recorded. Trees and shrubs were represented by fruits of *Alnus glutinosa* and *Tilia cordata*, endocarps of *Prunus fruticosa* and *Rubus idaeus*.

The carpological data reflect local aquatic, wetland and, to some extent, forest vegetation. According to the obtained results, lime forests were spread in the valleys of Ugra

River and Vytebet' River in the end of the climatic optimum of the Holocene. Local carpological assemblage from "Istochek" section reflects local aquatic and wetland plant communities with adjacent black alder stands.

This study contributes to the State Task № 0148-2018-0002 (FNI Program, paragraph 127; NIOKTR № 01201352492).

Keywords: Holocene, plant macrofossils, carpological analysis, reconstruction of palaeovegetation.

BACK

THE NORTHERN CASPIAN SEA: ENVIRONMENTAL CONSEQUENCES OF CLIMATE CHANGE DURING THE HOLOCENE

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Studying of the Holocene history of the Caspian Sea is important for understanding of its current state and evolution in the conditions of climatic changes. A structure of the Holocene deposits in the Northern Caspian Sea fully reflects the level fluctuations of different scale. Our studying is based on the processing of high and low frequency seismic-acoustic profiles, as well as on the core investigations by complex of methods. The Holocene deposits are presented by Mangyshlakian regressive and Novocaspian transgressive layers. The Mangyshlakian deposits are established in the paleo-lows in the strata of the Khvalynian deposits in the interval of the present-day sea depth 3-33 m, similar to the modern ilmeni water bodies of the Volga delta, paleo-valley and the cover of paleo-deltaic deposits in the southern part of the Northern Caspian Sea. There formation took place under the arid climate conditions, in the shallow-water lacustrine water bodies with freshwater mollusks and diatom algae. Based on the data of radiocarbon dating, the age of the Mangyshlakian deposits is in the interval between 10.5-11.9 cal ka BP. Such was the Caspian response to increasing continentality of the climate in the Boreal period of the Holocene. The Novocaspian horizon is represented by various shallow facies with abundant shells of mollusks. It contain uneven-age cuttings into the Novocaspian, Mangyshlakian, and even into the Khvalynian deposits. Three sub-horizons are identified on the basis of Caspian brackish-water mollusk composition. The mollusks shells from depressions contain freshwater species. So, the Novocaspian transgression developed in three stages divided by two falling of level. According to radiocarbon data, the first stage of rise answered the Atlantic period of the Holocene. The next two highstands appear to coincide with two periods of increased precipitation in Eurasia, the 2600 BP event and the Little Ice Age. The last

regression was coeval with the Warm Mediaeval Period. The work is supported by Russian Geographical Society (Grant 3/2017-R).

Keywords: Holocene, Mangyshlakian regression, Novocaspian transgression, climate change.

BACK

C6.12 Geography of Governance

Chairperson(s):

Local Governance for Local Development in the XXI Century: Opportunities and Limitations

BACK

TERRITORIAL PUBLIC SELF-GOVERNMENT IN RUSSIA: CONTEMPORARY STATE, TRENDS AND PROBLEMS OF DEVELOPMENT

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In modern Russia, territorial public self-government (TOS) means the self-organization of citizens at the place of their residence on the part of the territory of the settlement, the inner city area of the city of federal significance and the intraurban area for independent implement its own initiatives on issues of local importance (according to Part 1 c Article 27 of the Federal Law of 2003 no. 131-FZ On general principles of the organization of local self-government in the Russian Federation. TOS are not the part of the system of local government, they are the link between the population and the municipal level of public authority and are a reserve for the development of democracy and real involvement of the population in the management of social processes, improving the quality of life of the population, creating a sense of patriotism among citizens, and reducing the level of social tension.

In total in Russia there are about 31000 TOS, they cover 1/4 of all municipalities. The most developed TOS are in Volgograd oblast, the Republic of Buryatia, Krasnodar krai, Rostov, Novosibirsk, and Omsk oblasts. A few hundred TOS are in the cities: Voronezh, Kursk, Nizhny Novgorod, Orel, Tambov, Chelyabinsk. In some regions, TOS form a network structure. The administrative way to increase the number of TOS gives quick results, but this does not stimulate citizens to perform an active role in solving local problems.

TOS authorities are granted extensive rights, they:

1) represent the interests of the population residing in the respective territory;

2) ensure the implementation of decisions taken at meetings and conferences of citizens;

3) may carry out economic activities for the improvement of the territory;

4) have the right to submit draft municipal legal acts to local self-government.

Today, issues of monitoring the quality of housing and communal services are among the priorities of the TOS. In addition, some TOS successfully counteract corruption of local municipal government and business in the case of plans for super-dense settlements of multistorey buildings, deterioration of environmental conditions, development of external

transport for settlements (Case: the urban settlement Bykovo in Moscow oblast, TOS “Centralny”).

BACK

SUSTAINABLE HYDROSOCIAL ARRANGEMENTS IN THE WESTERN PAMIRS, TAJIKISTAN

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In terms of changing interrelations between post-socialist societies and the natural environment, academic research has strongly focused on problems arising, as a rule, from environmental change, shifting resource entitlement and ownership regimes, and competing interests pursued by actors with different levels of power thus far. Promising examples of purposefully applied mutual support and cooperation among local resource users to make a living under shifting natural and social conditions have been documented more seldom. However, such cases exist. They can reveal how sociocultural assets such as local knowledge, common decision-making, as well as solidarity and trust within social groups can be successfully employed to make natural resources sustainable and equitably accessible. This talk presents empirically based findings that exemplify such a case. To pursue this claim, this paper presents a ‘sustainable hydrosocial arrangement’ from the Western Pamir Mountains, Tajikistan. Hydrosocial arrangements are seen here as configurations of entwined physical and social elements encountering the interconnected water-food-energy challenge at the local level. Based on historical and current data, the paper shows the strengths of local efforts to encounter the challenge of a reliable supply of food and fuel in marginalized regions. Despite the potentials of such arrangements, the paper concludes that the structural challenges for food and fuel supply cannot be fully addressed by local efforts. The lesson learned is that external actors are crucial to promote sustainable development efforts for the benefit of the people living in marginalized regions.

BACK

LEGAL REGISTRATION OF MUNICIPAL BOUNDARIES IN RUSSIA: THE NEEDS AND PROCESS

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State tax and budget policy is one of the tools for developing the territories. According to the Budgetary Code of Russia, only a land tax and a personal property tax are completely received by local budgets. Therefore, a land tax is one of the main income sources for municipalities. However, the collected land tax amounts are low due to incomplete cadastral valuation and underestimated land resources, inefficient collection of payments, and the existence of tax exemptions. In such circumstances, it is essential to strictly define territories of municipal units. The aim of the study is to analyze regional features of the determination of municipal boundaries. This function is assigned to regional authorities and local self-governments. During the 20 century, boundaries of Russia's regions, i.e., modern federal subjects and of intraregional districts changed many times. At the beginning of the 21 century, territorial changes within regions continue associated with local self-government reform. However, often even between stable administrative-territorial units their boundaries are not fixed both on the ground and legally. As of early 2018, only about half of municipal boundaries and 18% – of settlements have been legalized. The situation varies greatly by regions. The analysis showed that the necessary regulatory frameworks for cadastral works do exist both at the federal and regional level. The main obstacle to the legal fixing of boundaries is scarcity of municipal budgets, since cadastral and land management works should be carried out at the expense of municipalities. As a result, there is a vicious circle: lack of financial resources – lack of cadastral works – inefficient land use – low incomes of local budgets – lack of financial resources. In addition, in some areas, interregional boundaries have not been agreed upon; this makes it difficult to define the territory of bordering municipalities. The specifics of process of municipal boundaries legalization in federal subjects are largely determined by their economic development level, as well as features and problems of land use. However, there are also institutional reasons. To effectively manage land resources at the local level, it is necessary to develop mechanisms for federal support.

Keywords: municipal territory and boundary, land tax, legalization, federal subjects, Russia.

BACK

SYNERGY AND DECISIONAL CENTRIFUGAL FORCES IN THE METROPOLITAN AREA OF CLUJ-NAPOCA, ROMANIA

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Cluj-Napoca is a tier one city in the national Romanian hierarchy, following the capital city of Bucharest, alongside six other urban centres (Iaşi, Constanţa, Galaţi, Craiova, Timişoara, and Braşov). It commands, through its functions (county and regional administrative center, university, medical, cultural, trade, media, and transportation pole, etc.), almost the entire historical province of Transilvania. Its population slowly grew in the past quarter century, from 313,562 in 1992 to 323,108 inhabitants, in the year 2017. However, the neighbouring rural localities grew considerably in population, mostly as result of the lower land prices in these areas compared to the city. In the territorial contiguity there are nine “rural” administrative areas, mainly functioning as bedroom communities as they have gradually lost their rural character.

Methodologically, the delineation of the study area is based on the principles of intensity and spatial connections between component localities, with Cluj-Napoca at its center. The maps were created using GIS software, with the main intent of presenting the infrastructure components that possess synergetic functions (water, electricity, heating, transportation, waste management etc.) and decisively shape the entire territorial whole.

Nevertheless, each territorial unit retains its administrative and political independence, which roughly translates to an inefficient usage of development funds, especially for infrastructure, and a fragmentation and acute waste of land. In said situation, when decision making forces are mostly centrifugal and individualistic, it is imperative to create a single administrative body for such territorial structures as maintaining the status quo will exacerbate the chaotic state of the entire territorial ensemble.

BACK

LOCAL GOVERNMENT REFORMS IN THE FIVE LUSOPHONE AFRICAN COUNTRIES: THE TORTUOUS PATH TO LOCAL DEMOCRACY

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This paper explores, compares and draws practical lessons from local government in the five Lusophone African countries – Angola, Cape Verde, Guinea-Bissau, Mozambique and Sao Tome and Principe. The paper addresses the following research question: what are the main features and what are the determinants of the current level of development of local government in these countries? In particular, the paper explores and discusses the implementation of the current formal institutional models of local government, central-local relations in the spatial planning systems, the constraints affecting the implementation of these decentralization reforms, the opportunities for improvements, and the challenges confronting sub-national tiers of government in these countries, following the transition in the early 1990's from single party political regimes, centrally planned economies and systems of centralized public administration, that had been adopted at the time of independence in 1975 (1974 for Guinea-Bissau), to multi-party democracies, market economies and formally decentralized countries. The evidence collected shows how the development of a true system of local government is critical for the successful reform of the state in these African countries.

BACK

MACROREGIONS AND MANAGEMENT OF LOGISTICS STRUCTURES FOR A NEW SCENARIO IN THE SOUTH-EASTERN MEDITERRANEAN

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This study aims to highlight the role of cross-border and inter-territorial cooperation policies on a macroregional level in the Euro-Mediterranean context, with particular attention to sectoral cooperation projects in the fields of transport, environmental management, health, waste disposal, public services and energy, in accordance with the indications contained in the European Outline Convention on Transfrontier Co-operation between Territorial Communities or Authorities (ETS No.106) and its first two additional Protocols, which marked an important stage in the development of such cooperation.

Particular attention will be paid to the role played by the macroregions of the eastern Mediterranean (and the possible contributions of local and regional bodies) and the policies implemented on the regional and European level to tackle common challenges and take decisions concerning cooperation on questions of general interest, such as the creation of port structures and/or infrastructure transport in the Mediterranean Basin.

The study stresses the need to promote and develop cross-border and inter-territorial cooperation, in the awareness that the advantages for regional bodies, by their nature highly numerous, can help restore the key role of the countries of the Mediterranean in the management of flows of goods and people and in the promotion of cultural and environmental heritage in support of the sustainable development of the area.

After a presentation of the eastern regions of the European Mezzogiorno, special attention will be paid to sectoral cooperation policies and projects aimed at the promotion of mobility and transport. The focus will be on certain measures adopted in the regions of the Adriatic Sea, on the interregional and cross-border level, in the course of the 2007-2013 cycle and planned for the 2014–2020 period. The aim will be to identify their strengths and

weaknesses, but also to suggest new strategic approaches, which, on the various levels of governance, enable preferences in the allocation of resources.

Keywords: cross-border cooperation, macroregions, Euro-Mediterranean, Southern Italy.

BACK

INTER-MUNICIPAL COOPERATION IN WASTE MANAGEMENT: THE CASE OF POLAND

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Inter-municipal cooperation has become a popular way of organising and managing public services in many West European countries. A considerable proportion of studies of inter-municipal cooperation published so far deal with joint operations in municipal waste management. Research in this field has recently become ever more popular. This presentation seeks to present the scale of inter-municipal cooperation in waste management in Poland in the light of the role of three key factors of cooperation. The first shows spatial regularities in the distribution of inter-municipal bodies involved in waste management in Poland, both in the system of voivodeships and historical-cultural regions. The second is institutional conditions confirming the scale of the Europeanisation of public policies taking place in Poland. It embraces the implementation of the EU legal framework in the Polish legal system and the cooperative behaviour of municipalities as a result of those changes. The third is a negative verification of the assumptions of the economic theory upholding the role of financial motivation in establishing cooperation (looking for savings and economies of scale to reduce unit cost); the presented results do not corroborate this type of motivation.

Keywords: inter-municipal cooperation, waste management, europeanisation, Poland.

BACK

CHALLENGES IN CENTRAL – LOCAL RELATIONS IN HUNGARY

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After two decades of decentralisation process based on the idea of "Good State" a strong centralization has started in Hungary since the beginning of this decade. The objective of the paper is to demonstrate the space for local municipalities to react on changes in central-local relations after the new law on Local Government, which came into force since 1st of January, 2012.

Based on the basic indicators like per capita GDP, employment and unemployment rate etc. the paper describes the health of the public sector in Hungary and some CEE countries (Albania, Belarus, Bulgaria, Croatia, Czech Republic, Moldavia, Estonia, Poland, Ukraine).

According to the general trend of the changes of model in public sector – turn from the New Public Administration theory to the New Webarian State – after the government change in Hungary turned towards a strong centralization.

This country case study has two approaches. First is the analysis of the effect of changes on central government. How central government reorganized the functions what centralized from the lower level of governments (counties and local) like public education and public health (hospitals) and rate setting of local public services? The second view is the side of local governments. How these changes have effected local government finance, like decreasing pressure on the side of expenditures and further increasing role of locally generated financial resources like local taxes?

The final chapter separates actions by the side of revenues and expenditures, additionally by time period of effects (short term, long term). The interconnection of the findings about the general situation in the countries and the specific experience in local governments by the size of populations and the range of managed local public services.

BACK

POSTER

THE APPLICABILITY OF THE SPECIAL ECONOMIC ZONE MODEL OF LOCAL DEVELOPMENT – LIPETSK EXPERIENCE

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The cluster model of regional economic development in the Lipetsk region based on the allocation of industry and agriculture production in Special Economic Zones has shown its effectiveness for the development of the whole region. However, this model was helpless to introduce any significant breakthrough changes in the structure of the economy. There is an attempt to apply the same allocation model to tourism segment objects. It is shown that tourist entities unlike industrial and agricultural have different development imperatives. The main condition for the formation and functioning of a tourist cluster is a tourist destination. A tourist cluster can not be created outside tourist destinations, as well as within one site. The tourist objects on the territory of a tourist cluster must be distributed according to tourist destinations or connected with them through a well-developed infrastructure in a single functional system. So it is necessary to change the ways of applying the SEZ model in accordance with the specifics of the allocated objects. The conclusion is that the application of the same management model in the same environment for different economy segments needs some adjustment.

Keywords: the cluster model, Zadonsky district, Lipetsk region, Special Economic Zones, tourist cluster, tourist destination.

Lipetsk region is one of the most dynamically developing regions of Russia. In recent years, there has been a positive dynamics in the regional economy, exceeding the average Russian rate in many respects. So, according to the results of 2016, the growth rate of industrial production was 103.4%, agricultural production - 106.7%. The growth of investments in fixed assets amounted to 103.6%, the average monthly wage increased by 105.9%, the growth of average per capita cash income of the population amounted to 103.1% (Ob itogakh 2017).

On the other hand, there is a number of problems. The predominant sector of the economy is the production sector, in which the metallurgical industry is highly dominating. As a modern stable structure of the economy assumes other priorities, diversifying the sector structure of the economy is an important task. Another imbalance is territorial – more than half of the production and the population is concentrated in the regional center - Lipetsk. Therefore, in addition to diversifying the sectoral structure, a territorial de-concentration of the economy is needed.

To solve these and other problems in the Lipetsk region the cluster approach in the management of regional economy has been successfully applied. A cluster in this case we can identify as an association of enterprises and suppliers, services and other interdependent organizations on a territory, which are altogether involved in producing goods or services. One of the ways to put this idea into practice and distinguish such clusters to manage them is to create special economic zones (SEZ).

One special economic zone of federal level "Lipetsk" and 10 special economic zones of regional level of various specialization have been created in Lipetsk region. The “special” in them is that any investor, who wants to become a resident of a special economic zone (to work on that territory), receives a number of benefits: renting a land plot without bidding, ready engineering infrastructure, reduced land rent rates, a number of tax customs privileges. Thus attracting investors, today in the economic zone of federal level 47 participants are registered, in 10 regional - 51 participants. Such an experience of attracting and concentrating industrial and agricultural enterprises in small areas with a preferential management regime proved to be more than successful (Table 1).

Table 1. Some results of the work of the SEZ "Lipetsk" in 2016 (Otchet 2017)

Share in tax revenues of the region,%	2
Share of revenues in the GRP of the region,%	2,1
Share in the volume of output of processing industries,%	8
Share in the number of newly created jobs,%	10,5

The SEZ "Lipetsk" in 2017 (for the fourth year in a row) received the winner's diplomas in two nominations in the Global Free Zones of the Year rating, comducted by *The FDi Intelligence* - a specialist division from “The Financial Times”, which provides industry leading insight and analysis on crossborder expansion, greenfield inward investment and foreign direct investment trends. At the same time, it should be noted that there have been no significant

changes in the sector structure of the economy that were expected from the introduction of high-tech industries. Many changes have no direct causal relationship with the work of special economic zones (Table 2).

Table 2. Changes in the industrial structure of the economy of Lipetsk region in 10 years of SEZ existence (Lipetskaya 2017)

		2006	2016
Average per capita monetary income, thousand rubles. per capita		5,5	28,5
Share of processing industries in fixed assets,%		18,8	28
Share of the two largest segments in the structure of the gross regional product,%	manufacturing industry	55	40,6
	agriculture	7	12,6
Share of the three largest segments in the commodity structure of the manufacturing industry,%	metallurgy	68	61
	food	16	25,1
	engineering	9	5

Nevertheless, the success of the cluster approach model in the development of the economy is beyond doubt speaking about production concentration at industrial and agro-industrial zones in terms and conditions of Lipetsk region's environment. If speaking about tourist and recreational zones developing in conditions of the same environment, it is necessary to change the ways of applying the SEZ model in accordance with the specifics of the development of tourist industry objects. In other terms, the application of the same management model in the same environment for different economy segments needs some adjustment. We shall consider for an example the auto-tourist cluster "Zadonshchina", which is being formed on the territory of the Zadonsky district of Lipetsk region. The whole territory of the district is declared as a cluster. But the overwhelming part of the new construction is located on a small investment area adjacent to the federal highway M-4 "Don" (Fig. 1). It is planned to create 60 investment sites on this area, each with a defined specialization. In addition to the standard set of objects for an autotouristic cluster (motels, campsites, car-care centers, trade and catering facilities) it is planned to build new recreation centers, health complexes, clubs of various kinds (golf, shooting), complexes for environmental and agrarian tourism, a water park, other tourist facilities.

Fig. 1. The allocation of investment sites of the "Zadonshchina" Special Economic Zone.

In the case of a tourist cluster, it must be taken into account that such clusters have a number of features that distinguish them from industrial and agrarian clusters:

- availability of tourist and recreational resources, on the basis of which tourist products and tourist services are formed;
- a cluster is formed on the basis of a product node (product dominant).
- presence of specialized tourist infrastructure that unites the elements of the cluster and ensures the unity of its functioning;
- the main role in the formation of regional tourist clusters belongs to local administrations that initiate and coordinate the activities of all its participants;
- the flexibility, fuzziness and variability of geographical boundaries within administrative areas or at the junction of several territorial entities (interregional clusters);
- tourist clusters always have a routing-territorial organization of objects, due to which the cluster objects are transformed into interacting elements;
- cluster members are territorially distributed within the destination (Kruzhalin et al. 2014; Morozov et al. 2014)

The main condition for the formation and functioning of a tourist cluster is a tourist destination (Rassokhina 2014; Morozov and Vojt 2013). It is defined as a territory that has a certain attractiveness for tourists. Such territory must satisfy at least the following three conditions: 1) have a specific set of tourist services (in accordance with the peculiarities of tourist demand), necessary for the reception of tourists; 2) be geographically accessible; 3) have

available information systems, necessary for tourist facilities functioning. Therefore, a tourist cluster can not be created outside tourist destinations, as well as within one small site. The tourist objects on the territory of a tourist cluster are distributed according to tourist destinations or are connected with them through a well-developed infrastructure, forming a single functional system (Safaryan 2015; Zyryanov 2014)

In other words it is rather likely that tourist objects created at one site (“Zadonshina”) far from tourist destinations could be of low economic benefit. Such objects could only meet the demand of autotourists travelling through the M-4 "Don" highway. That could mean that those objects would have a local impact. That does not correspond to the expected role of regional clusters as points of economic growth of a territory.

Thus we can conclude that the cluster model of regional economic development in the Lipetsk region based on the allocation of industry and agriculture production in special economic zones has shown its sufficient effectiveness for the progressive development of the whole region. However, this model was helpless to introduce any significant breakthrough changes in the structure of the economy. The attempt to apply the same allocation model to different economic segments (industry and tourism) with different development imperatives could be unsuccessful.

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BACK

C16.26. Land Use and Land-Cover Change – Land Use and Land-Cover Change: Challenges of Globalization. Land Cover Change at Global and Regional Levels

Chairperson(s):

Land Use and Land-Cover Change: Challenges of Globalization

- Current Trends Of Arable Lands Dynamics As A Marker For Agricultural Development In Russia
  A. Nekrich, D. Lyuri

- Agricultural Landuse Pattern In Pune District In India
  Sanjay Patil

- Modeling Based Study Of Spatio-Temporal Dynamics Of Land Use And Land Cover In Rapidly Developing Varanasi District (India) Using Remote Sensing
  Varun Narayan Mishra, Praveen Kumar Rai, Rajendra Prasad, Milap Punia, Mărgărit-Mircea Nistor

- Scientific Background And Peculiarities For Selecting Indicators For Land Degradation Neutrality In Russia
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- Implications Of Massive Cropland Expansion During Virgin Lands Campaign In Russia And Kazakhstan On Soil Carbon Stocks
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- Climate And Dynamics Of Cereal Yields In Russia: How Far They Go Beyond Historical Patterns?
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- The Creation Of Preventive Peat Fire Danger Monitoring System
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- Adaptation Of Land Use Management To Military And Political Instability In Regions Of Afganistan
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- Transformation Of The Natural Environment Along The Baikal-Gobi Meridional Transect In The Context Of Climate Change

  E. Garmaev, B. Tsydypov, Zh. Alymbaeva

POSTER

Effect Of Conservation Farming On Carbon Sequestration In Soils Of Different Bioclimatic Regions

V.O. Lopes de Gerenyu, D.A. Khoroshaev, I.N. Kurganova

The Response Of Steppe Geosystems Of Central Asia To Modern Climate Changes

O.I. Bazhenova, V.A. Snytko

BACK

CLIMATE AND DYNAMICS OF CEREAL YIELDS IN RUSSIA: HOW FAR THEY GO BEYOND HISTORICAL PATTERNS?

Nikolai Dronin

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Most general circulation models (GCMs) applied to the northern hemisphere simulate wetter and warmer climate in forest zone and growing aridity of the steppe and forest-steppe zones of Russia. In general these projections are supported by observation over current climate transformation in Russia. Current climate warming in the northern hemisphere is mostly associated with more intense activity of the North-Atlantic Oscillation (NAO) and weaker Siberian Anticyclone (SA) while connection between their intensity and rising concentration of greenhouse gases in the atmosphere is not firmly established. To answer the question about of nature of the current climate transformation we have to define the “historical” and “new” climate by quantitative parameters. We use statistical models «yield-weather» as a proxy for «historical climate». These simple regression models are designed for each region (oblast) of Russia for the period of 1961-2010. In general the models demonstrate a good correlation between cereals yield data and combination of meteorological parameters (monthly temperature and precipitation) specific for each region. We suggest that if some Russian regions show strong divergence of results of simulation from actual yields for current period (2010-2017) it would indicate emerging of “new climate” at least for agricultural sector. If no such regions are found we would conclude that current climate in Russian regions still go within its historic fluctuation patterns.

Keywords: climate warming, cereal yields, agricultural regions of Russia, regression models.

BACK

THE CREATION OF PREVENTIVE PEAT FIRE DANGER MONITORING SYSTEM

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Marches and wetlands occupy about one-fifth of the territory of Russia. To use them, they are drained: currently drained swamp areas are more than 10 million hectares, about 1.5 millions of them are occupied by peats. Most of these lands were used during the maximum peat extraction rates in Soviet Union. However, after the decline of peat industry, most peatlands were abandoned without the necessary cleaning. It caused the set of problems, the main of them is high flammability of former peats.

The research is focused on the creation of a project of preventive peat fire danger monitoring system. There are two research tasks:

- creation of the system on basis of the peat fire detection method with the use of remote-sensed data: MSI/Sentinel-2, MODIS/Aqua&Terra, OLI&TIRS/Landsat-8;
- determination of threshold values of monitoring parameters – brightness temperature, water index (NDWI), which characterize state of peats, his flammability.

The peat fire detection method is a set of operations for satellite image processing and statistical analysis of monitoring parameters. The result of these operations is a complex of images of potentially fire dangerous peats. The advantage of this method consist in convenience for algorithmization and using as basis of monitoring system.

For detect potentially fire dangerous peats are used threshold values. The excess of monitoring parameters over them indicate high peat fire danger. These values were determinate by using trend analysis of satellite monitoring parameters during peat fire formation and development on European Russia in 2013-2016.

In summary, constrict preventive peat fire monitoring system have set of advantages:

- combination of different remote-sensed data and analysis methods – monitoring reliability growth;
- preventive detection – peat fire forecast possibility;

- freeware distribution of monitoring results because of using open remote-sensed data.

Keywords: peat fire danger, satellite image, preventive monitoring, fire detection.

BACK

ADAPTATION OF LAND USE MANAGEMENT TO MILITARY AND POLITICAL INSTABILITY IN REGIONS OF AFGANISTAN

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The Islamic republic of Afghanistan has been developed in condition of permanent military and political insecurity since 1970s. The goal of the study is to investigate impact of military instability on economic and social performance of regions of the Afghanistan. We assessed all (34) provinces in relation to military instability measured by frequency of reported armed conflicts in the last years. The provinces with different degree of instability are analyzed in relation to their economic and social performance. We used official statistics on growth of population, dynamic of cultivated area, agricultural production, agricultural cooperatives, infrastructure development, amount of collected taxes, number of implemented international projects, non-governmental organizations, medical facilities and others. The study reveals a paradoxical situation when the most instable provinces are characterized by the highest rate of economic and social development. For instance, this group of provinces would get the highest growth of crop area and road construction with probability of 60%. They would also get the high level trade infrastructure, taxes collection, and realization of international projects of development with probability of 40%. In contrast, in the “calmest” provinces the very high growth of crop area is met with probability of 25% and the high level of trade development as well as taxes collections could be found only with 13% probability. We conclude that the most Afghan provinces managed to adapt to permanent military and political instability due to some specific ways of land use and resource management.

BACK

TRANSFORMATION OF THE NATURAL ENVIRONMENT ALONG THE BAIKAL-GOBI MERIDIONAL TRANSECT IN THE CONTEXT OF CLIMATE CHANGE

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Starting in the eighties of the 20th century, the scientists of the Baikal Institute of Nature Management (BINM SB RAS) have been conducting field observations of the Transbaikalia geosystems transformation due to the change of climate and nature management.

An utmost importance is placed on the study of a negative response of the land geosystems. This is particularly shown through their deterioration, degradation, and desertification. During 1985-2017 the scientists of the BINM SB RAS established a network of key sites for contact monitoring of the geosystems status and dynamics and the negative natural-anthropogenic processes along the Baikal-Gobi meridional transect in dry areas of the north of Central Asia. The monitoring of the vegetation cover status and its dynamics of some key sites is conducted by processing and analysis of multitemporal and multispectral Landsat and MODIS Terra imagery. An automatic analysis of the NDVI time variation and a comparison with the progress of the index in the previous seasons are performed. The landscape indication of the key sites is made on the basis of satellite imagery and complete geobotanical descriptions. To analyze the transformation of the environment by the climatic factors, we compared NDVI series and the precipitation and temperature and calculated the degree of correlation between them.

The assessment of the spatio-temporal dynamics of steppe plant communities is conducted to reveal their response to the current climate change. Mapping of selected modeling polygons was carried out on the basis of satellite data decoding and field surveys. The large-scale map of actual vegetation reflects the current state of the vegetation cover and its horizontal structure. With multitemporal satellite Landsat and MODIS imagery we consider the vegetation cover dynamics of the test range.

The reported study was funded by RFBR according to the research project № 17-05-01059.

Keywords: desertification, dry climatic zones, vegetation cover, transformation, Landsat, MODIS, NDVI, mapping of vegetation.

BACK

CLIMATE AND DYNAMICS OF CEREAL YIELDS IN RUSSIA: HOW FAR THEY GO BEYOND HISTORICAL PATTERNS?

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Most general circulation models (GCMs) applied to the northern hemisphere simulate wetter and warmer climate in forest zone and growing aridity of the steppe and forest-steppe zones of Russia. In general these projections are supported by observation over current climate transformation in Russia. Current climate warming in the northern hemisphere is mostly associated with more intense activity of the North-Atlantic Oscillation (NAO) and weaker Siberian Anticyclone (SA) while connection between their intensity and rising concentration of greenhouse gases in the atmosphere is not firmly established. To answer the question about of nature of the current climate transformation we have to define the “historical” and “new” climate by quantitative parameters. We use statistical models «yield-weather» as a proxy for «historical climate». These simple regression models are designed for each region (oblast) of Russia for the period of 1961-2010. In general the models demonstrate a good correlation between cereals yield data and combination of meteorological parameters (monthly temperature and precipitation) specific for each region. We suggest that if some Russian regions show strong divergence of results of simulation from actual yields for current period (2010-2017) it would indicate emerging of “new climate” at least for agricultural sector. If no such regions are found we would conclude that current climate in Russian regions still go within its historic fluctuation patterns.

Keywords: climate warming, cereal yields, agricultural regions of Russia, regression models.

BACK

CURRENT TRENDS OF ARABLE LANDS DYNAMICS AS A MARKER FOR AGRICULTURAL DEVELOPMENT IN RUSSIA

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Since the beginning of the 1990s, a catastrophic reduction of cultivated lands has taken place in Russia. The total area of abandoned agricultural land reaches more than 60 million hectares and it seemed that this tendency should have a long-term character. Since 2006–2007 the tendency of returning the fallows to the agricultural use has been observing in many Russian regions. Authors studied geographical location of arable lands in dynamics during the crisis period (1990-2017) in order to reveal different types of areas where re-argrogenesis impact is strong. Based on report materials, field research and statistical analysis we set 3 specific types of croplands dynamics: *«long-term decrease»*, *«stability»*, and *«increase»*. The type of *«long-term decrease»* extends in Non-Black Earth Regions, unites territories from Pskov to Sverdlovsk regions, covers Tomsk and Kemerovo regions and stretches to Zabaykalsky Krai. The type of *«stability»* is placed in 29 agrarian regions: Volga region, Southern part of Western and Eastern Siberia, western part of Non-Black Earth Regions. The areas of *«increase»* are widespread in 22 regions of Russia where environment is favorable for agrarian activity – the Black Earth, some republics of the Caucasus, steppes of South Ural, Altai Krai, Primorye. The contemporary trends of croplands dynamics for the majority of agricultural regions of the Russian Federation are defined by combination of the regional Bioclimatic potential (BCP) and rural population.

Keywords: arable lands, agricultural lands, croplands, efficiency of agrarian policy, fallows lands, Russian agriculture.

BACK

AGRICULTURAL LANDUSE PATTERN IN PUNE DISTRICT IN INDIA

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The human being has modifying land to obtain food and other essentials from thousands of years. Landuse and Landcover changes are far greater than ever in history deriving unprecedented changes. Agriculture continues to sustain millions of people in India. This is despite the rapid industrialization which is acquiring significant proportions in many regions of the country. In India 63 percent population lives in rural area and it contributes nearly 14.20 percent of gross domestic product. Over 63 percent population depends on agriculture for their livelihood. In India 60 percent area is rainfed. Better agriculture techniques have successfully applied in order to achieve self-sufficiency in agriculture production. The five year plans are aimed to make India self-reliant in agriculture sector. Hence for the last five plans, many programmes such as community development programme, extension services, expansion of irrigation facilities, fertilizers, agricultural machineries, high yielding varieties of seeds, expansion of transport, power, marketing and institutional credit have introduced. Before green revolution Indian agriculture was facing many problems such as lack of irrigation, limited use of technology, unsuccessful land reforms, explosive population growth, decreasing investment in agriculture sector, expansion of urban settlement, dead use of agricultural land etc. Green revolution-I and II has changed the face of agriculture in India. The present study is a modest attempt to assess the spatio-temporal variation in landuse pattern in Pune district in India.

This region has not been so far studied thoroughly from landuse point of view by geographers and therefore study region has remains still untouched for landuse planning. Secondly, irrigation is influencing factor in study region. Presently, it has considerable impact in changing cropping pattern. The region has 60 percent net sown area. The per capital land holding of farmers is 1.54 ha. Total irrigation in study area is 27 percent. There are 26.9 percent cultivators and 12.7 percent agricultural labourers in study region. The present research has been undertaken to make comprehensive study of agriculture landuse in study region by evaluating the general and agricultural landuse and establishing the relationship between

selected variables and delineate the agricultural regions and suggesting remedial measures for better landuse planning.
Keywords: landuse pattern, landcover, irrigation, agriculture, Pune District.

BACK

MODELING BASED STUDY OF SPATIO-TEMPORAL DYNAMICS OF LAND USE AND LAND COVER IN RAPIDLY DEVELOPING VARANASI DISTRICT (INDIA) USING REMOTE SENSING

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Land use and land cover changes (LULCC) are one of the foremost aspects of environmental changes caused by human-induced activities mainly in rapidly developing areas. This study endeavors to evaluate and compare three hybrid models Stochastic-Markov chain (ST-MC), Cellular automata-Markov chain (CA-MC) and Multi-layer perceptron-Markov chain (MLP-MC) to predict future land use and land cover (LULC) scenario in Varanasi district. LULC information extracted for years 1988 and 2001 was first employed to predict LULC scenario for 2015 using three hybrid models. The predicted results were compared with the observed LULC information for year 2015 to appraise the validity of models through kappa index statistics. The MLP-MC model yielded reliable and best results. Finally, based on this consequence the prediction of future LULC scenario for years 2030 and 2050 were performed. The findings of this study exhibited constant but overall increase of built up and considerable reduction in agricultural land. The results also demonstrate the potentiality of hybrid models for better understanding of spatio-temporal dynamics and predicting future scenarios.

Keywords: LULCC; Stochastic; Cellular automata; Multi-layer perceptron; Markov chain; Prediction.

BACK

C16.26. Land Use and Land-Cover Change – Land Use and Land-Cover Change: Challenges of Globalization. Land Degradation

SCIENTIFIC BACKGROUND AND PECULIARITIES FOR SELECTING INDICATORS FOR LAND DEGRADATION NEUTRALITY IN RUSSIA

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The global indicators of Land Degradation Neutrality (LDN) proposed by the United Nations Convention to Combat Desertification can not be directly used for the territory of Russia. The main reasons for this are a large territory and, accordingly, a great variety of biophysical and socio-economic conditions, as well as the existing and relatively conservative multi-level system of state land monitoring (GMZ), which has a long history of development. For this reason, for Russia only one approach is possible that provides the correspondence of global LDN indicators with selected analogues from among the existing national indicators and measures. Our research resulted in the following:

- The system of 4 main indicators (the share of degraded lands, changes in land cover, changes in productivity, changes in soil organic carbon SOC)) should be supplemented by the fifth indicator characterizing the dynamics of irregular extreme manifestations of land degradation (droughts, floods, fires, outbreaks of pests, mudflows and landslides);

- The changes in the content of SOC should be characterized by an indicator of carbon stocks in the humic horizon (with regularity of observations every 15 years) and supplemented with an integral indicator of the agrochemical state, which in turn requires refinement and coordination;

- Change in the productivity: for forests should be characterized by the dynamics of the stocks of the growing part of forest stand plus the fall and intermediate use, for agricultural lands – by the yield of the main crops, for other territories – by the dynamics of the vegetation index NDVI, which in turn serves as a verification indicator for the two previous ones.

The two remaining indicators in the Russia's GMZ system have the largest number of potential analogues, and the rationale for their selection requires additional study. To the moment we can state there is no one unique analogous indicator but at least three per each should be selected to be used on the equal basis.

Keywords: Desertification, droughts, scientific center, Russia.

BACK

LAND COVER CONVERSION AND FRAGMENTATION DUE TO OIL-AND-GAS DEVELOPMENT IN STEPPES OF RUSSIA

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Oil-and-gas production is one of the leading global economy sectors and one of the primary factors aggravating the ecological problems in the regions. Oil and gas companies in Russia, where oil-and-gas industry form around 37% of Russian Federal budget, continue to exploit already existing oil-and-gas extraction sites, but also expand to new, often pristine areas. Despite growing interest in renewable energy, unfortunately, the Russian governmental plans suggest that fossil fuel extraction would still play a significant role in the country's economy. As a result, the natural landscapes of oil-and-gas fields are transformed into the impervious surface, resulting in fragmentation of natural landscape and land degradation. We utilized Landsat imagery and landscape indices to study 306onversion of grasslands and croplands into the impervious surface and also land-cover fragmentation across nine oil-and-gas study sites (approximately 100 km^2 each) that are located in the South Ural–Volga steppe zone of European Russia from 1988 to 2015. Our results showed oil and gas production was the second significant factor of disturbance and fragmentation of Ural–Volga steppes after agricultural land use. Disturbance of steppe landscape stemmed from the construction of well pads, roads, which connected oil-and-gas fields, but also from oil and water spills. The study revealed degradation of lands was the dominant disturbance of landscapes in areas of oil-and-gas production, allotted to the infrastructure fields, including paved and unpaved roads (up to 5% of extent of each study site). While from the first look the share of disturbed landscape in total area is negligible, given a smaller portion of remaining steppes and concentration of oil-and-gas development on remaining steppe fragments raises our concern. Our detailed check of infrastructure around oil-and-gas extraction sites revealed up to 59% of developed roads were unofficial roads made to transport heavy machinery. The study also indicated oil-and-gas development resulted in fragmentation of landscape from 1988 to 2015 with approximately 2,600 steppe fragments /100

km^2 across disturbed landscape compared to 700 steppe fragments /100 km^2 in areas not affected by oil-and-gas development. Such fragmentation if worrisome, because resulting fragmentation of steppes due to oil-and-gas development leads to a decrease of habitat and biodiversity, but also represents an additional source of soil organic carbon losses (GHG emissions). Our study underscores the importance of satellite monitoring of oil-and-gas development and necessity of environmentally-sounded land-use policies, which would prevent the fragmentation of remaining steppes in European Russia due to oil-and-gas development.

The study was supported by ERA.Net RUS Plus Science & Technology CLIMASTEPPE project (ID # 559).

Keywords: Steppe landscapes,oil-and-gas production, soil degradation, land disturbance, fragmentation.

BACK

CHANGING CROP OCCUPANCY AND DIVERSIFICATION OF CROPPING PATTERN IN STATE OF RAJASTHAN, INDIA DURING POST LIBERALIZATION PERIOD

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Economic liberalization in India was initiated during early 1990s. It has touted to be the policy that would induce commercialization and diversification of cropping in the country. The present study is aimed at exploring the changes in the cropping pattern and crop diversification or specialization during post liberalization period in the state of Rajasthan in India. Its objectives are to assess the spatial pattern of the cropping pattern, to examine the spatial pattern of crop diversification since early 1990s and to evaluate the pattern of crop diversification in the favour of non-foodgrain remunerative crops at the level of agro-climatic zones. It is based on secondary data obtained from Agricultural Statistics of Rajasthan, Planning Department, Directorate of Economics and Statistics, Rajasthan. It uses Herfindahl Index and Simpson Index of crop diversification. The study brings out that despite some decline in area foodgrains continue dominating the cropping pattern in the state. The share of pulses, oilseeds, cluster bean (fodder crop) and minor crops like spices, drugs & narcotics and vegetables have recorded marginal increase in their acreage. There is dominance of coarse cereals, pulses and fodder crop in rainfed agriculture in arid and semi-arid areas in western and northwestern parts of Rajasthan. But semi-humid and irrigated areas experienced dominance of fine cereals and remunerative crops. The cropping pattern in the state continues to be quite diversified with not much change over last two decades. Central and southern parts of the state dotted with Aravalli hills have had most diversified cropping pattern. Least diversified cropping pattern in the state is found in the core of the That Desert. There is a tendency of diversification of cropping away from foodgrains particularly in northwestern and extreme southwestern region. Overall there are not much economic liberalization induced changes and diversification in cropping pattern. Continued diversified cropping pattern in the state, indeed, reflects the diversity in agro-ecological conditions, and diffusion of irrigation and agricultural technology in some areas. The tendency

of diversification in the cropping pattern in favour of non-foodgrain crops such as cluster beans and soybean may be attributed to price factor and commercial value.

Keywords: Rajasthan, cropping pattern, crop diversification, post-liberalization period, foodgrains.

BACK

ASSESSMENT OF THE LANDSCAPE STABILITY OF RUSSKII ISLAND (THE SEA OF JAPAN)

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The landscape stability of Russkii island was assessed based on complex physico-geographical and geoecological studies. A total of 17 indicators were used. Spatial and quantitative analysis of scores showed that moderate sustainable and unstable landscapes dominate on the island. It was found that geological-geomorphological and vegetative parameters have a great influence on the sustainability indicators of natural-territorial complexes. The examples of implementation of construction projects without considering of landscape functioning are given. These projects led to negative geomorphological and soil processes, and degradation of vegetation cover. Correction of planning errors will result in significant financial investments.

BACK

SOIL DEGRADATION IN SOUTHERN SIBERIA

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Presented are regional features of soil erosion, determined are the extent and soil degradation degree in Asian Russia on the basis of generalization of long-term studies of soil erosion. It is noted that soil degradation occurs in the southern semi-arid and semi-humid regions, where agricultural arable land is located, occupying about 24 million hectares. 9 million hectares are subject to flushing and deflation in varying degrees. It is estimated that the mechanism of degradation processes varies from west to east. In the western plains, the role of meltwater is high, rainfall has a subordinate significance. To the south and east the melt runoff decreases, and the rainfall runoff increases. As a result of economic development, the intensity of erosion processes increase, but the area of their development enlarges including taiga territories.

For the regions of the south of Siberia we obtained long-term experimental data on the rate of natural erosion on steppe slopes, which vary from hundredths of a millimeter on gentle slopes to the first millimeters on steep slopes. In most river basins in the south of Eastern Siberia arable land washout averages 5-10 tons/ha, sediment discharge is usually less than 20 tons/km^2 per year.

The long-term dynamics of erosion processes is analyzed based on data on the runoff of suspended sediments in 18 basins, partially or completely located within the belt of agricultural lands. A rather complex long-term course of erosion processes with well-defined cyclicity was revealed. The average perennial sediment runoff modules vary from 2.8 to 53 tons/km^2 and show a decrease in erosion from the forest-steppe to the steppes and in general from west to east. Detailed mapping of soil erosion rates in model basins has been carried out. Obtained are the trends and tendencies of soil erosion development in Asian Russia and the quantitative indicators of potential soil losses from erosion and deflation. Special attention is paid to soil degradation in the Lake Baikal basin. The proposed three regional model of soil protection from degradation. Erosion zoning of Asian Russia was carried out.

Keywords: soil, erosion, deflation, Siberia.

BACK

C16.26. Land Use and Land-Cover Change – Land Use and Land-Cover Change: Challenges of Globalization. Land Use and Climate Change

IMPLICATIONS OF MASSIVE CROPLAND EXPANSION DURING VIRGIN LANDS CAMPAIGN IN RUSSIA AND KAZAKHSTAN ON SOIL CARBON STOCKS

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Land-Use and Land-Cover Change (LULCC) often drastically shape biogeochemical cycles, including carbon © sequestered in vegetation and soil, and impact climate through greenhouse gas (GHG) emissions. The radical shifts in Soviet agricultural land-use policy in the mid-1950s resulted in massive cropland expansion of approximately 45 million ha at the expense of pristine steppe frontiers from 1954 to 1953 in Russia and northern Kazakhstan – the so-called Virgin Land Campaign (the Campaign). Here, we present the first assessment of soil organic carbon (SOC) losses from soils in Russia and Kazakhstan due to cropland expansion during the Campaign based on the spatially explicit reconstruction of land use from 1954 to 1963, detailed SOC chronosequences, empirical and bookkeeping modeling. Our results showed from 1954 to 1963 rainfed cropland expansion occurred toward drought-prone areas with annual precipitation as low as 200 mm. The rate of SOC losses after the conversion of virgin steppe soils to croplands depended strongly on soil type and initial SOC stocks prior LULCC. The weighted average SOC losses in the upper 50-cm layer over a 20-year period after LULCC comprised 0.96±0.32 t C ha^{-1} yr^{-1} for plowed areas in Russia and were substantially lower -0.44±0.04 t C ha^{-1} yr^{-1} in soils of northern Kazakhstan. The unprecedented “Soviet

Virgin Lands Campaign" resulted in substantial soil degradation and organic SOC losses – 852 Mt C for upper 0-50 cm during the first 20 years after the conversion of steppes to croplands. Such substantial SOC emission during the Campaign likely could increase the CO_2 concentration in the atmosphere. In sum, land use policies which favor, large-scale cropland expansion have strongly effect on above and below ground terrestrial C stocks and cause an increase in global GHG emissions. In the light of ongoing cropland expansion in Russia, the necessity about any additional cropland expansion has to be weighted up due to adverse implication to C stocks and existing yield gaps on already cultivated lands.

The study was supported by the RFBR (project no. 18-04-00773a) and the ERA.Net RUS Plus Science & Technology CLIMASTEPPE project (ID # 559).

Keywords: Land use change, steppe ecosystems, soil degradation, organic carbon losses.

BACK

CLIMATE AND DYNAMICS OF CEREAL YIELDS IN RUSSIA: HOW FAR THEY GO BEYOND HISTORICAL PATTERNS?

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Most general circulation models (GCMs) applied to the northern hemisphere simulate wetter and warmer climate in forest zone and growing aridity of the steppe and forest-steppe zones of Russia. In general these projections are supported by observation over current climate transformation in Russia. Current climate warming in the northern hemisphere is mostly associated with more intense activity of the North-Atlantic Oscillation (NAO) and weaker Siberian Anticyclone (SA) while connection between their intensity and rising concentration of greenhouse gases in the atmosphere is not firmly established. To answer the question about of nature of the current climate transformation we have to define the “historical” and “new” climate by quantitative parameters. We use statistical models «yield-weather» as a proxy for «historical climate». These simple regression models are designed for each region (oblast) of Russia for the period of 1961-2010. In general the models demonstrate a good correlation between cereals yield data and combination of meteorological parameters (monthly temperature and precipitation) specific for each region. We suggest that if some Russian regions show strong divergence of results of simulation from actual yields for current period (2010-2017) it would indicate emerging of “new climate” at least for agricultural sector. If no such regions are found we would conclude that current climate in Russian regions still go within its historic fluctuation patterns.

Keywords: climate warming, cereal yields, agricultural regions of Russia, regression models.

BACK

THE CREATION OF PREVENTIVE PEAT FIRE DANGER MONITORING SYSTEM

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Marches and wetlands occupy about one-fifth of the territory of Russia. To use them, they are drained: currently drained swamp areas are more than 10 million hectares, about 1.5 millions of them are occupied by peats. Most of these lands were used during the maximum peat extraction rates in Soviet Union. However, after the decline of peat industry, most peatlands were abandoned without the necessary cleaning. It caused the set of problems, the main of them is high flammability of former peats.

The research is focused on the creation of a project of preventive peat fire danger monitoring system. There are two research tasks:

- creation of the system on basis of the peat fire detection method with the use of remote-sensed data: MSI/Sentinel-2, MODIS/Aqua&Terra, OLI&TIRS/Landsat-8;
- determination of threshold values of monitoring parameters – brightness temperature, water index (NDWI), which characterize state of peats, his flammability.

The peat fire detection method is a set of operations for satellite image processing and statistical analysis of monitoring parameters. The result of these operations is a complex of images of potentially fire dangerous peats. The advantage of this method consist in convenience for algorithmization and using as basis of monitoring system.

For detect potentially fire dangerous peats are used threshold values. The excess of monitoring parameters over them indicate high peat fire danger. These values were determinate by using trend analysis of satellite monitoring parameters during peat fire formation and development on European Russia in 2013-2016.

In summary, constrict preventive peat fire monitoring system have set of advantages:

- combination of different remote-sensed data and analysis methods – monitoring reliability growth;
- preventive detection – peat fire forecast possibility;

- freeware distribution of monitoring results because of using open remote-sensed data.

Keywords: peat fire danger, satellite image, preventive monitoring, fire detection.

BACK

ADAPTATION OF LAND USE MANAGEMENT TO MILITARY AND POLITICAL INSTABILITY IN REGIONS OF AFGANISTAN

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The Islamic republic of Afghanistan has been developed in condition of permanent military and political insecurity since 1970s. The goal of the study is to investigate impact of military instability on economic and social performance of regions of the Afghanistan. We assessed all (34) provinces in relation to military instability measured by frequency of reported armed conflicts in the last years. The provinces with different degree of instability are analyzed in relation to their economic and social performance. We used official statistics on growth of population, dynamic of cultivated area, agricultural production, agricultural cooperatives, infrastructure development, amount of collected taxes, number of implemented international projects, non-governmental organizations, medical facilities and others. The study reveals a paradoxical situation when the most instable provinces are characterized by the highest rate of economic and social development. For instance, this group of provinces would get the highest growth of crop area and road construction with probability of 60%. They would also get the high level trade infrastructure, taxes collection, and realization of international projects of development with probability of 40%. In contrast, in the “calmest” provinces the very high growth of crop area is met with probability of 25% and the high level of trade development as well as taxes collections could be found only with 13% probability. We conclude that the most Afghan provinces managed to adapt to permanent military and political instability due to some specific ways of land use and resource management.

BACK

TRANSFORMATION OF THE NATURAL ENVIRONMENT ALONG THE BAIKAL-GOBI MERIDIONAL TRANSECT IN THE CONTEXT OF CLIMATE CHANGE

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Starting in the eighties of the 20th century, the scientists of the Baikal Institute of Nature Management (BINM SB RAS) have been conducting field observations of the Transbaikalia geosystems transformation due to the change of climate and nature management.

An utmost importance is placed on the study of a negative response of the land geosystems. This is particularly shown through their deterioration, degradation, and desertification. During 1985-2017 the scientists of the BINM SB RAS established a network of key sites for contact monitoring of the geosystems status and dynamics and the negative natural-anthropogenic processes along the Baikal-Gobi meridional transect in dry areas of the north of Central Asia. The monitoring of the vegetation cover status and its dynamics of some key sites is conducted by processing and analysis of multitemporal and multispectral Landsat and MODIS Terra imagery. An automatic analysis of the NDVI time variation and a comparison with the progress of the index in the previous seasons are performed. The landscape indication of the key sites is made on the basis of satellite imagery and complete geobotanical descriptions. To analyze the transformation of the environment by the climatic factors, we compared NDVI series and the precipitation and temperature and calculated the degree of correlation between them.

The assessment of the spatio-temporal dynamics of steppe plant communities is conducted to reveal their response to the current climate change. Mapping of selected modeling polygons was carried out on the basis of satellite data decoding and field surveys. The large-scale map of actual vegetation reflects the current state of the vegetation cover and its horizontal structure. With multitemporal satellite Landsat and MODIS imagery we consider the vegetation cover dynamics of the test range.

The reported study was funded by RFBR according to the research project № 17-05-01059.

Keywords: desertification, dry climatic zones, vegetation cover, transformation, Landsat, MODIS, NDVI, mapping of vegetation.

BACK

POSTER

EFFECT OF CONSERVATION FARMING ON CARBON SEQUESTRATION IN SOILS OF DIFFERENT BIOCLIMATIC REGIONS

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Most agricultural activities, especially intensive tillage, lead to a strong decrease of soil organic C stocks and release CO_2 into the atmosphere. The use of conservation farming has both economic and ecological benefits compared with the conventional system of agriculture. Today, No-till technology is the most promising way for sequestration of soil organic carbon (SOC) and prolonged mitigation of climate change. The aim of the present study was to investigate the effect of various tillage systems on the content of various SOC pools (total organic, C_{org}; biodegradable, C_{bio}; recalcitrant, C_{rec}; microbial, C_{mic}) under various climates: temperate semi-arid (Prague, Czech Republic) and continental arid (Orenburg, Russia).The field experiment in Czech Republic (Crop Research Institute, clay-loamy Orthic Luvisols) has been running from 1995 and established the rotation of 3 crops: winter wheat, spring barley, and white mustard. Three treatments (tillage methods) were set up: (1) conventional tillage, CT; (2) no-tillage, NT; (3) no tillage + mulch (NTM). Each tillage treatment included 2 variants of mineral N fertilization – 50 and 150 kg N per ha. In Orenburg region, the field experiment has been running from 1992 (Orenburg State Agrarian University, loamy Calcic Chernozems) and established the rotation of cereal crops. Five treatments were foreseen: (1) CT, (2) subsurface tillage, ST; (3) minimal tillage, MT; (4) minimal tillage + ploughing, MT-P; (5) no-tillage + ploughing, NT-P. Conservation systems resulted in an increase in C_{org} content in topsoils by 5-18% and 9-30% in semi-arid and arid climates, respectively. In both experiments, C_{mic} content under conservation technology was 1.5-3 times higher in comparison with conventional system. Thus, all conservation technologies improved the quality of soil and led to SOC sequestration. The NT treatment indicated most significant influence on the soil carbon pools while the effect

of N-application rate was not observed. Conservation farming should be recommended for both regions studied to prolong the mitigation of climate change.

The study was supported by RFBR (projects #18-04-00773).

Keywords: soil carbon pools, no-till technology, soil recovery, climate mitigation.

BACK

GLOBAL INDICATORS OF LAND DEGRADATION NEUTRALITY AND THEIR VALIDATION AT THE NATIONAL LEVEL: CASE OF RUSSIA

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Three indicators were recommended by the UNCCD to follow the progress in the monitoring progress towards achieving the Land Degradation Neutrality targets at the national level: land cover change (LCC), land productivity dynamics (LPD) and trends in soil organic carbon (SOC). All of them are based on open source datasets with global coverage: ESA CCI Land Cover product time series from 1992-2015, JRC's LPD Dataset and SoilGrids (ISRIC). The use of these datasets are supposed to ensure comparable and standardized results in terms of revealing trends in land degradation for different evaluation periods based on "one-out – all-out rule" and to support spatially-explicit framework for land monitoring and revealing hotspots. In the meantime, at the national level all the initial data and their assessments results need for trusted refinements, accuracy assessment and validation based on existing comparable data sources. In the case of Russia with its huge territory elaborative approach to assessment and interpretation trends in LDN indicators is necessary to keep in mind high and spatially heterogeneous diversity of ecosystems, climate types and land use patterns.

In the absence of national time-consistent land cover products in Russia ESA CCI Land cover products for the period 2000-2015 was used without default in LDN methodology aggregation of land cover classes. Such approach affords to interpret numerous land cover transitions types separately for the regions with different landscape conditions and drivers of land degradation, more accurately and precisely reveal and evaluate the land degradation and land restoration spatial patterns in the semiarid areas. The accuracy assessment of cumulative LCC from ESA CCI products founds the overestimation of cropland expansion in steppe zone and underestimation of boreal forest loss for the Russian territory. The results of LPD assessment are consistent with trends revealed from different national evaluations and inventory, and also well verified with changes in crop yield and forest stocks. The main trouble presents SOC assessments derived from SoilGrids as this product have low accuracy and contain the great discrepancies both in absolute values as in their spatial distribution.

Keywords: land degradation, land cover change, geospatial data, national level assessment.

BACK

MODELLING HISTORICAL LAND USE CHANGE IN MESHCHERA LOWLANDS (CENTRAL RUSSIA)

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Land use change models are tools for allocating different types of land use depending on a variety of factors in certain periods of time. They visualise results of statistical analysis and show the cumulative impact of different driving forces on land use change. Our study is based on applying CLUE model for analysing three key areas in the northern part of Ryazan region, namely the Meshchera Lowlands. Original land use data had been obtained from General Land Survey maps (XVIII c.), Atlas Mende maps (XIX c.), Corona satellite imagery (XX c.) and modern satellite images (XXI c.). Two kinds of factors influencing land use distribution were analysed: local biophysical (various relief, hydrology, soil parameters) and socio-economic (population density, distance to roads, rivers, etc). Results of logistic regression analysis were used for running the model. In most of existing models population density is the main driver of land use transformation, so one of our goals was to manipulate model parameters and examine the role population density plays in land use dynamics and spatial distribution across the key areas of research. Our results suggest that the relationship is very complex and often hugely dependent on other factors. Comparison of generated and existing land use patterns shows that population density does not determine the extent and spatial distribution of agricultural transformation on this scale. In XVIII-XIX centuries, despite significant population growth, in the absence of technologies agricultural expansion was limited by biophysical factors; later, it was outmatched by nationwide socio-political changes. Another result is a time series of land use maps interpolating between periods with known land use patterns.

The study was supported by RFBR, project № 16-17-10045.

Keywords: Meshchera, historical maps, CLUE, land use change, modelling.

BACK

PASTURE DEGRADATION OF THE DRY STEPPE: A CASE STUDY IN THE STATE NATURAL BIOSPHERE RESERVE "ROSTOVSKIY"

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The problem of pasture degradation is extremely relevant for the remaining unplowed steppe in the south of European Russia.

Almost all unplowed steppe areas in the region are used as pastures numerous livestock farms. Large-scale degradation of the natural environment of the steppes can lead to a violation of the natural state of protected steppe communities, the loss of stability of dominant plant species and the formation of non-typical biotopes in a given territory.

The aim of the study was the development of remote methods for assessing the state of steppe vegetation cover under the influence of grazing.

In the study, the following tasks were performed:

- obtained empirical relationship between the green phytomass and the relative values of the vegetation Indices;

- studied the relationship of vegetation indices with phytomass stocks and meteorological data;

- defined and mapped of critical areas of pasture load on the basis of satellite imagery data.

Keywords: pasture degradation, vegetation cover, vegetation indices, phytomass.

BACK

LAND COVER TRANSFORMATION AS A FACTOR OF ANTROPOGENIC PRESS ON WATER RESOURCES (CASE STUDY FOR DON BASIN)

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The land cover of the catchment area is an important factor in the runoff formation process. Changes in the structure of land use can indirectly affect the water availability in different seasons of the year. The Don basin is one of the most developed river catchments in Russia. During last 9 years a continuous long-term low flow period has been observed in this region. The main cause of the drought is undoubtedly climatic factors - rainfall deficit and positive temperature anomalies. However, the intensification of economic activity can also affect the formation of water shortages. Based on the analysis of the Landsat archive of images, the dynamics of land use in the Don basin was studied. Several key dates have been chosen: the mid-1980s, the mid-1990s, the mid-2000s and the last 2-3 years, corresponding to the drought period. The analysis was carried out for three key areas - the Upper Don, Khoper and Lower Don area. As a result of the automated classification, the following classes of objects were distinguished: water objects (rivers and ponds), forests, fields and pastures, anthropogenic objects. From 1985 to 2015, the Khoper basin is characterized by an increase in forestation from 10.0% to 15.2% and a slight increase in anthropogenic development. The increase in the area of water bodies in the 1980s - the 1990s was followed by a decline in the early 2000s. From 2007 to 2014 the area decreased almost twice (from 0.90 to 0.49%). For the Upper Don, the increase in the forest area from 870 km2 to 3580 km2 is even more evident. Thus, from 1996 to 2014, the area occupied by forest increased 4-time (from 1.2 to 5.2% of the total). The area of anthropogenic objects also increased (from 5.3% to 7.8%) due to the expansion of the private sector and the growth of industry since the mid-1990s. The Lower Don is characterized by a sharp increase in the urban area observed since the late 1990s. This increase could become an additional factor in the formation of water shortages.

The study supported by President's Grant No. MK-2331.2017.5 and Russian Science Foundation in terms of water regime analyses (Project No. 14-17-00155).

Keywords: Land cover, Landsat, Don river basin, Extreme drought.

BACK

CHANGING LAND MANAGEMENT INSTITUTION AND ITS EFFECT ON THE DEVELOPMENT OF GULLY EROSION IN BLACK SOIL AREA OF NORTHEAST CHINA

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Land management institution is the integral human decision made based on assessing quantitatively land system change and its ecological effects, which is prerequisite to understand and propose sustainable land management strategies. Under the goal of achieving land degradation neutrality and the background of readjustment of Chinese agricultural structure, it is necessary and urgent to pay attention to the influence of different land management institutions on land system changes. The evolution process of land management institution, experienced army-owned farms (A1) and collectively owned People's Commune (B1) (1947-1956), to state-owned farms (A2) (after 1956) and household contract responsibility system (B2) (after 1978), to the farmer specialized cooperatives (B3) (after 2006), which could be reflected by the types of farmers. The boundary of army owned and state-owned farms were delineated based on the thematic map. Other region outside the farms was tilled by individual farmers. The gully data in the study area were extracted by interactive human-machine interpretation method, based on remote sensed images of the Corona images centered the year of 1965 with spatial resolution of about 3m, Spot5 images centered the year of 2005 with spatial resolution of 5m and GF-1 images with 2m spatial resolution obtained in 2015. The gully data of 1965 had been validated by historical observation records, and that of 2005 and 2015 validated by field survey. Through the analysis with comparing the number, speed and erode area of gullies developed respectively under the institutions of A and B, the results showed that erosion gullies increased during the period of 1965- 2005. The increasing speed of number, length and erode area of gullies under B was 5.25, 6.77 and 12.8 times of those under A. For the area of individual farmland was nearly 4 times larger than the area of state-operated farms, we then normalized the value. The results indicated when land management institution of B1 was implemented in 1965, the number, length and erode area of gullies outside state-operated

farms was 6.60, 7.79 and 8.55 times of those inside the state-operated farms. While land management institution of B2 was implemented in 2005, the times of the number, length and erode are of gullies outside state-operate farms decreased to 1.39, 1.77 and 3.03. Compared to the land management institution of B, the level of mechanization, management, input and environmental awareness under A were much better to prevent effectively the development of gullies. However, compared to B1, the land management institution of B2 could arouse the enthusiasm and initiative of individual farmers to better manage the farmland. The results would provide a reference to the readjustment of agricultural structure and decision making of sustainable agricultural institution.

Keywords: land management institution; gully erosion; remote sensing; the Black Soil Area.

BACK

THE RESPONSE OF STEPPE GEOSYSTEMS OF CENTRAL ASIA TO MODERN CLIMATE CHANGES

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Since 1957 the V.B. Sochava Institute of Geography of the SB RAS performs stationary and semi-stationary studies of the dynamics of the steppe geosystems of the South-Eastern Transbaikalia, which are part of the Central Asian physicogeographical region. The geosystems are characterized by high sensitivity and rapid response to modern climatic changes. Most quickly and noticeably these changes manifested themselves in the functioning of morphodynamic systems. In connection with the intracontinental position of the territory the uneven progress of processes in time is characteristic as well as a sharp change in morphodynamic regimes.

The regional warming rates in Onon-Argun steppe (0.03 ºC / year) are higher than global warming. For the period from 1951 to 2009 the mean annual temperature increased by an average of 1.9 °C in the study area, varying in some areas from 1.5 to 2.2 °C. The effect of climate warming on the course of exogenous relief formation in the region is expressed in increasing the intensity of cryogenic processes under the degradation of permafrost, and primarily of thermokarst.

The most characteristic feature of the long-term flow regime of rivers is cyclicity. Separate consideration of low-water and high-water phases yielded polynomial trends for increasing water availability in high-water areas and for lowering the water content of low-water phases, i.e. there is an amplification of the amplitude of fluctuations in the moisture content of the considered territory in different phases while maintaining the background level of moisture. In accordance with the background forecast, we should expect an increase in the intensity of both the erosive (in the high-water phases) and the aeolian (in the years of low moisture) processes. In this case, the contribution to the relief formation of extreme catastrophic manifestations of processes will increase. The obtained positive trends of the time series of runoff of suspended sediments, the erosion index of rainfall and the number of days with a dust storm confirm the correctness of the forecasted assertion and allow us to speak generally of an

increase in the intensity of exogenous relief formation in the steppes of Central Asia while maintaining the structure of its dynamic phases.
Keywords: climate warming, permafrost degradation, sediment runoff, aeolian processes.

BACK

C16.33 Population Geography

Chairperson(s):

Migration, Mobility and Climate Change an Overview with a Specific Focus on Russia and Neighbouring Countries

- *Assessment Of Climate Conditions Impact On The Socioeconomic Situation And Settlement Patterns In Russia's Regions*

  T. Borodina, V. Vinogradova, O. Glezer, I. Sokolov, A. Zolotokrylin

- *The "Migration Crisis" Of 2015/16 In Europe The Beginning Of A New Migration Era?*

  Etienne Piguet

- *Migration Trends In The Post-Soviet Space*

  O. Chudinovskikh, M. Denisenko

BACK

ASSESSMENT OF CLIMATE CONDITIONS IMPACT ON THE SOCIOECONOMIC SITUATION AND SETTLEMENT PATTERNS IN RUSSIA'S REGIONS

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For assessment of climate conditions impact on the socioeconomic situation in Russia by regions—federal subjects, a multifactor typology of regions combining climate conditions, on the one hand, and demographic, social, and economic indicators, on the other hand, was carried out. Types were formed based on conjugate spatial distribution of regions by three climatic zones (favorable for living, neutral, unfavorable) according to the zoning of the Russia's territory with consideration for the 1991–2010 climate changes and three categories of the demographic, social, and economic situations (wealthy, average, poor), identified according to nine statistical indicators for 1990-2013. It is found out that migration and health indicators are the most climate-dependent; natural increase and population dynamics are less dependent. Other indicators should, rather, be attributed to climate-neutral; among them, economic indicators are the least sensitive to climate conditions. In a number of regions, absence of a sufficiently close relation between the majority of socioeconomic indicators and climate conditions, as well as the observed inversion (i.e., the high migration inflow of population to the autonomous okrugs of Tyumen oblast or positive natural increase in some northern republics), are due to economic and ethnic factors stronger than climate one. The impact of climate conditions on settlement patterns is analyzed on a larger geographical scale. Case studies of settlements of similar economic specialization in the Chukotka Autonomous Okrug and Republic of North Ossetia – Alania proved that favorable climate conditions often lose to poor economic ones also within local areas, and settlement patterns undergo negative transformations both in the north and in the south. However, the role of the climate factor increases if it affects in the same direction as the economic one: this, in particular, caused a catastrophic migration outflow from the northeast Russia. Thus, the research showed that the degree of climate impact on the population life activity depends on the relation between the directions of the climatic and other factors impact.

Keywords: climate impact, population, socioeconomic indicators, settlement pattern, factors.

BACK

THE "MIGRATION CRISIS" OF 2015/16 IN EUROPE
THE BEGINNING OF A NEW MIGRATION ERA?

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Most commentators of the recent rise in the number of people attempting to find protection in Europe have stressed either the intensity of violence in origin countries or the lack of adequate response by the EU as main explanations of the so called “migration crisis”. These two factors obviously played a major and dramatic role in recent months, but we content that, behind such conjunctural explanations, more structural changes have to be taken into account to theorize and understand the evolving geography of contemporary forced migrations and mass displacement. This paper aims at giving a broad interpretation of the crisis that revolves around four concepts: proximity, connectivity, territory and solidarity. Our hypothesis is that major changes occurred in these four domains within a broader context of globalization and social change.

BACK

MIGRATION TRENDS IN THE POST-SOVIET SPACE

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The paper discusses the reasons and consequences of the long lasting migration connections between Russia and the countries of the former USSR, and the main factors driving migration flows in the area. The national censuses of population in the newly independent states showed the results of long-term migration trends for both donor and destination countries, that are expressed in considerable changes in the stock of persons born in the European and Asian parts of the former USSR and ethnic composition of population of the former Soviet republics. The influence of environmental and climatic factors on migration is considered in the context of the other circumstances. They can play an important role in internal migration, but only complement the system of factors that push migrants to leave their states both on permanent and temporary basis. Political circumstances, inter-ethnic conflicts or economic causes prevailed during different periods of the recent history. Besides, we discuss the issues of information support of research in this area. The paper is based on the materials of the national statistical offices of the CIS countries and the databases of international organizations.

BACK

C16.35 Toponymy (Jointly with International Cartographic Association)

Chairperson(s):

Use of Place Names in Public Space.

BACK

USE OF PLACE NAMES IN MAPS OF THE WORLD ENCLOSED IN BROCHURES OF INTERNATIONAL AIRLINE COMPANIES

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Maps enclosed in brochures of some major international airline companies like Alitalia, Lufthansa, Iberia, Ethiopian Airlines, American Airlines, United Airlines, Air China, Varig, Aeroflot, etc. are consulted, in order to know which names they use in maps. Of course, we will consider which of them prefer endonyms or exonyms or both. We also will investigate the rational, if any, behind these various usages.

We have to distinguish the passengers travelling on international low coast airlines, because most of them have no particular place names geographical knowledge.

Airline passengers traveling on continental routes generally belong the premium and middle class and most of them travel for business or scientific meetings. They generally have a good geographical knowledge. But those who travel on intercontinental routes for visiting their origin countries and relatives have a limited knowledge of the cities, mountains, lakes and seas overflown.

During the airline journeys most passengers listen to the music or watch a film or play with a computer or a mobile. Only some of them watch the places overflown on airplane screens or portholes. A very few passengers have knowledge of place-name meaning and changes. The minority names like those of US countries and states – as Dakota - are understood only by those who know the places themselves or have studied them.

BACK

TOPONYMIC METONOMY AS AN INTERACTION PROCESS OF THE LEVELS IN A TOPONYMIC SYSTEM

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One way of forming geographical names is toponymic metonymy. The essence of this phenomenon is the name transfer from one object to another. As a matter of course, nominated objects are territorially close, adjacent, although they can refer to different tiers (levels) of the toponymic system. In this case, certain patterns characterizing the process of such a contact "name" transfer can be identified. The primary (initial) is always the name of the macroobject, whereas the microtoponym is coined as a result of the name transfer. This occurs due to the earlier appearance of the names of the macrolevel and their wide range of uses, their popularity and fame. Toponymic metonymy is primarily represented among microhelonyms, microagroonyms, microdrimonyms. As a rule, the lexical base is made up by the names of rural settlements (villages), later reflected in the names of agricultural lands, forests and marshes.

Derived microtoponyms are morphologically distinct from primary names. Two main variants of the transformation happening to the primary toponymic basis can be noted. In the first case, the transformation occurs by adding formants. For instance, by attaching the suffix "-shchina". In the other variant, primary names become a part of mixed toponyms, often transforming into adjectives. The second word, which constitutes a part of a complex micro-toponym, is often represented by a popular geographical term (moss, field, meadow, forest).

Frequently, if a village ceases to exist, the primary toponym disappears from general use and from official documents, while the microtoponym formed as a result of toponymic metonymy and commonly used in the vicinity of the neighboring settlement, is still preserved in the speech of local residents.

Thus, the phenomenon of toponymic metonymy is an example of the interrelation between the two levels of the toponymic system and serves as the confirmation of their constant development.

Keywords: toponymic metonymy, microtoponym, formants.

BACK

MICROTOPONYMS AS A PART OF THE TOPONYMIC SYSTEM

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As a historically formed unity and interconnection of toponyms of a particular territory, the toponymic system is not homogenous since geographical names of two levels coexist within it. There naturally arises a question concerning the identity of their etymology, functioning and patterns of development. Obviously, microtoponyms are more numerous, relatively young and simple in terms of etymology, meanwhile they have a narrower scope of use and a limited distribution area. A clear criterion for any geographical name of the micro-level is its unofficial status. The toponymization process at the local level is largely determined by certain landscape features, moreover, it is dominated by a historical and geographical component. The microtoponymic level of the toponymic system is primarily concerned with the modern ethnic stratum and reflects the mentality of the particular ethnic group that currently prevails in this territory. Migrant toponyms are not characteristic of local toponymization. Transformation, i.e. change in the process of use, is not typical for microtoponyms. The map of nominated microobjects is updated relatively quickly, which is associated with a change in the consumer and aesthetic qualities of natural objects.

Possessing certain specific features, microtoponyms function as an integral component of a single toponymic system of the region. They perform nominative, targeted, communicative, differentiating functions. The main principles of classification and selection of macrolevel geographical names classes are applicable to them. Traditionally, the process of nomination at the local level is carried out through metaphorization and symbolization as well as through direct transition of a popular term to a geographical name, and widespread use of personal names as a lexical base.

A major part of the differences is mainly caused by the relative “youth”, the fragility of geographical names of small territorial objects. Coined as a result of toponymization at the local level, microtoponyms have signs of macrotoponyms which are still at the initial stage of their development.

Keywords: toponymic system, microtoponym, toponymization.

BACK

ROAD SIGNS: MARKERS OF MULTILINGUAL COMMUNITIES OF VOJVODINA

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Autonomous province of Vojvodina is located in the north part of the Republic of Serbia. It occupies 24% of the territory of Serbia and has a population of 1.9 million people distributed in 467 settlements. Its population is highly heterogeneous with the Serbs constituting around 65 percent and six most populous national minority groups that have from 14.8 to 1.5 percent: the Hungarians, the Slovaks, the Romanians, the Roma minority, the Croats and the Rusyns.

The question raised in the research presented in this paper is to what extent the official use of languages of national minorities in Vojvodina regarding display of topographical indications is implemented in practice?

European institutions have developed instruments for protecting minority rights and preserving minority languages. Most countries, including Serbia, have accepted and ratified these instruments and have been applying them in national legislation and practice. The Constitution of the Republic of Serbia provides the right to official use of languages and scripts of national minorities in various domains of public use. This means that road signs denoting place names in areas (counties) where national minorities constitute a significant majority of population are written in both the Serbian Cyrillic script, which is the official script, and in Latin scripts of the national minority groups, that is, in their endonym form (e.g. Novi Sad (Serbian) / Újvidék (Hungarian), Vršac (Serbian) / Vârşeţ (Romanian)). The use of local minority place names enables members of national minorities to preserve their identity, language and culture. In this sense, Vojvodina presents a positive example of a region in which minority rights are respected, unlike some other regions of former Yugoslavia where road signs with place names written in the languages of national minorities are often destroyed. In Vojvodina, diverse languages and cultures have coexisted successfully for centuries and linguistic heritage and cultural identity of minority groups have been preserved.

Keywords: Vojvodina, national minority, multilingualism, topographical indication, road sign.

BACK

WHICH SEA ARE WE SAILING?
THE NAME OF THE ADRIATIC SEA ON OLD MAPS

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The use of several names for the same feature is common in toponymy. There may be different names for the same geographic feature, depending on motivation and use in various language communities which refer to the named object in different ways. For larger spatial units, the use of a toponym may indicate a historical linguistic background, linguistic adaptation, or a message communicated by the allocation of a new, or previously used name. This process can be traced, among other ways, by studying old maps, which are important sources of spatial data. As a medium for communicating space on maps, the creation of mental maps has also been of influence in the past, i.e. the perception of the area depicted, which includes the toponymic component.

The Adriatic Sea is the most deeply recessed unit of the Mediterranean Sea, bordered by three European relief systems: the Appenines, the Alps, and the Dinaric Alps. For thousands of years, it has functioned as a link between Europe, Asia and Africa, and this accounts for its early naming in ancient written sources. Over time, its name stabilised, linked with the Etruscan harbour of Adria on the Appenine Peninsula (Gk. *Αδριατικός κόλπος*, Lat. *Mare Hadriaticum, Mare Adriaticum*). Variants of this name remain today in the Italian (*Mare Adriatico*), Slovenian (*Jadransko morje*), Croatian (*Jadransko more*), Montenegrin (*Jadransko more*), Albanian (*Deti Adriatik*) and modern Greek (*Αδριατική θάλασσα*). The name of the sea was adopted in other European languages from the languages of the peoples who inhabited the Adriatic coast (e.g. Eng. *Adriatic Sea*, Fr. *Mer Adriatique*, Ger. *Adriatische Meer*, Russ. *Адриатическое море*). However, in the early modern era, the Republic of Venice used the name *Golfo di Venezia* for the entire Adriatic Sea in official correspondence, and Venetian cartographers used it on their maps. Thus, Venice demonstrated its political and economic sovereignty over most of this sea, and considered it to be its own economic-navigational basin. Significantly, the Venetian cartographer Coronelli (1688) stated that the name of the Adriatic Sea was the old name of the Bay of Venice (*Golfo di Venezia olim Adriaticum Mare*) on his

map of the sea. Through business and diplomatic relations between Venice and other European states, and in accordance with Venetian geographic maps and nautical charts of the Adriatic Sea, the name *Golfo di Venezia* began to be used in other European languages (Eng. *Gulf of Venice*, Fr. *Golfe de Venise*, Dutch *Golf van Venetië*, etc.). The Venetian name was also adopted by Ottoman cartographers (for example Pîrî Reis used the name *Wenedik körfezi'nde*). But this name was not accepted by the Habsburgs, who themselves had pretensions towards the Adriatic Sea, particularly from the early 18th century on. So, on maps by Austrian cartographers, the old toponymic form *Adriatische Meer* was retained.

With the abolition of the Republic of Venice in 1797, and changed geopolitical relations in the Adriatic, the name *Golfo di Venezia* began to be used for the northwest part of the Adriatic Sea, that is, the area north of the line connecting the mouth of the River Po and Cape Kamenjak on the Istrian peninsula. The old name for the entire sea, the Adriatic Sea, returned to general use.

Although over two centuries have passed since the last use of the name *Gulf of Venice* for the entire Adriatic Sea, the name has been retained in the local speech of the inhabitants of the Croatian islands, in the form of the appellative *kulaf* (from the Italian *golfo*), for the open part of the Adriatic Sea. So, as a consequence of the former use of the name *Golfo di Venezia*, which demonstrated the Venetian sphere of interest in most of the Adriatic Sea, the island populations still use this one appellative in their local speech to refer to most of it.

Keywords: Adriatic Sea, Gulf of Venice, map, chart, geographic name.

BACK

TOPONIMICAL LANDSCAPE DE JURE AND DE FACTO

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Toponyms perform the most important function – address, therefore play an enormous role in the vital activity of people and human communities throughout history. They are formed in historico-geographical landscapes under the influence of diverse natural and cultural factors, in specific linguistic and ethnic environments. Forming the component of the historico-geographical landscape, the toponyms themselves are their brightest illustrator, reflecting the specific features of the area and its entire history. Toponymical landscapes are an integral part of the intangible cultural heritage, one of the most stable and at the same time fragile. The most complex structure is possessed by toponymical landscapes of multinational regions and cities. In ethnically diverse areas, the elements of ethnotoponymic differentiation are especially vividly manifested. The same objects, localities and urban units can have multiple and often different names. More often they are etymologically identical and only adapted to the specific language and speech (Киев/Київ, Кишинёв/Chişinău, Баку/Bakı, Алма-Ата/Алматы), sometimes, due to specific circumstances, are completely different (Грузия/საქართველო(Sakartvelo)/Georgia; Россия/Krievija/Venemaa/Venäjä).

In developed multinational countries, toponymical heritage is protected at the state level (the practice of saving multilingual forms of toponyms and protecting toponymic landscapes, both intra-urban objects, and entire regions). Legally fixed guarantees of the functioning of languages and linguistic units, and successful law enforcement practice de facto are excellent examples of heritage protection (Genève/Genf/Ginevra/Genevra in Switzerland, Liège/Lîdje/Luik/Lüttich in Belgium). Unfortunately, legal protection alone does not guarantee the full-fledged preservation of such fragile elements as toponyms of ethnic minorities among national majority. The actual state of things depends on the values promoted in society, the real relation to the application of legal norms.There are serious problems of preserving toponymical landscapes in countries that do not care about safeguarding the intangible cultural heritage, in the regions of explicit and even hidden interethnic conflicts – toponymic repressions, numerous renames under the influence of political circumstances.

Keywords: Toponyms, historico-geographical landscapes, toponymical landscapes.

BACK

THE POLITICS OF PLACE NAMES: THE USE OF MINORITY TOPONYMY IN MULTIETHNIC SETTINGS IN EAST CENTRAL EUROPE

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Ethnically and culturally diverse settlements in Central and Eastern Europe often witness local power-struggles along ethnic/linguistic boundaries that may center on the visibility of ethnic groups in public space. Thus displaying mono/multilingual place names (and other geographical names) in public space is embedded into political discourses and debates. The local majority – as the possessor of power – is in a more favorable position to control and/or limit the access of minorities to be visually present in the linguistic landscape which serve as evidence for the existence of minorities. Such conflict of interests and power dynamics may contribute to the evolvement of alternative city-texts and ethnically peculiar toponymy. In that context the topic of naming and the representation (or non-representation, absence) of geographical names are far outreach the level of local politics and embedded into the national discourse on minority politics.

The present paper aims to show how place names are presented in some multiethnic/multilingual settings in East Central Europe and what sort of regional differences, peculiarities can be revealed in this sense. Based on examples from Slovakia, Romania and Ukraine our aim is to present what kind of processes, background deals have an influence on visibility of inscriptions, namely how and what way place names turned to be the subjects of political power-struggles. The study pays special attention to describe how the public space gets re-structured and ethnicized by visualization of multi-lingual signs (street names, settlement names).

We argue that – although the visibility of geographical names and ethnic groups is highly politicized issue in which the participating parties have different aims and power – on local level the linguistic landscape is formed by constant power dynamics and allow local patterns different of national narratives.

BACK

EVOLUTION OF OLD RIO DE JANEIRO`S DOWNTOWN STREETS AND PUBLIC SPACES, FROM 1770 UNTIL NOW

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The city of Rio de Janeiro was founded in 1565 by Estácio de Sá, shortly before the expelling of French invaders. The "New City" was transferred to the Old City's site, in 1567, beginning its nomination process. The urban evolution of the already established city of São Sebastião of Rio de Janeiro, begins among 4 hills and several mangroves, setting the boundary area in urbanization, not only by streets and ways, but also by its buildings, churches and public places that initially shows a pattern of nomination, which gradually deteriorates to an amorphous structure.

This paper aims to show how the toponymy of the area in the Center of Rio de Janeiro City was developed, analyzing the changing factors in the names of its streets and public areas, such as parks, fields and squares.

The analysis will be carried out according to a survey on the historical cartography of the City, as well as to documents listing the names of the streets, buildings, hills, rivers and public spaces. Aspects of the toponymic motivation of the initial names will be observed, as well as the diverse aspects that led to the names changing. Thus, trying to establish, in a diachronic approach, the main motivations and periods in which such changes occurred.

BACK

ARMENIAN TOPONYMY ON THE MAP OF MOSCOW

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The Armenian community exists in Moscow for many centuries, and its active and varied life, their rooting in Moscow life - in its economy, culture, including education, medicine, art, etc. are reflected in the toponymy of the metropolis, in the names of streets, squares, alleys. Not only do toponyms reflect the presence of Armenians in Moscow and their multilateral integration into Moscow life, but also many memorable places, monuments, temples and much more. This work is devoted to only one aspect – to the Armenian toponymy in Moscow. There are only 30 urbanonyms associated with the Armenians and Armenia in Moscow, but they are not uniform from the different points of view. Firstly, they differ in time of occurrence: a) prerevolutionary b) the Soviet (pre-war and wartime), c) the Soviet (post-war) and d) post-Soviet. Secondly, among them there are: a) the names, spontaneously formed in the course of history and b) the names, officially assigned according to the decision of the city authorities. These urbanonyms reflect the historical events, perpetuate the names of historical figures, carry the names of symbolically important geographical objects of Armenia on the map of Moscow. A separate category is a series of disappeared, renamed names and even disappeared streets. The toponyms associated with Armenians in Moscow reflect the history of the Armenian community in Moscow and the different social strata of the population represented in the Armenian community of different historical periods, and the figures of all kinds of art, literature, science and so on. The geographical aspects is also interesting: in what areas of Moscow are most common Armenian names and why. The post-Soviet period is the time of intensive growth of the Armenian community in Moscow and its activity in the city, which, however, has not yet found adequate reflection in toponymy of Moscow. However, the process continues, new Armenian toponyms appear on the map of Moscow (the latest-in 2013).

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Contested Social Spaces

New Concepts and Methods in Urban Studies

Subjective/Objective Well-being in Cities

Sustainable to Resilient Cities

Urban Governance, Planning and Participative Democracy

Urban Heritage and Conservation

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BACK

THE CURRENT STATE OF THE ART OF URBAN ECOSYSTEM SERVICES ASSESSMENT IN RUSSIA

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In January 2016, the "17 goals for the transformation of our world" officially came into force. Russian Federation adopted sustainable development goals and declared the 2017th as year of ecology. This fact shows the readiness of the Russian Federation to start active measures aimed at preserving the natural capital of the country. Currently, national programs for the protection of wild species of animals and plants, national processing and utilization waste system are implementing; national legislation is changing to ensure conservation of forest, water and land resources; a network of specially protected territories tending to be developed. However, despite the fact that measures planned by the Russian Federation are unconditionally needed, they are inadequate to creating a truly resilient and comfortable city due to one-sided approach: focus on improving statistical environmental and sanitary-hygienic indicators, without paying enough attention on social, economic, cultural and other aspects. At the United Nations Conference on Housing and Sustainable Urban Development - Habitat III, held in Quito (Ecuador) in October 2016 a new urban development program was adopted to achieve sustainable development goal No. 11. This program brings together the best proposals to form truly comfortable and safe urban environment. Research report No. 16 “Urban Ecosystems and Resource Management” by Habitat III declared the key role of ecosystem services to create a resilient and comfortable urban environment and named urban planning a main tool for managing the urban environment. At the same time, more and more scientific publications and conferences are devoted specifically to the study of urban ecosystem services, which makes this area of research one of the main frontiers of modern science.

Currently urbanization is probably the most important global process. The constant growth of urban dwellers’ amount and size of urban territory are obvious and there is no doubt, urbanization affects the state of the whole Earth. On the one hand, the urbanization is a progressive development of the humankind due to the wider possibilities for each person, development of infrastructure, communication and innovations; on the other hand, this process leads to accumulating and emerging of wide range of problems (overpopulation, ethnic, religion conflicts and criminality, epidemic and biological hazards, traffic jams and air pollutions, decreasing of number of green zones, forests; water pollution because of higher pressure on water cleaning infrastructure; transition of peri urban landscapes to urban landscapes, etc.) [Berry, 2008]. Moreover, higher density of population causes growth in resource demanding and leads to increasing pressure on cities’ ecosystems and city environment. All these problems along the poor planning of urban development, aimed only to economic prosperity of the city, lead to unsustainability of the city [A Research Prospectus for Urban Resilience, 2007].

The urbanization, as a complex socio-technic-economic process along the transition of the science to post-non-classical stage of development, creating a new understanding of the city as a complex system with the focus on its development and its future states prediction, make scientists to find new approaches to resolve these problems [A Research Prospectus for Urban Resilience, 2007]. However, scientists and city dwellers were aware about the state of their surroundings since 1970s, when the urban ecology emerged. This science dealed with the impact of humankind on the natural environment of the city. With development of science and

urban ecology and emerging of sustainable development concept urban planning became the most effective approach to provide city sustainability (in other words to resolve most part of cities' problems). Next stage of development of sustainable development concept, regarding the cities, was invention of urban resilience concept based on the capacity of the urban system to respond to and recover from certain hazards [Holling, 1973, 1986, 1995; Chaplin, Konfinas, 2009]. A great number of researches were dedicated to the link between urban resilience and urban planning [McPhearson, 2012; Schäffler A., 2013], most of them considered urban planning as a mean to provide or improve resilience of the city to some certain factors. The needs of socio-ecological approach to urban planning lead to implementation of ecosystem services (all the profits humankind get from ecosystems) assessment [De Grot, 1992, 2000, Daily, 1997, Constanza, 1997] as an instrument for decision-making while urban planning process [Bastian O., Grunewald K., 2015, Felipe-Lucia M., 2014, D. Haase, 2012, 2014, Niemela J., 2010, Gómez-Baggethun E. 2012, Elmsqvist T, 2013]. Currently most part of this researches are exploring in Europe and USA, while in developing countries this approach is still not considered [MA, 2005; TEEB, 2010].

In January 2016, the "17 goals for the transformation of our world" officially came into force [Official site of UN]. Russian Federation adopted sustainable development goals and declared the 2017th as year of ecology. This fact shows the readiness of the Russian Federation to start active measures aimed at preserving the natural capital of the country. Currently, national programs for the protection of wild species of animals and plants, national processing and utilization waste system are implementing; national legislation is changing to ensure conservation of forest, water and land resources; a network of specially protected territories tending to be developed.

The 2017th will be an important period for Russian cities. Such measures as creation of a green shield (a forest belt around cities), toughening of control over industrial enterprises are aimed to improve the ecological security of the urban environment [Russian Federation. Laws, 2016]. All these actions to some extent correspond to goal No. 11 "make cities inclusive, safe, resilient and sustainable". However, despite the fact that measures planned by the Russian Federation are unconditionally needed, they are inadequate to creating a truly resilient and comfortable city due to one-sided approach: focus on improving statistical environmental and sanitary-hygienic indicators, without paying enough attention on social, economic, cultural and other aspects.

At the United Nations Conference on Housing and Sustainable Urban Development - Habitat III, held in Quito (Ecuador) in October 2016 a new urban development program was adopted to achieve sustainable development goal No. 11 [The New Urban Development Program, 2016]. This program brings together the best proposals to form truly comfortable and safe urban environment. Issue paper No. 16 "Urban Ecosystems and Resource Management" by Habitat III declared the key role of ecosystem services to create a resilient and comfortable urban environment and named urban planning a main tool for managing the urban environment [Issue Paper No. 16, 2016]. At the same time, more and more scientific publications and conferences are devoted specifically to the study of urban ecosystem services, which makes this area of research one of the main frontiers of modern science.

Transitional state of Russian cities between industrial and post-industrial stage [Becker, 2012] form an urgent need to revise existing approaches to their planning. In this context, together with a high concentration of the population in cities (over 100,000,000 people live in cities in Russia [Official site of Russian Federal statistics service]), accumulated environmental damage, the urban ecosystem services assessment investigation seems necessary for Russian cities.

However, researches in this field are not numerous and include assessment of the specially protected areas within the city border and the translation of foreign experience in the

assessment of urban ecosystem services. Noting the special way of forming and modern development of Russian cities [Becker, 2012], their diversity and diversity of leading processes, unique natural and climatic conditions, economic, technological and social prerequisites, this approach is not fully correct. The accumulated experience of Soviet and Russian landscape studies and landscape-ecological mapping, new Russian research institutes (Strelka, VShU, Shaninka) should serve to adapt existing approaches to the assessment of urban ecosystem services to the realities of Russian cities.

The purpose of this research is to analyze the scientific papers devoted to the study and assessment of ecosystem services of urban ecosystems, as well as the existing prerequisites for the introduction of an assessment of ecosystem services in the process of Russian urban planning.

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THE ROLE OF URBAN ECOLOGICAL POLICIES IN UNSUSTAINABLE URBAN ENVIRONMENT

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In the present article a theory of the urban ecological balance is viewed with regard to the promising role of the balance for sustainability of ecosystems and ecological equilibrium within the urban environment; effective experience of the land use in the Brazilian city of *Curitiba* is introduced in this paper as a bright example. Also, the softscape is discussed as an aspect of the natural frame of a city, and functions of the softscape are analyzed.

In the modern days, area planning issues are of great importance in the process of wise land use and sustainable development of cities. Now the world witnesses deep re-interpretation of the views concerning the quality of life and inner urban environment; new scientific ideas on urban and public areas are being introduced to life. The reason of that is obviously a speedy pace of the development of cities.

Cities have their special landscapes with their own ecosystems. When humans interfere with the natural process through development of more territories, megalopolises grow. Ecosystems then lose their resources for self-regeneration and gradually acquire the anthropogenic features.

The consequences of these changes are usually the man-induced impact and some transformation of natural geosystems. These, in their turn, result in a disorder of the urban environment and ruin the whole system of natural aspects – thus, there come changes in geological formations, landscape, climate, soils, flora and fauna, as well as in the physical and psychological state of people (Azhghirevich, Azarov et al., 2010).

The reunion of humans and nature can be possible only in a comfortable ecological environment where sustainability and balance become first-place issues, and thus, humans and nature make integral parts of each other – that is, a geo-eco-socio-system comes into existence (Kochurov, Ivashkina, 2012).

Sustainability and the ecological balance in the urban softscape and anthropogenic systems seem realistic to achieve, preserving biodiversity, through sound practices to improve the quality of life in urban areas.

In particular, the problem can be solved with the help of a theory of the urban ecological balance introduced by Professor Boris I. Kochurov.

The key provisions of the theory of the urban ecological balance show that academic ideas of eco-polises, as well as attempts of building such cities and of wise city planning, are more than relevant nowadays.

A strategy of building an eco-polis includes the development of high quality environment for humans, harmony in relationships of humans and nature, guaranteed sustainability in natural and anthropogenic systems.

Eco-polis is not a myth today, the world's practice knows a lot of examples of such projects. One of the most prominent of them is Curitiba – a unique ecologically friendly megalopolis. Due to prominent expertise of urban professionals, the city equals Vancouver, Chicago, Wellington, Portland and other cities of the same level of comfortable living environment, landscape planning and park design.

The urban development master plan for Curitiba, apart from the integration of the three interrelated systems – land use, roads and city traffic, includes a consistent, socially orientated policy with clear goals, which is essential if a city intends to reach a high living standard of the urban environment, and it should be noted that the administrative institutions of Curitiba were once in difficult conditions, having no rich budget resources and modern technology.

Also, the integrated master plan of the development of Curitiba includes hydrology, softscape, waste recycling, the plan also considers unemployment and crime issues, education and health care.

The effective city planning in Curitiba has resulted in a comfortable ecological response in the urban environment, in particular, 80% of the city population have no cars in individual use, parking lots and asphalted areas have been turned into 400 square km of softscape, 160 km of bicycle lanes have been built, the unique recycling system "Green Exchange" (rewarded by the UN) has been introduces which allows people to exchange waste and garbage for transportation tokens, food products, basic consumer goods (Baburov, 2009, 2010).

Results similar to those in Curitiba can be reached through the urban ecological balance (the Balance). The Balance improves the performance of the land use in a megalopolis, and over the long term a natural frame is formed which is able to minimize the anthropogenic burden over the natural environment and the landscape. Thus, the Balance supports sustainability and full functioning of the ecosystem.

The implementation of the Balance implies the interdisciplinary approach and different research techniques in the analysis of the state of the environment in a megalopolis, and requires collaborative effort of different experts who can reach practical results.

An important idea of the Balance is to keep some areas in a city undeveloped and to create the natural frame of an area. The natural frame of an area, according to N. Reimers, is a system of natural territories, ranged by their ecological significance, where the close integration of these territories makes it possible for the natural ecological balance to come into existence and to resist anthropogenic influence.

The basic component of the natural frame is a system of softscape, the natural frame cannot function properly without this. The softscape gives more oxygen to the urban environment through photosynthesis, it boosts ionization, preserves the gas balance in the atmosphere, makes the urban noises and heat lower, and it is a good wind screen.

The softscape plays a significant role in city planning. The softscape introduces into the urban environment a touch of nature, it improves the view of urban landscapes and helps to support human-nature accord. The softscape also has a decorative importance, since it develops the expressiveness of urban landscapes if integrated with natural lines, on one hand, and with anthropogenic elements, on the other; thus, a city acquires its unique urban design.

Most large cities have undeveloped natural frame systems, for example, people have difficulties with reaching recreational city areas, or city areas lack integral order and regularity. The main reason of this is the insularity of land use. An integral ecosystem requires that its development should be founded on the principle of the solid land use which allows to broaden the sustainable areas. The solid land use should be applied to the whole territory of the system "city + suburbs" (Kochurov, Ivashkina, 2014).

The implementation of the solid land use needs a detailed preliminary analysis of the natural conditions in city areas. Geo-ecological problems revealed with this analysis enable to draw a plan of enhancement of urban areas and improvement of the population's life (Artemiev, Yeriomin et. al., 2003).

Landscapes of perfect harmony do not dominate in today's world, and a better performance of the use of land, the development of a more ecologically friendly urban environment are thus needed.

Urban specialists face today the challenge to develop the culture of the land use, this critical task can become a way to more harmonious relationships between humans and nature, but without necessary sacrifice to nature (Ivashkina, Kochurov, 2013).

Keywords: urban ecological balance, sustainable development, eco-polis, use of land, ecosystem, natural frame, city softscape.

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URBAN RESILIENCE: TOWARD MULTI-LEVEL APPROACH

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Resilience to natural disasters is mostly about the actions of government and people in the situation of an unexpected environmental shock that are generally quite predictable: evacuation, provision of shelter for those, whose houses were destroyed, renovation of damaged areas etc. In terms of socio-economic processes the actions of government and people can be very different, sometimes even opposite to each other. In the last case, we observe not only intentional responses of policy-makers and other stakeholders, but also the process of self-organization of social and economic systems in multi-level cities interactions. Thus, the originality of the presented research is to consider urban resilience as a concept that is not bounded only by natural disasters but also includes socio-economic dimensions. As a theoretical framework we take a multi-level approach of cities' systems proposed by D. Pumain, that considers the role of each city as a connector between micro level (for example, individuals, firms or institutions) and macro level (system of cities that arises from the interactions between individual cities such as exchanges of people by travel and migration, trade of goods, phone calls, circulation of information and knowledge, etc.). We put an extra attention to different types of networks within and between cities that form these interactions and illustrate that they are key factors of urban resilience. The presentation will introduce the theoretical framework in order to discuss the research position and the grid of concepts and methods, that will be applied empirically in a future stage on the Post-soviet urban systems.

Keywords: urban resilience, multi-level approach, city, complex systems, networks.

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THE IMPACT OF URBAN SPRAWL ON THE ECOLOGICAL FOOTPRINT OF CITIES: THE CASE OF BUDAPEST METROPOLITAN REGION

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Former state-socialist cities were described as compact and dense urban forms. Residential or commercial urban sprawl could not evolve, at least comparable to the West, because private sector was missing, farmland was owned by the state and low-density urban development was not preferred by planning authorities. However, since the political transition of 1989-90 urban sprawl has been increasingly observed around post-socialist cities. The metropolitan region of Budapest has also been affected by rapid suburbanization and urban sprawl after the change of regime. New functions appeared in the suburban belt, better off people moved to newly developed residential areas, agricultural land was converted to urbanised land in great masses. The main objective of this paper is to measure the impact of urban sprawl on the changing ecological footprint of metropolitan Budapest. To measure the ecological footprint of the city and its agglomeration zone we combine the top-down compound approach with a bottom-up ecological footprint analysis at the sub-national scale using an urban metabolism framework. The compound method considers regional GDP and national ecological footprint data calculated by the Global Footprint Network (GFN), whereas the component method relies on local data covering the consumption of households, the daily mobility of people and changing land use pattern. Combining urban metabolism analysis with ecological footprint analysis proved to be an effective way of detecting the spatial shifts in energy and materials flows within the city-region.

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ILLUMINATED CITIES: AVANT-GARDE PROCESSING OF MUNICIPAL WASTE A SCRUTINY OF GHAZIPUR LANDFILL, DELHI, INDIA

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Delhi has been witnessing a boom in its population as compared to all other metro cities in India. At present in 2017, its population is estimated to be over 190 million. and is estimated to cross 25 million in 2020. Over 9,500 tonnes per day (TPD) of garbage is generated per day in the city. Per day per capita production of waste is around 3.8 kilogram. About 8,000 TPD of waste is collected and transported to three landfill sites at Bhalswa, Okhla and Ghazipur. Actual waste generation in the city could be much higher, as a bulk of the waste is managed by the informal sector. Most horrible fact is that these three landfill sites are not designed as per the specifications mentioned in the Solid Waste Management Rules, 2016. According to the Master Plan for Delhi, 2021, these landfill sites had exceeded their capacity way back in 2008. Most of these sites have contaminated the aquifers and groundwater in and around their neighborhoods.

As per the latest draft manual on municipal solid waste management prepared by the Union Ministry of Urban Development, three million tonnes of waste can be accommodated on 40 ha of land (keeping in mind that the life of a landfill is 20 years). Delhi needs 800 ha of land, which would cost Rs 80,000 crore going by the present (Centre For Science and Environment). **But the city simply does not have the land**. According to an assessment by the Centre for Science and Environment (CSE), every tonne of waste disposed of at a landfill would cost the MCD about Rs 14,500—a sum that is highly unsustainable.

The need of the hour is to find a sustainable and eco-friendly solution to the ever increasing and unavoidable evil of urban municipal solid waste (MSW). The most worrisome aspect of MSW is the production of harmful flue gases if it is burnt and also it's seepage into the ground, contaminating it. In order that the waste is utilized efficiently and in an eco-friendly manner so as to cause minimum damage to the environment, government of Delhi has started a Waste-to-energy plant in Ghazipur land fill site. According to the Bhaba Atomic Research Centre (BARC), the technology being used as one that can "process biodegradable waste, such as kitchen waste, paper, grass, gobar and dry leaves. It offers zero garbage and zero effluents and provides high quality manure and methane gas. Weed-free manure obtained from such waste has high nitrogen content and acts as an excellent soil conditioner."

The Waste-to-energy plant is proposed to be set up in an area of 1,500 square metres within the next door slaughter house campus. Once fully commissioned, it will be able to supply 1,800 kW per hour of electricity, all of which will be used to meet the power demand of the wholesale meat market. The plant, which will use 1,300 tonnes of Municipal Solid Waste (MSW) on a daily basis from the Ghazipur landfill site, is Delhi's second such facility after the operational Timarpur-Okhla WtE plant.

The salient features of the WtE plant include an elaborate seven-stage pre-processing section which converts waste to Refuse Derived Fuel of high calorific value.

The plant will contribute to combating global warming by mitigating 8.2 million tons of greenhouse gases over the life of the project.

The plant is India's first WtE plant compliant with Euro norms for emission along with the highest standards of pollution control measures.

To implement the highest levels of transparency, a Continuous Emission Monitoring System (CEMS) enables online viewing of key emission parameters on real time basis.

Apart from positively impacting the health and hygiene of the nearby communities by processing fresh municipal solid waste, the project's initiatives for generation of employment, alternative livelihoods and functional literacy are creating societal benefits. The project will also help in saving 105 ha of scarce urban land valued at over Rs 2000 million.

In this waste-to-energy plant(WtE), dioxins are subjected to treatment and pollutants are reduced to suitable acceptance levels. These dioxins are generated in residential fireplaces, open burning, diesel engines, paper mills, chemical industries etc. and are generally formed in lower temperature range and only in the presence of halogens like chlorine which can be destroyed at temperature beyond 1200 degrees centigrade.

Flue gases are directed into a semi-wet reactor where lime is also injected in order to neutralize acid gases and heavy metals. Activated carbon is also added to the reactor to absorb organic compounds like dioxins, furans and odorous constituents. the un through mixture is then run through bag filters which remove all SPM including lime and carbon injection down the stream. The remaining gases are pushed into the atmosphere through a chimney before it has passed through CEMS using ID fan.

Environment friendly and sustainable technologies are the need of the hour today with an encompassing atmosphere filled with green house gases and mountains of garbage assembling in every street corner. This technology needs to be replicated in every metropolitan city of developing countries through their respective governments so as to make them self sustaining and to decrease their dependence on fossil fuels for all the energy needs.

Keywords: Waste-to-Energy, landfill site, eco-friendly waste disposal.

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GREEN MANAGEMENT IN MOSCOW CITY: SCIENTIFIC BASIS FOR PARTICIPATIVE DEMOCRACY

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Despite disturbance and fragmentation, remnants of nature in cities have enough size for keeping all components of ecosystems (producers – consumers – decomposers) even in residential quarters and along transport networks. This makes the environment more favourable for citizens. Well-planed configuration of the Moscow green place distribution makes possible to support the connection of the city ecological network with surrounding natural areas. The Moscow City Department of Nature Use and Environment (DNUE) involves scientists and activists in developing environmental policy. For example, we have worked out amendments for Moscow City Greenery Rules. Now the Rules envision among other low-cost managed multispecies loan composed by plant species of local flora. Unfortunately, it's not wide implemented because of greenery firms interest in expensive technologies. In response to this, citizens develop and implement nature friendly green management projects them-selves. They increase the level of interaction from communal to regional. It could improve the DNUE position in City government but sometimes relations between activists and DNUE become unconstructive. The report applies on the results of studies under the State Assignments "Identification of biotic indicators of sustainable development and nature use optimisation, developing biogeographic basis of territorial conservation" and "Formation and dynamics patterns of fauna, communities, and metacommunities in nature and cities", and the DNUE Project "Inventory and Monitoring of Flora and Fauna in Moscow".

Keywords: City Green Management, Participative Democracy, Environmental Policy.

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COMPARISON OF ECOSYSTEM SERVICE VALUE CHANGES UNDER DIFFERENT MANAGEMENT MODES: A CASE STUDY IN FUJIN CITY, NORTHEAST CHINA

Shuwen Zhang, Fengqin Yan Jiuchun Yang, Lingxue Yu, Liping Chang

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Ecosystem services represents the diverse values that ecosystems provide to humanity, which are necessary for human well-being, health, livelihoods, and survival. Interest in ecosystem services values (ESV) has grown quickly since the publication of 'Millennium Ecosystem Assessment'. Attentions have been paid to the estimation of ecosystem service values, the influence of land use and land cover changes (LULUC) on ESV, the impact of population density changes on ESV, the effects of information, value-deliberation and group-based decision-making on ESV etc. Some studies discussed the effect of ecosystem management on ecosystem services. However, there are few studies that compare the differences in ESV changes under different management modes. China has a special region called the reclamation region (Re), which has different management modes than the agricultural region (Ag). In this study, Landsat Thematic Mapper (TM), China-Brazil Earth Resources Satellite 1 (CBERS - 1) data, Operational Land Imager (OLI) as well as unmanned aerial vehicle (UAV) images were used to obtain the LULCC for Fujin City over four periods (1986, 1995, 2005 and 2015). We modified the equivalent value factors (EVF) method by crop yields in the study area and in the whole China to estimate the ESV in different years. Finally, we compared and analyzed the impact of management modes on changes to ecosystem service values and ecosystem service structures. The results show that cultivated land expanded from 4630.2 to 6783.2 km^2 at the expense of wetland, forest and grassland in two regions. Statistics show that paddy increased from 59.2 to 1341.8 km^2 in the agricultural region while it increased from 60.1 to 2236.3 km^2 in the reclamation region during 1986-2015. The total ESV decreased by 49.0% and 43.4%, respectively, in the agricultural region and in the reclamation region. The agricultural products function exhibited a larger increase and the freshwater supply function exhibited a greater decrease in the reclamation region than in the agricultural region. Compared with the Ag region, the percentages and structure changes in different functions' ESV were larger in the Re region, which was due to the changes from to dry farmland to paddy over large areas. Therefore, more attention should be given to ecological protection such as evaluating regional water resources capacity in the two regions, especially the Re region. The two regions can cooperate with each other to promote common developmental goals.

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C16-37/7- Urban governance, planning and participative democracy

NEW PARADIGM OF URBAN DEVELOPMENT: AN ASSESSMENT OF TRANSFORMATION OF PUNE SMART CITY, INDIA

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Government of India has launched a flagship mission called ‘Smart Cities Mission’. The Smart Cities Mission is an innovative and new initiative by the Government of India to drive economic growth and improve the quality of life of people in urban areas by enabling local development and harnessing technology as a means to create smart outcomes for citizens. In the approach to the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. A smart city is an urban development vision aimed at integrating multiple practical solutions with respect to infrastructure facilities and services to the citizens and also for efficient management of a city’s assets. The goal of building a smart city is to improve quality of life by using urban informatics and technology to improve the efficiency of service delivery and meet residents’ needs. Throughout history, a city’s evolution has been driven by the needs of its residents and by its ability to integrate new innovations into its structure and way of life. Although Smart Cities have various applicable definitions, a Smart City may be broadly defined as a city that is able to respond to the needs of its citizens as promptly and efficiently as possible.

‘There will be special emphasis on participation of citizens in prioritizing and planning urban interventions’ under this flagship mission and citizens will play very pivotal role in prioritizing the problems of the city to transform the city in better way. Pune city is selected as for the competition for smart city out of 100 cities in India. The problems and perspectives of the cities as being smart city are discussed here, namely, traffic, solid waste management, water, electricity, e-governance, etc.

Open public participation, enhances transparency and accountability which leads to better decision-making. A strengthened relationship between local citizen and authorities is mutually beneficial, as it leverages a wider canvas through participative, deliberative, community-based planning for sustainable development.

Keywords: Smart city, governance, Pune, sustainable environment.Разрыв страницы

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PERCEPTION OF INSTITUTIONS AND SOCIAL CAPITAL ACCUMULATION IN LARGE URBAN VS PERIPHERAL AREAS: MICRO LEVEL FINDINGS FROM RUSSIA

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The present study aims at investigating the linkages existing between individual perceptions of institutions and accumulation of structural and cognitive social capital, and the way in which the type of residence place affects such linkages. To this aim, a structural model is proposed and tested over Russian European Social Survey 2016 data for a) large urban areas and b) peripheral (small towns and rural) areas respondents.The theoretical framework integrates a critical perspective on social capital-based development studies with social psychology theories (social categorization and shared agency) and post-socialist studies in the domains of human geography, sociology, and political science. Three dimensions of perception of institutions (trust in institutions; satisfaction with institutional performance; perception of citizens' empowerment) and three components of social capital (socio-political engagement; generalized trust; informal SC) are included in the model. Results show that: a) different forms of perception of institutions affect different forms of social capital; b) informal social capital appears as a sort of mediating factor between perception of institutions and other forms of social capital; and c) the correlation between socio-political engagement and generalized trust is sensitive to the type of residence place. In general, the mediating role of informal SC is stronger in large urban areas; the correlation between socio-political engagement and generalized trust is positive and significant among respondents in large urban areas, but non-significant among respondents in peripheral areas; the same is true for the correlation between satisfaction with institutional performance and socio-political engagement.

Keywords: Social capital; perception of institutions; centre vs periphery; Russia; structural equation modeling.

Разрыв страницы

BACK

TRANSFORMATION OF HISTORICAL RURAL PLANNING FORMS IN THE URBAN ENVIRONMENT OF MOSCOW

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Any city in the process of its growth absorbs the surrounding countryside. Part of it disappears forever, but many of its elements are preserved, fitting into the urban environment. Main evolutionary tendencies are visible in urban plans of Moscow throughout the last four centuries. During all centuries Moscow step by step assimilated rural neighborhood, but last hundred years these steps became real big. Despite the multiple increase in the size of the city, the transformation of all urban structures and the position of Moscow among the global cities of the world, some rural features still remain in the urban environment of Moscow. This applies both to the planning structure and the presence of rural architectural forms in different functional structures of Moscow. Closely spaced *pereulki* (lanes), the distance between them, even in the most central part of the city, within a radius of 500 m to the north-west of the Kremlin, is the result of the implementation in the 16th–17th centuries rural planning forms, more precisely, their symbiosis with urban forms. In various in their functions planning structures there are rural architectural and planning elements – in public spaces, industrial areas, and residential areas. Inclusion of specific rural architectural and planning forms in the urban structure of Moscow is constantly going on for centuries, despite population growth and increasing complexity of economic specialization. Once included into the structure of the city, rural planning and architectural forms do not disappear, but after the termination of the implementation of their parent species and ways of life, really related to agriculture and other "non-urban" activities, they are transformed for integration into urban life and the environment, contributing to an increase in their diversity. This pattern can be traced consistently, at least, from the 18th century.

Keywords: rural planning forms, urban planning structure, urban development, urban environment, Moscow.

BACK

THE IMPACT OF THE RAILROAD ON THE EVERYDAY LIVES OF THE CITIES ALONG THE BAIKAL-AMUR MAINLINE

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Once served as an attraction for the movement of millions of young people to its construction and declared as a region-forming object, nowadays the phrase "Baikal-Amur Mainline" (BAM) among locals is associated only with history, and the railway itself is more often called simply " zhelezka" (piece of iron). Nevertheless, its role in organizing the daily routine of cities is difficult to overestimate. At one extreme there are projects and measures to modernize the railway, which appeal to the projected growth in the volume of transported goods to the Asian markets and the geostrategic role of the railway. At the other extreme, the practices of the existed before the BAM construction adjacent settlements dwellers, who sometimes do not have access to the services of the railway, and its functioning is even perceived as a hindrance related with the risks of livestock death, environmental pollution, and disruption of the traditional ways of life. More complex relations between everyday life and the railway can be found in the BAM cities, where the importance of the railway is more nuanced depending on the origin, occupation, age, sex of the local residents, and their experience of interaction with the railway. The article examines the following questions of the railroad's impact on the organization of the BAM cities everyday lives:

- Who and in which ways is the most affected by the railway operation in the BAM cities?
- How this impact is conditioned by social and cultural differences?
- How does this impact occur, what are its rhythms?
- How and in what spatial and temporal framework does the daily life of local residents change as a result of interaction with the railway?

In order to answer these questions, the article will focus on the following forms of the railroad impact: direct work on railway (labor of the maintenance workers, engine drivers, electricians, carloaders, train attendants), accompanying types of economic activity (employees of railway station stalls, street vendors, taxi drivers) and travel in passenger trains. Data for the analysis derive from the field studies (interviews and observations) in 2016-2017 in the cities of Ust-Kut, Severobaikalsk and Tynda.

BACK

DEVELOPMENT STRATEGIES ON THE SHADOW OF A METROPOLIS - BUCHAREST. CASE STUDY POPEȘTI-LEORDENI TOWN (ROMANIA)

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After the fall of communism and the abolition of some restrictive rules (regarding population mobility, the restoration of individual property, the emergence of real estate markets), in the proximity of Romania's capital, Bucharest, took place a process of territorial remodeling, the main driver being the urban expansion. The peri-urban area of Bucharest did not have a homogeneous development, but in patches, the first area that developed was the northern one, followed by other places, especially from the East and West, and more recently from the southern area. The post-2008 economic crisis has led to a stagnation in the real estate market, but gradually there has been a recovery, culminating in an intensification of the construction of new houses. Popești-Leordeni town is located in the southern area of Bucharest, with a population of 33,000 inhabitants, in 2017, 135% more than in 1992. Of the 8 cities near the capital, Popești-Leordeni registered, in the mentioned interval, the largest increase in the number of inhabitants, with about 20,000 people, almost entirely after 2007. The methodology of this paper consists of three main steps, the first of which focuses on analyzing the dynamics of the residential space in the post-communist period, identifying the main stages of development, using aerial photographs and the geographic information system. The second stage consists of field trips and the mapping different issues such as the type of dwellings, public utilities, waste management, etc. The third stage analyzes the development strategies applied by the local authorities, under the pressure of new home buyers and real estate investors. In the context of legislative shortcomings, of a strong local autonomy and the lack of integrated development projects together with the capital, has come to a chaotic development as well as to problems with the provision of urban facilities. Given that residential development is on an ascending trend, a series of questions arise regarding the long-term costs of public authority decisions, their sustainability, governance, lessons learned, civil initiatives etc. Some scenarios for further development can also be developed.

Keywords: Bucharest, Popești-Leordeni, town, development strategies.Разрыв страницы

BACK

COMMUNAL AND FISCAL DRIVERS OF TERRA FIRMA TRANSFORMATION IN RURAL DELHI

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Land is a fundamental factor of production, and through much of the course of human history, it has been closely tied to economic growth. As a result, control over land and its use is often an object of intense human interactions. Human activities that make use of, and hence change or maintain, attributes of land cover are considered to be the contiguous sources of change. Rural areas are dynamic and inexorably changing in response to a wide range of social, economic and political factors. A primary study of fifteen villages in Delhi reveals many factors which were hitherto unknown. These Push factors of land cover and land use have changed rural Delhi both qualitatively and quantitatively. Industrialization and urbanization - which offer higher incomes and job security to the jobless and underemployed rural youth are a few of the push factors besides Caste, illiteracy of land owning class, lack of money for important family occasions, weddings, push up the land prices forcing the land owners to sell off their lands.

Pressure from the real estate mafia, in search of land for commercial, residential and industrial use often pressurize the land owners to convert from agriculture to other land uses like factories, godowns, farmhouses, mills processing rice and pulses, automobile workshops, cold storages etc.

Stringent government policies regarding industrial location, pollution control have sent the land prices skyrocketing. Big luxury cars, mansion sized homes of land owners also force other landlords to sell off their lands.

A study of the satellite imageries of three time periods of reveal an astounding change in the land cover transformation. From ninety percent agricultural land to ninety percent built up area in 2000 decade – the transformation been astonishing. Unless planned development policy is adopted by the governments strictly, this land cover transformation cannot be moved in a sustainable direction.

Keywords: Land cover, push factors, caste, economic factors.

BACK

PLANNING FOR THE GREEN CITY – A COMPARATIVE ANALYSIS OF DIFFERENT MODES AND UNDERSTANDINGS OF PARTICIPATION IN LEIPZIG (GERMANY) AND SOFIA (BULGARIA).

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Citizen participation has become a key aspect of governance for sustainable development. It is, however, practiced in diverse ways in different European contexts and does not automatically translate into inclusion of some of the most marginalised constituencies in planning processes.

This paper addresses the contradictions arising from such diverse understandings (which??) and modes of participation as well as some of the obstacles to inclusion that result from them, based on research in two post-socialist cities: Leipzig in Germany and Sofia in Bulgaria.

Comparing initial findings in Sofia and in Leipzig, the authors consider the influence of different political conditions and approaches to citizen engagement for inclusion in urban sustainability planning. We further present examples of different forms of engaging actors from diverse constituencies, including state and civil society organisations, asking how tokenism and the instrumentalisation of participation can be avoided. The paper also considers how young people are included in urban participation concerning their city's futures.

BACK

C16-37/8- Contested social spaces

SHAPING DEGRADED AREAS IN POLISH CITIES – BETWEEN URBAN RENEWAL AND GENTRIFICATION

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In recent years, city centers in Poland have undergone an intensive urban renewal process. This has been caused, among other things, by European Union funds, under which since 2004 it has been possible to finance projects curbing the degradation of urban areas. Since 2015, the Polish regeneration act has on the one hand structured the urban renewal programming process, and on the other hand has created new legal tools that facilitate public intervention in the most neglected areas. At the same time, along with urban renewal and sometimes as a result of this process, many cities in Poland are faced with gentrification, which means the taking over by the middle and higher class of buildings previously occupied by poorer residents (on purely market terms) and the gradual modernization of these premises. While urban renewal usually meets with a positive reception of city residents, gentrification raises conflicts which are difficult to resolve.

The aim of the paper is to analyze and assess the spatial manifestations of urban renewal and gentrification processes in degraded areas, with the city of Poznań (Poland) as a case study. Actions initiated by the Poznań Muncipality are considered to be exemplary in Poland, as a result of which they are imitated by many other cities.

The paper presents the results of analyses of the changes that took place in the years 2006–2016 in those downtown city districts which developed the municipal regeneration program. The transformations identified include, e.g. an increase in real estate transaction prices and in rents and, above all, transformations of the social structure. The spatial consequences of these changes include: improvement of the state of residential and public buildings, restoration of green areas and modernization of public spaces. The paper attempts to assess which of the two processes, urban renewal or gentrification, is the principal driving force behind the above changes.

Keywords: urban renewal, gentrification, city transformation, Poznań, Poland.

BACK

THE ROLE OF HOUSING MARKET AND RETAIL PRICES IN THE SPATIAL DIFFERENTIATION OF THE BUDAPEST METROPOLITAN AREA

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After the change of regime, the Budapest Metropolitan Area became the most dynamical region of Hungary. This most developed region of the country consists of more than 80 settlements around the capital with more than 800 000 inhabitants.

In the 1990s the main factors of development were the suburbanization, the retail and industrial investments. The winners were those settlements which are located near the motorways (they pull the investments) and those which are located in an attractive residential area, namely in the Buda hills or by the Danube.

The paper investigates the characteristics of the settlements and the purchasing power of local population. It addresses the question of relationship between investments and consumption level in the region. The major question to be analysed is whether we can find the most investments in towns and villages with high consumption level. Another aim of the paper is to provide a statistical analysis of how the location of suburban settlements and transport facilities affect the real estate prices and housing market.

BACK

PROBLEMS OF EMPLOYMENT OF THE POPULATION OF THE REPUBLIC OF KAZAKHSTAN AS AN IMPORTANT INDEX OF QUALITY OF LIFE UNDER THE CONDITIONS OF SOCIAL MODERNIZATION OF KAZAKHSTAN

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Subject/topic. The article deals with the problems of employment of the population of the Republic of Kazakhstan as an important element of labor market regulation and a social and economic indicator of the quality of life of the population. This problem is considered in the context of social modernization of the republic. The causes of the unemployment rate, consequences and ways to minimize this phenomenon are affected.

Goals/objectives. The purpose of the article is to analyze the main directions of state regulation of employment and identify the reasons for the existence of problems in employment. The article provides statistics on employment and the level of unemployment in recent years. The Concept of the state policy of employment of the population of Kazakhstan is analyzed. The basic models of regulation of employment of the population and a labor market are in detail considered.

Methodology. The methodological basis of the research is a systematic approach to the phenomena under study. The main methods are the abstract-logical approach based on the analysis of the processes of socio-economic life and employment relations, socio-historical, allowing to trace the processes of formation, function and development of the sphere of employment as the most important sphere of society.

Results. It is revealed that the important reason for existence of problems in the sphere of employment is the weak registration of regional development features in state and regional programs. In a decisive degree, overcoming the current situation depends on the ability of the State Employment Service and its regional structures to use the methods of diagnosing the state of employment in the labor markets that are adequate to the current situation.

Conclusions/significance. The necessity of the development and implementation of the regional employment program, the improvement of legislation in the spheres of employment and unemployment is substantiated.

Application. The mechanisms of implementing the employment and social protection policy for the unemployed can be used to improve the regional employment policy, taking into account the local characteristics of the labor market.

Keywords: Labor market, employment, unemployment, social modernization, quality of life of the population.

BACK

CS: Subjective/Objective well-being in cities

SPATIAL ERGONOMICS: A CRITICAL CONTRIBUTION OF GEOGRAPHERS TO COUNTER-TERRORISM?

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Many contributions, both academic and practical, have tried to address the multiple interactions between spatial morphologies and social behaviour, especially regarding security in public places and spaces. Among the earliest practical approaches, we should mention the attempts to design urban spaces in order to reduce and/or neutralize deviant behaviours in public spaces and places (Jacobs 1961, Newman 1996). A more recent approach considers the concept of 'spatial ergonomics' (Saint-Gérand 2002). So far, this approach has never been applied to terrorist risks.

Spatial ergonomics is defined as the capability of a given space to give accessibility to localized resources to its inhabitants and users at a lower cost (Saint-Gérand 2002). In this approach, the level at which space suits its community also depends on the ease it allows these people in accessing needed/ expected resources (Saint-Gérand 2002, Propeck-Zimmermann 2015).

Then, spatial ergonomics focuses on the access to localized resources regarding the criteria of cost and ease (or comfort). But spatial ergonomics should now include another criterion which is: security (or safety). Then, spatial ergonomics can be seen as the capability of any space to give access to some resources with a better degree of costs, ease and security. By including this criterion, spatial ergonomics becomes a relevant way to analyse the social and political reaction to (Islamic) terrorist risk, especially the social expectation regarding security in public spaces and the policies designed by public authorities to ensure this security.

This research aims at better understanding the social and political response in France to the Islamic terrorist events since 2012. As those events have led French society and policy-makers to developing new security expectations and policies, we must analyse the 'risk design process' as a socio-spatial process attributing a possible hazard to some places in some social circumstances.

In this approach, socio-spatial proximities are of critical importance. One of the symbolic proximities involved in the process is the perception that 'a strike can happen anywhere at any time against anybody'. This perception produces (hypothesis) a socio-spatial diffusion of the feeling that everybody is now in proximity with terrorist hazard. This is new given that, historically, most citizens in European democracies could consider themselves to be far from, or 'out of reach' of such threats.

Confronted to such processes and perceptions, the social and political response aims first at designing solutions which are supposed to neutralize hazards. Then, in front of a threat like a ram-raid, it will seem natural to most people to rely on solutions which will make it difficult, or even impossible, to use such tactics: concrete cubes, vehicles used as a barrage, technical barriers, concrete or steel poles, etc.

The result of those processes is that a new urban landscape has arisen while society produces visible and lasting expressions of the social response to terrorist risk. This part of the 'risk design process' produces shared representations of risk, of its possible and likely

localizations. It will operate also as a geographical memory of social and political responses and their underlying fears.

The analysis of these processes is critical because: 1/ the policy-makers and decision-makers have very limited knowledge of these topics AND are crushed between two contradictory forces: their doubts about the relevance of these solutions and the fact that it is politically impossible not to do anything visible in public spaces. 2/ These processes are rarely reversible. Then these security solutions (hypothesis) are going to become an influencing part of our urban landscapes and of our socio-spatial interactions. They will remain as a kind of visible and lasting memory of our collective fears.

Thus, a 'spatial ergonomics' frame of analysis will help us focus on the actual effects of these evolutions: how do they impact effectively representations, behaviours and interactions in urban public spaces? If these fixed or removable security solutions interact with our behaviours, both individually and collectively, then this will change the conditions for access to a range of resources and the global experience of our urban spaces.

Keywords: Spatial Ergonomics, Terrorist Risk, Spatial Morphologies, Socio-spatial Interactions, Geographical Memory.

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BACK

HEALTH AND WELL – BEING FOR CHILDREN FROM THE DAYCARE YARD – GREEN SOLUTIONS TOWARDS SUSTAINABLE CITIES

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Good health and well-being is one of the sustainable development goals of the United Nations. In developing solutions to facilitate transitions towards sustainability and resilience, human relationship with nature is crucial, especially in urban areas where capacities to connect with nature have decreased. In Western societies the improvement of hygiene levels and reduced green space has decreased exposure to microbes needed for the proper development of human immune system. Hence, immune-mediated diseases such as asthma and allergies have increased rapidly. According to the biodiversity hypothesis, contact with diverse environmental microbiota affects human commensal microbiota and drives effective immunoregulation that persists into adulthood. Interacting with nature has also been shown to increase well-being.

We examined biodiversity hypothesis in real urban environment by studying how greening of daycare yards affects children's well-being and health. For transforming the yards, we used forest floor vegetation, sod, peat blocks, and planters for vegetable and flower growing. Six daycare yards in the cities of Lahti, Tampere, and Espoo, Finland, were transformed in 2016–2017.

First, we examined how increasing contact with vegetation and soil altered the children's skin and gut microbiota. The results showed that changes were associated with microbes that in earlier studies have been connected to immunomodulation and health. Second, survey- and interview-based data was used to investigate how the intervention influenced children's play and physical exercise in the yard and their well-being. The results indicated that green materials diversified children's play and exercise and improved quality of air in the yards. Green yards had positive impacts on children's and adults' mood, energy, and motivation in the daycare centres.

The results can be used in designing health-enhancing yards of daycare centres, schools, retirement homes, and other public buildings. Best practices that ensure our contact with nature are crucial in terms of creating sustainable and resilient cities.

Keywords: well-being, health, human microbiota, green solutions, sustainabilityРазрыв страницы

BACK

QUALITY OF LIVING IN INDIA: A HOUSEHOLDS LEVEL ANALYSIS

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Quality of life is a multi-dimensional process and influenced by a combination of interrelated variables. The present paper seeks to investigate the quality of living among the Indian households at district level from 2001 to 2011. The study is based on secondary data collected from Registrar General Census Operations, New Delhi. The quality of living has been examined in terms of 5 main dimensions i.e. i) housing quality, ii) basic amenities like health, sanitation and cleanliness, electrification, fuel consumption, iii) banking iv) information & communication and v) assets ownerships covering 14 indicators. The spatial variations in quality of living have been portrayed and discussed with the help of composite index. The study reveals that only one-tenth districts (63 districts) of the country have witnessed very high and high quality of living whereas half of the districts (about 53% of all districts) have recorded very low or low quality of living at the household level. The study also portrays visible north-south divide in quality of living among the Indian households. The southern half of India especially the majority of the districts of Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra and Gujarat have witnessed very high and high quality of living at the households level. By comparison, a vast tract in northern, eastern and north eastern part of country have witnessed very poor quality of living in terms of housing quality, electrification, health, sanitation and cleanliness, information, communication, banking and assets ownership.

Keywords: Quality of Living, Households, Composite index, Spatial Variations, India.

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SMALL TOWNS IN ROMANIA - URBAN VITALITY, CHALLENGES AND RESPONSES

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Small towns (less than 20,000 inhabitants) represent 70% of the urban network of Romania, concentrating about 10% of the country's population (over 2,090,000 inhabitants). Almost half (47%) of them have a population between 5,000 and 10,000. The level of development is different from those which are thriving, most often located in the metropolitan areas, as compared to those struggling with a multiple process of degradation (economic, social, infrastructure etc.). Starting from these considerations, the purpose of this paper is to analyze the urban development level of small towns in Romania, by means of an aggregate index called urban vitality index. For its construction, several statistical data series have been used, on the basis of which several indicators have been calculated, grouped into three categories: demography, socio-economy, infrastructure and land-use. For each of the three dimensions, a sub-index was built, based on which, by statistical analysis methods, the index of urban vitality was calculated. Later on, typologies have been realized, identifying the causes that led to a certain type of post-communist evolution, including correlations with small towns emergence stages, and the strategies adopted by small towns that are thriving. In the case of towns struggling with decline, one of the strategies adopted is the desire to return to the rural status, and some steps have been taken in this regard. Meanwhile, there is a legislative proposal defining an intermediate category between urban and rural, for example, "towns with rural characteristics". In fact, after years and years that small towns have been placed in a "shadow cone", the attention focusing on large cities, in recent years, policies and strategies are being discussed to revitalize them and regain the role of local development poles. In conclusion, the urban vitality index could be a tool for identifying the local potential of small towns, main challenges and the obstacles they face in the process of valorization, given that the European Union is encouraging an integrated, place-based approach.

Keywords: small towns, index of urban vitality, Romania, place-based approach.

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URBAN POVERTY AND PERSONAL HYGIENE: ROLE OF NGOS AND FREEBIES- A STUDY IN SLUMS OF DELHI, INDIA

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The city of Delhi is expanding – not just physically but also demographically at the rate of one thousand persons per day. Most of the immigrants are unskilled labourers from countryside who come in search of better jobs and money but land up as the lower most strata of the society. Living at the edge of the city, the women of these migrant families are the most neglected and affected by the poverty. Life in shanties made of tarpaulin is very tough for the women when they are affected by menstruation. Social taboos about this monthly female experience makes the women suffer silently without spending a single penny on themselves. The ladies, most of whom are illiterate, use dirty rags, soil, wood waste during this time, in turn exposing themselves to various diseases and infections of the urinary tract, cancer, septic etc.

In depth interview with the women folk of the slums gives an insight into the social and economic constraints faced by the women in their place of origin as well as in the shanties they call home in the city. During the course of continuous meetings with the women of the area, it was found that the women living in the area are illiterate or very less educated, making them extremely vulnerable to injudicious use of limited money, getting affected by water-borne and infectious diseases, very little knowledge about importance of personal hygiene.

Continuous interaction and counseling of the women and with the provision of soap, shampoo and sanitary pads and panties , free of cost, to the women by the Non Governmental Organization Amoli, it was found that the state of health of almost all women as well as their children improved –so much so-that the incidence of cholera, malaria and Urinary Tract Infections decreased.

It also took Amoli members quite some time and effort to convince the women to save money and spend on their own health and on that of their children. The efforts of Amoli members and volunteers in creating health awareness and economic awareness among women are continuing.

It was also found that if the freebies are withdrawn, the less educated and the illiterate women slip back to their old ways of dealing with menstruation. It can be concluded that it is only education and economic freedom of the women which can ensure a healthy and disease free society. freebies can solve a problem for a few days but cannot support a woman for her whole life time. For that women in Delhi's slums have to be made economically independent and educated.

Keywords: Migrant Labour, Illiteracy, Urban Slums, Menstruation Taboo, Personal Hygiene, Counseling.

Разрыв страницы

BACK

C16-37/10- Urban heritage and conservation

EVOLUTION OF OLD RIO DE JANEIRO`S DOWNTOWN STREETS AND PUBLIC SPACES, FROM 1770 UNTIL NOW

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The city of Rio de Janeiro was founded in 1565 by Estácio de Sá, shortly before the expelling of French invaders. The "New City" was transferred to the Old City's site, in 1567, beginning its nomination process. The urban evolution of the already established city of São Sebastião of Rio de Janeiro, begins among 4 hills and several mangroves, setting the boundary area in urbanization, not only by streets and ways, but also by its buildings, churches and public places that initially shows a pattern of nomination, which gradually deteriorates to an amorphous structure.

This paper aims to show how the toponymy of the area in the Center of Rio de Janeiro City was developed, analyzing the changing factors in the names of its streets and public areas, such as parks, fields and squares.

The analysis will be carried out according to a survey on the historical cartography of the City, as well as to documents listing the names of the streets, buildings, hills, rivers and public spaces. Aspects of the toponymic motivation of the initial names will be observed, as well as the diverse aspects that led to the names changing. Thus, trying to establish, in a diachronic approach, the main motivations and periods in which such changes occurred.

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BACK

CONSERVATION AND PRESERVATION OF HERITAGE SITES IN URBAN AREA, CASE STUDY OF PUNE CITY (INDIA)

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Heritage sites are the past of our culture, history, values, traditions and unique knowledge, that have developed by a combination of genes and environment over time. Heritage sites help to pass the knowledge and ideas and culture to next generation year by year. Nowdays, the symbiosis in both heritage sites and tourist has become a major objective in the management and planning of historic areas.These heritage sites are geting very little attention and weightage in urban development policy. This research paper focuses on conservation of urban heritage sites and historic monuments in the cities of the developing world.

The need for urban heritage site's conservation is discussed with reference to a number of sites in Pune city in India. Some key aspects of conservation i.e. encroachment, pollution, traffic, security, painting, behavior of tourists, visitors and salesman are discussed. Interview of tourists, shopkeepers, salesmen, administrative people and security has taken for better planning. The Key
indicator was developed using the theoretical approach. The paper presents the main concepts used as key performance indicators, that is, significance, integrity and authenticity and how th ey contribute to getting the objective of attaining the conservation of heritage sites.

The paper concludes with considerations on the need for re-development of area, re-structure the planning and infrastructure and reset the administrative system with support to local people as well as tourists. In this study we find that the government should arrange new techniques to preserve the heritage sites. Awareness programme should arrange by the people, NGOs and government agencies.

Keywords : heritage, conservation, tourism, culture.

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BACK

CONTEMPORARY URBAN LANDSCAPES AND HERITAGE GARDENS: THE CASE OF SUNDAR NURSERY IN DELHI

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The objective of this paper is to explore the changing social and cultural contexts of gardens as urban heritage, their meanings and utility and contemporary relevance to its stakeholders. Gardens express the relationship between humans and nature, articulating the urban cultural responses of society to nature. As a space for celebration of nature, gardens are weaved into urban landscapes imparting different secular and sacred meanings. As such gardens are invaluable part of our urban heritage. However, they are most vulnerable and, often the first to suffer destruction due to the process of development and growth of urban settlement.

Taking the case of 'Sundar Nursery' in Delhi, this paper examines the relationship between gardens as part of urban ecology and the changing meanings and symbolism imbibed in 'heritage sites' as a means of responding to the contemporary needs and demands of urban landscapes. In 2007 the Aga Khan Trust for Culture (AKTC) and the Central Public Works Department, Govt. of India (CPWD) jointly initiated a restoration project of 'Sundar Nursery' to create a major landscape of truly urban scale, deriving inspiration from the traditional Indian concept of congruency between nature, garden and utility, coupled with archaeological and environmental conservation. 'Sundar Nursery' was built in the 16th century in Delhi adjacent to the now World Heritage Site 'Humayun's Tomb'. During the Mughal period it was named *Azimbagh,* deriving its name from the famous caravan Sarai *Azimganj* situated on the Grand Trunk Road. In the British colonial period it was used as a site of horticultural experimentation, renamed after the only remaining structure '*Sundarwala* Burz'. After India's independence in 1947, it functioned as government horticultural department which neglected its original set up and composition.

This paper throws light on this changing perspective of urban conservation of gardens as 'heritage Spaces' and their utility within contemporary urban landscape. Using methods of garden archaeology and urban ethnography the paper tends to inspects how a heritage spaces are reimagined for the contemporary urban purposes.

Разрыв страницы

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CS: New concepts and methods in urban studies

THE EVOLUTION OF KAZAKHSTAN CITIES NETWORK IN THE 20TH AND 21ST CENTURIES: ECOLOGICAL AND HISTORICAL PERSPECTIVE IN URBAN PLANNING

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In modern urban planning as multi-cross-disciplinary scientific field of knowledge a wide range of urban challenges are studied. One of the important areas of focus is the analysis of the urban settlements network evolution ecological and historical processes.

We see the territory of modern Kazakhstan as one of the most challenging model areas. Between 1989 and 2009 this area showed reduction in the number of urban settlements from 292 to 121. At the end of the 20th century as a result of social-economic processes of the adjustment period first and then the collapse of the USSR the majority of Kazakhstan cities have been exposed to strong transformation. Political, economic and social upheavals in Kazakhstan, as well as the elements of the irrational management of natural resources have seriously changed the city. It took a few decades to turn the flourishing socialist cities into the centers of socio-economic and ecological disaster in Kazakhstan.

We have been studying the evolution of Kazakhstan urban settlements network in two areas: the analysis of historical and geographical sources and the study of the historical memory of German migrants in order to search and analyze the causes of urban environment major environmental transformation in the Soviet and post-Soviet times. Particular attention is paid to the role of multiple crises of the 1990s 20th in the evolution of cities and urban environmental management that affected the comfort of the population living in an urban environment. To date, a database has been made, cartographic models have been designed with the help of geoinformation technologies, as well as mathematical models based on the theory of complex networks have been created, archival materials and oral history data have been collected and processed. Such a combination of techniques has enabled us to eventually obtain the most objective, in our opinion, patterns of the distribution of settlements during separate intervals of historical time.

Keywords: Urban planning, historical urban studies, Kazakhstan.

Разрыв страницы

BACK

A READING OF PERIPHERAL AREAS THROUGH CULTURAL EXPRESSIONS: THE EXAMPLE OF RAP IN TUNISIA

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Geographical, sociological and political research has, since the revolution of 2011, been devoted to the study of the evolution of the tunisian society. They discovered another reality, censored for many times, by the regime to foreign media and to international tourists. The revolution revealed, in part, the mutations and disarray that tunisian population has experienced for decades. Before and after 2011, many forms of cultural expression have contributed to changes in the country. Long considered to be an underground cultural expression, the rap is one of those new cultural expressions. He even played the role of spokesman of the Tunisian youth's demands during the revolution. Some rappers were real actors during the revolution and in particular "The General" who, following a song, to the address of the former President of the Republic, was arrested. After 2011, Tunisian rap circumvented self-censorship in the official media and took advantage of opportunities in alternative media, such as social networks and Youtube. Infact, diffusing videos on youtube, gave a new breath to these rappers who were able to attract an audience interested in their music and their lyrics. These rappers have established themselves in the cultural landscape of the country. This new rap came out of the big disadvantaged neighborhoods, abandoned by authority, for decades. The songs show through the lyrics, the vocabulary used in these neighborhoods, sometimes vulgar and inappropriate. The selected landscapes reflect and emphasize peripheral areas, on the fringe of Tunisian centrality. Admittedly, we are in the city but on the periphery of its dynamism, of its organization and of its centrality. The places filmed, without any artistic improvement or special effects show a reality, so much hidden by the authorities, of poorly built or unfinished houses, young people and children in every corner of the streets, delivered to their spells, household waste thrown are part of the decor of the neighborhood. The lyrics explain the neighborhoods crisis, the "houma", in tunisian dialect. These territories are marked by many difficulties like youth unemployment, male-female relations, and a desire to leave Tunisia for the European Eldorado.

Through the study of rap we intend to highlight the logics that manages some peripheral geographical areas in Tunisia.

Keywords: Tunisia, rap, peripheral areas.

BACK

POSTER

SOCIAL INFRASTRUCTURAL DEVELOPMENT IN INDIA, 1971-2011: A DISTRICT LEVEL ANALYSIS

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The availability of adequate infrastructure is imperative for the overall socio-economic and regional development of any country. Social infrastructure is most important component of infrastructure and usually refers to those facilities which improve the quality of human life. The important social infrastructures are the facilities of education, medical, banking and housing. The role of social infrastructure in accelerating the economic growth and enhancing public welfare is more pronounced in developing economies like India. The present paper purports to investigate the regional disparities in the level of social infrastructural development in India from 1971 to 2011. The study is based on secondary data gathered from Directorate of Census Operations, Planning Department, Directorate of Economics and Statistics of each state/UT of India for three reference periods i.e. 1971, 1991 and 2011. The level of social infrastructural development has been examined with reference to three dimensions namely education, health and finance infrastructure covering 27 indicators. The spatial variations in social infrastructural development have been portrayed and discussed with the help of composite index and choropleth technique. The study reveals the remarkable regional or inter-district variations in development of social infrastructural facilities. The study also finds out that these facilities are required more in densely populated northern plains and peninsular region of the country. The southern part and west coastal plain of country covering almost entire Kerala and Maharashtra, southwest Karnataka, central Gujarat and areas around National capital territory of Delhi and Himalayan region are well endowed with social infrastructural facilities.

Keywords: Social Infrastructure, Composite index, Spatial Variations, India.

BACK

OBSTACLES TO URBAN RENEWAL IN SHANTYTOWNS: A CASE OF "VILLA 21-24" IN BUENOS AIRES

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The fragmentation of the urban space is one of the deepest problematic on the most of the contemporary cities. The principal causes of this problem, particularly in South America, has signed by the historically existing segregation levels in certain areas of each city.

On face of this problem, an urban renewal process conducts one of the most successful strategies for reducing the levels of segregation in these areas of the city. However, these processes can handle different obstacles that impossibilities the full realization of their objectives.

This study focuses on how the territorial construction and the existing social conflicts can determinate the composition of an urban renewal process in these fragmented areas of the city.

For illustrate this problem, we are going to use the example of the urban renewal plans carried on the shantytown "Villa 21-24" on the south of the Autonomous City of Buenos Aires, one of the most segregated areas as result of an evident lack of infrastructure and services.

The territorial construction on the Villa 21-24 has signed by the proliferation of illegal activities like the existence of an illegal real estate market, drug dealers, and others, which their existence can only exist on an environment of illegality. That is the reason that carries on a process of urban renewal in this area could determinate the end of the end or reduction of these activities.

A result of an exploratory research on the area, which employed questionnaires and interviews on the local community on the Villa 21-24, we conclude that the first step to solve this problem is reaching levels of governability that allow carry out an urban renewal plan that includes the most part of the inhabitants of the Villa 21-24.

By this way, an active participation of the population on the design of future urban renewal projects on the area, can guarantee the support to this kind of strategies, and be the first step to reduce the levels of illegality and segregation on the area.

The objective of this research is a guideline to deal with the contradiction between the urban renewal policies and the territorial construction on the city.

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C16.38 Water Sustainability

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BACK

TEMPORAL VARIABILITY OF RIVER INFLOW INTO LAKE BAIKAL

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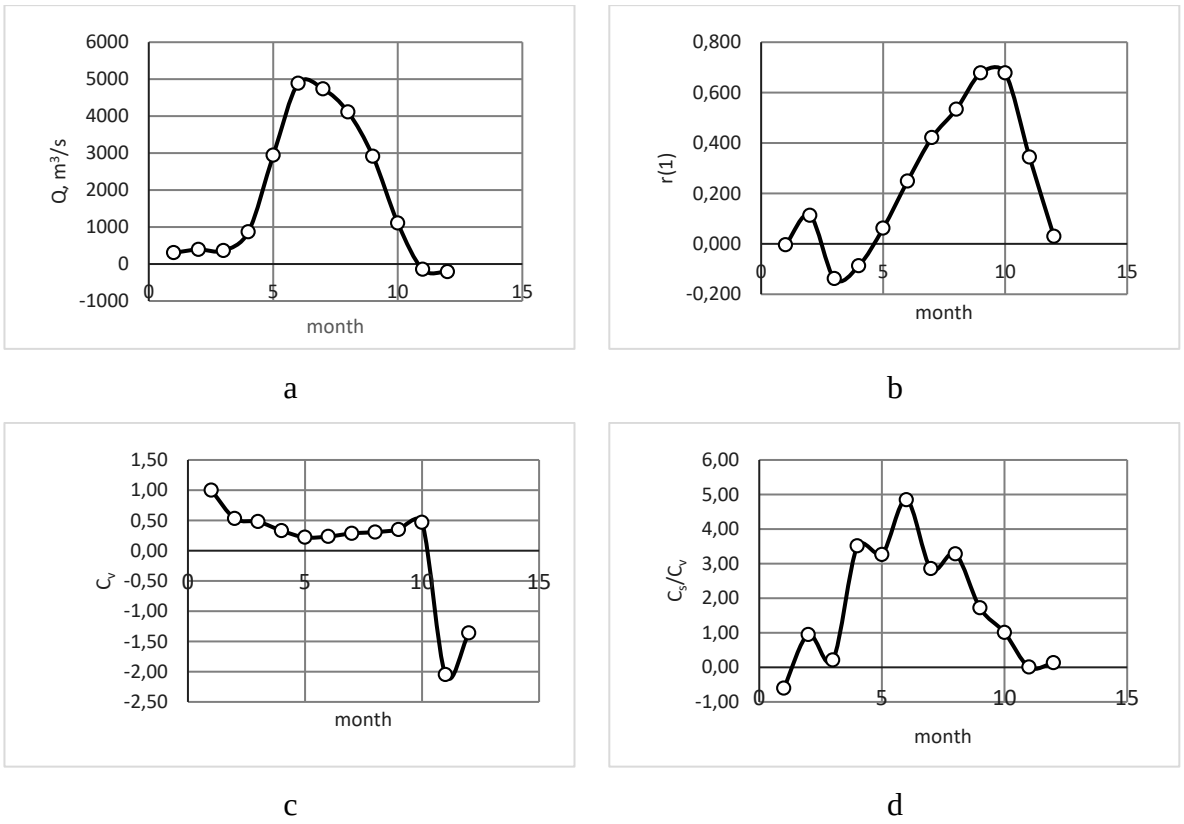
The problem of decrease in Lake Baikal water level arose in connection with the need to take into account the conflicting demands of water users when developing the water management plan for the Irkutsk reservoir (Lake Baikal) in low water years. River inflow is the main limiting factor in assessing the reliability of water consumption and energy supply in the region.

Simulation of synthetic series of inflows to the lake on the base of stochastic models of runoff reproducing regional features of the formation of the long low flow periods in the basin is the most important stage of the scientific justification of optimal water use. In the report, based on a statistical analysis of refined data on the monthly averages of the inflow to the reservoir of the Irkutsk HPP (Lake Baikal), an assessment of low-water periods is given; the features of the annual and seasonal variability of the inflow to the lake are discussed. A stochastic model is proposed to describe the long-term and seasonal fluctuations in the inflow to Lake Baikal.

The regularities of long-term fluctuations of the inflow into Lake Baikal

The investigated time series of the total inflow to Baikal (1900-2017) has a marked variability and irregularities against the backdrop of many years of cyclicity. The total annual inflow is characterized by an average value of 1856 m^3/s, a small coefficient of variation (0.2), a noticeable asymmetry with the ratio of the coefficients of asymmetry and variation 3.4, and the first-order autocorrelation coefficient $r(1) = 0.23$. The seasonal variations of the characteristics of the inflow is shown in Fig. 1a-d.

The autocorrelation functions of the flow sequences r (1) vary with the season. The period from October to March is characterized by a sharp decrease in the closeness of the correlation of monthly inflow values (Fig. 1b). The coefficient of variation C_v is uniform in the summer months, and varies greatly in the autumn-winter period, taking the value from -2 to 1 (Fig. 1c). Asymmetry C_s/C_v is characterized by a considerable range of variation with the highest value of 4.9 in June.



a b c d

Fig. 1. Intra-annual changes in the parameters of distribution of mean monthly inflow to Lake Baikal (a – mean, b – coefficient of autocorrelation $r(1)$, c – coefficient of variability C_v, d – coefficient of asymmetry C_s/C_v)

When setting scenarios for the development of a water management system, especially in conditions of extreme low water availability, such characteristic of a random process as excursions below threshold levels is important. Threshold levels are chosen as quantiles of 1-D distributions. Table 3 shows the characteristics of excursions, determined in the observed time series of inflow to Lake Baikal. Excursions characteristics (such as frequency and duration of events) are calculated for different threshold levels with cumulative probability 50, 75, 90, 95 and 99%.

Table 1. Characteristics of excursions in the observed time series of inflow into Lake Baikal

№	P,%	Q, m^3/s	The number of excursions	Average duration of excursions, years	Average volume of runoff during excursion, km^3
1	50%	1813	21	2,8	139,6
2	75%	1587	17	1,7	76,0

3	90%	1416	11	1,5	60,3
4	95%	1332	9	1,1	43,7
5	99%	1184	3	1,0	35,2

Probability distribution of monthly inflow values to the Lake Baikal

Information on the total inflow to Baikal, losses on evaporation, and the values of underground water exchange are characterized by significant errors because of only water levels and runoff from the lake are reliably measured. Inflow and evaporation are estimated in total, by the reverse way, proceeding from the available information on the increment of the level for a given calculated time interval and the outflow of water from the lake during this interval. This way takes into account the underground runoff, possible changes in the shape of the lake bottom as a result of tectonic movements, and all other factors and discrepancies in the water balance. As a result, the inflow to Baikal in the winter months, when the expenditure part of water balance account prevails over the income due to loss of ice formation and evaporation, the inflow values become negative. It creates difficulties in stochastic modeling. Flow values cannot take values less than zero, so flow oscillations are used to be described by distributions for essentially positive random variables (gamma distribution, Pearson distributions, Kritskii-Menkel distributions, etc.). The three-parameter distribution of Kritskii-Menkel (except of some discrepancies at the ends of the distribution) is generally acceptable for the values of the total annual inflow to Baikal, which are positive (Bolgov et al. 2017). But in our case for the series of average monthly inflow values, a non-traditional task for hydrology arises, namely the selection of an analytical distribution curve $f(x)$ for $x \in (-\infty; +\infty)$.

The fitting empirical and theoretical security curves is important question of hydrology. In our country, truncated and composite distribution curves are used for inhomogeneous series (Rozhdestvensky 1974). Also, the selection of curves for such sequences can be performed using the conditional probability fitting procedure proposed by Haan (Haan 1977). Mixed models are known for series with "zero" values, in which the "zero" and "nonzero" parts of the series of observations are modeled separately, and then combined using the total probability theorem (Bulu 1997). In this paper, the Pearson distribution type IV for a stochastic description of the long-term fluctuations of the monthly inflow to the lake Baikal is proposed to use.

The Pearson curve of type IV is quite universal because the domain of the function definition is the entire numerical axis $x \in (-\infty; +\infty)$, and it is described by the equation (Kendall and Stuart 1966):

$$y = y_0\left(1+\frac{x^2}{a^2}\right)^{-m} e^{-\nu \arctan\frac{x}{a}}$$

where $a = \frac{\sigma}{4}\sqrt{16(s-1)-\beta_1(s-2)^2}$

$m = \frac{s+2}{2}$, $\nu = \frac{s(s-2)\sqrt{\beta_1}}{\sqrt{16(s-1)-\beta(s-2)^2}}$, $s = -r$

The sign of ν is chosen opposite to the sign of μ_3. The initial ordinate $y_0 = 1/[a^* F(s,\nu)]$ is a tabulated function. The origin is taken at the point $m_x + \frac{\nu a}{s}$ (here m_x is the mathematical expectation of the random variable *X*). The Pearson curve of type IV is asymmetric; the mode of this distribution $M = m_x - \frac{\mu_3(s-2)}{2\mu_2(s+2)}$.

Using the Pearson distribution of type IV, the distributions of the average annual and mean monthly inflow into Baikal Lake for the period 1900-2017 are described. The calculated distribution parameters are presented in Tables 2, 3. An example of the fitting of analytical curves to empirical data is shown in Fig. 2.

Table 2. Statistical characteristics of distribution of average annual inflow

	Series length, years	Q_{av}, m^3/s	C_v	C_s/C_v	Cumulative probability, P%					$r(1)$
					50	75	90	95	99	
Inflow into Baikal	118	1856	0,20	3,4	1813	1587	1416	1332	1184	0,26

Table 3. Statistical characteristics of distributions of the average monthly inflow

Month	January	February	March	April	May	June	July	August	September	October	November	December
Mean, m^3/s	304	393	360	869	2944	4888	4736	4111	2911	1106	-143,2	-208,5
C_v	0,99	0,532	0,48	0,33	0,22	0,23	0,29	0,31	0,35	0,47	-2,05	-1,4
C_s/C_v	-0,59	0,93	0,21	3,5	3,3	4,9	2,8	3,3	1,7	1,0	0	0,13

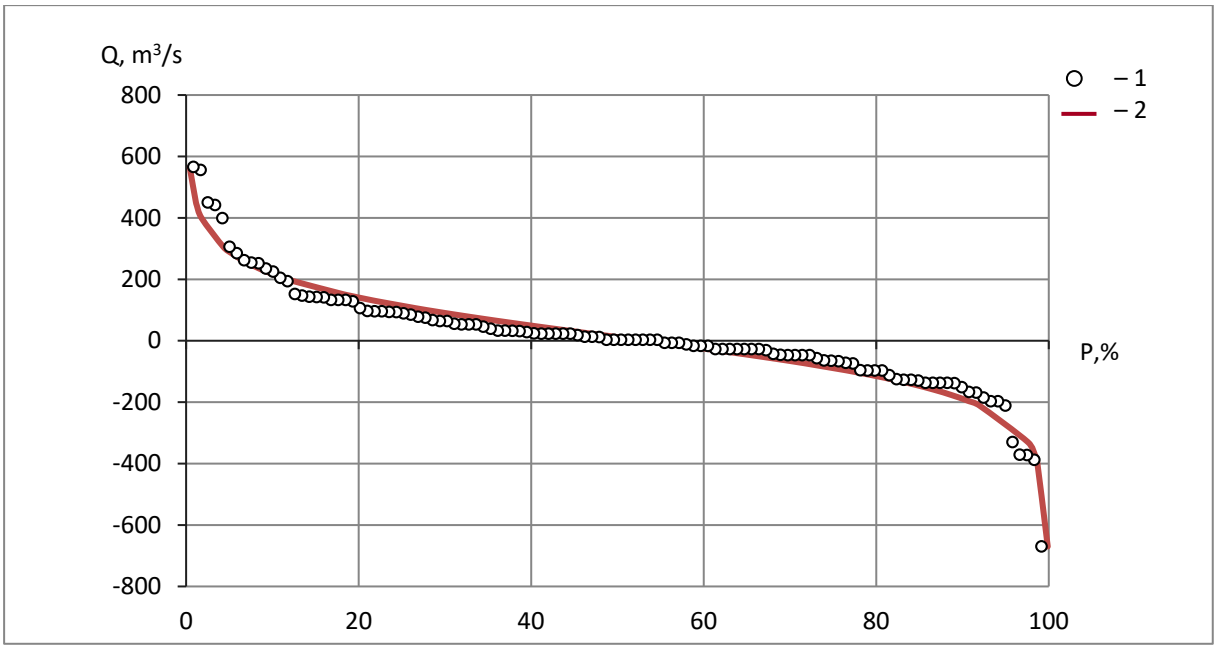


Fig. 2. Distribution curves of the inflow into Lake Baikal for March
(1 – empirical distribution, 2 – Pearson distribution type IV)

On the base of Pearson distribution type IV, we can propose a stochastic model of seasonal fluctuations of inflow into the lake, intended for simulation of synthetic time series with given distribution parameters and with a time step of one month. Synthetic time series of long duration (10,000 years) obtained with using such a model are necessary for use in optimization calculations when choosing a management strategy for the Irkutsk Reservoir (Lake Baikal).

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Keywords: Lake Baikal, inflow, stochastic modeling, Pearson IV distribution.

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BACK

MAPPING OF AREAS SUSCEPTIBLE TO FLOOD BASED ON HYDROLOGICAL AND HYDRODYNAMIC MODELLING INTEGRATED TO GEOGRAPHIC INFORMATION SYSTEMS

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Abstract

This paper presents a methodology used to model areas susceptible to flood to support the forecasting and decision making in disaster situations. The analysis was carried on the São Lourenço do Sul municipality, located in the South part of RS, Brazil. The execution of this proposal was organized into two main phases. The first one consists in building a Geographical Information System database and in studying and systematizing relevant variables to the modelling of a pilot area. The second one is related to the application of hydrological and hydrodynamic models for future scenario generation, in the form of flood patches, to analyze the impacts of a intense rainfall event over the municipality in hand. To do so, ArcGIS 10.4, HEC-HMS, and HEC-RAS software were used. Preliminary results comprise cartographic representations of the susceptibility to flood in the area of interest, according to the parameters of the implemented models.

Keywords: Hydrological modelling, Flood, Geographic Information Systems, HEC-HMS, HEC-RAS.

Introduction

In the State of Rio Grande do Sul (RS), southern Brazil, climate conditions in the last decades have been responsible for the significant increase in the number of extreme events such

as windstorms, hail, landslides, and floods. The official records of recent years show a significant increase in these events in the coastal municipalities of the state and, consequently, of the social, economic and environmental damages (Defesa Civil RS 2014).

The municipality of São Lourenço do Sul located in the coastal zone, underwent a concentrated rainfall episode between March 9 and 10, 2011, which generated a flash flood, covering more than half of its area, with water levels at 2.7 meters on average. Approximately 20,000 people were affected, 300 families were isolated and about 500 people were exposed to the harsh weather while they waited for rescue. Bridges were submerged or destroyed, isolating the southern part of the state (Sausen et al. 2012).

The source of these situations has been attributed to recurrent extreme climate events. However, anthropic factors, such as the land cover and use patterns, extensive waterproofing of the urban areas, non-compliance to the Brazilian Forest Code legislation regarding the occupation of Permanent Preservation Areas in urban and rural areas are preponderant factors in the magnification of the damages caused by the hydrometeorological phenomena. On the other hand, the handling of disasters in Brazil has evolved beyond post-event actions (rescue, victim assistance and reconstruction) towards risk management and disaster management. This new system is described in the National Policy on Civil Protection and Defense (PNDC, Law 12.608, April 10, 2012), and provides for the following actions: prevention, mitigation, preparation, response and recovery (Brazil 2012; CEPED 2016). As prevention actions, the PNDC emphasizes the need to identify and map risk areas and to conduct studies to identify threats, susceptibilities and vulnerabilities.

Susceptibility is the higher or lesser predisposition of occurrence of a particular extreme event in a specific area. In the case of floods, susceptibility is derived from a set of factors that condition its occurrence, such as land cover and use, types of soil and slope (Bressani & Costa, 2013; CEPED 2016). Currently, several methods are used for the generation of flood susceptibility models, among which the ones that use hydrological and hydraulic simulation integrated to Geographic Information Systems (GIS) stand out (Cabral 2016; Decina and Brandão 2016; Correia et al. 2015; Suriya and Mudgal 2012; Knebl et al. 2005). In general, such studies define the methodological strategy considering the physical parameters of the study region, the data availability and the choice of a set of specific modeling techniques within the available instruments.

Considering all the above, the purpose of this paper is to present the model developed for the mapping of areas susceptible to floods, based on the integration of hydrological and hydrodynamic modeling software and Geographic Information Systems. The model is applied

in the São Lourenço River watershed, in which most of the urban area of São Lourenço do Sul is located, in the state of Rio Grande do Sul (Figure 1). It is a watershed with an area of approximately 197 km^2, and elevations ranging between 0 and 240 meters.

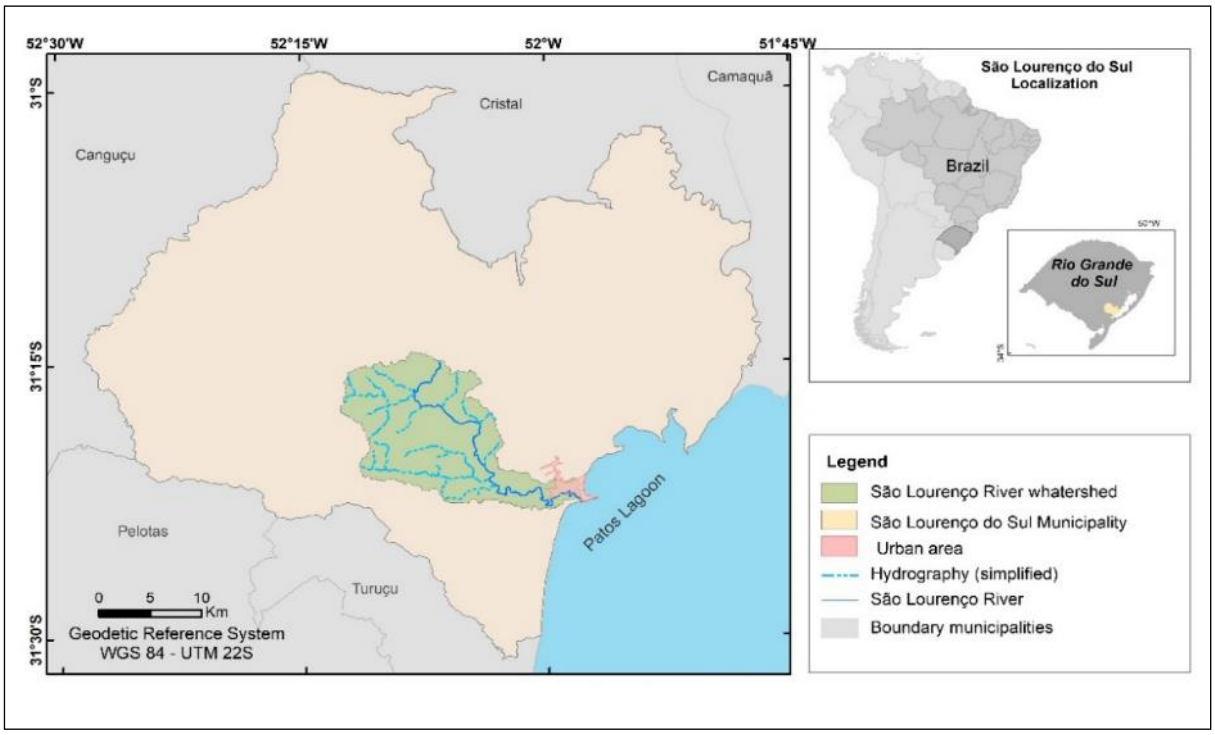

Fig. 1. Location and delimitation of the São Lourenço do Sul River watershed, RS.

Methodology

The first step of the methodology is based on the review, organization and storage of geographic data available for the municipality of São Lourenço do Sul, from public sources provided by official authorities such as the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE), Geological Survey of Brazil (Companhia de Pesquisa de Recursos Minerais - CPRM), National Water Agency (Agência Nacional das Águas - ANA), State Foundation for Environmental Protection Henrique Luiz Roessler (Fundação Estadual de Proteção Ambiental Henrique Luiz Roessler - FEPAM-RS), among others. The purpose of this database was to characterize the municipality, delimit the watershed of interest and obtain the physical parameters needed for the following steps. The database was prepared in ArcGIS 10.4 GIS software and consists of images from the RapideEye satellite, thematic geology and geomorphology maps, digital elevation model (DEM), digital terrain model (DTM), slope, pedology, in addition to the tables from with IBGE census sections. Other information was derived from the original data, such as the map of land cover and use, slope and hydrography.

The second step of the methodology consists in hydrological and hydrodynamics modeling, in the HEC-HMS and HEC-RAS software packages, integrated with ArcGIS 10.4, with the use of the HEC-GeoRAS extension. To this end, the São Lourenço River watershed was divided into four sub-basins in order to obtain more precise results due to the limitations regarding the extent of the area imposed by some of the methods to be applied. As a result, the topological model of the set of sub-basins of interest was created, to carry on the data input and output and subsequent flow transport calculation.

Initially, the hydrological model developed by the Soil Conservation Service (SCS) was used, which estimates the effective rainfall and distribution of surface runoff (Geetha et al, 2008). This model uses the surface runoff Curve Number (CN), as the main parameter. The CN value is obtained from the relationship between soil types, land cover and land use, and the previous moisture conditions (hydrological groups) present in the region of interest. Based on the work of Sartori et al. (2005), the following hydrological groups were attributed to the soil types of the study area: B (red-yellow argisol), C (fluvic neosol) and D (haplic planosol). The hydrological groups were then crossed with five classes of land cover and use (field and pasture, forest, exposed soil, agricultural crop and urban area), resulting in the CN values.

For the calculation of the maximum retention potential value, the equation that relates this parameter to the CN ($S = 25{,}400/CN - 254$) was used. Thus, we first calculated the time of concentration of the sub-basins, using the Kirpich equation (NRCS 2010), and then selected an adequate rainfall duration (synthetic storm), in order to obtain more accurate calculations. Afterwards, the following physical parameters were obtained from the sub-basins: thalweg length, elevation variation in the main channel, mean CN, area, time of concentration and lag time, as shown in Table 1.

Table 1. Physical parameters obtained from the sub-basins of the São Lourenço River

Sub-basin	**Thalweg length (km)**	**Elevation variation (m)**	**Mean CN**	**Area (km^2)**	**Time of concentration (min)**	**Lag time**
1	16.60	12	83.30	28.86	561.85	337.11
2	12.80	87	69.66	55.07	194.08	116.45
3	12.70	76	72.47	38.59	202.61	121.56
4	12.50	98	61.56	75.25	180.38	108.23

The flow measurement (flood propagation) was based on the Muskingum-Cunge method, which requires flow input data, topography and the Manning roughness coefficients.

The Manning coefficients were obtained in Chow (2009), with the values of 0.035 in the channel bed and 0.045 in the flood plain.

Based on these data, we calculated and simulated the peak flow rates of a synthetic storm for different return periods (RP), expressed in years. The flow rates can be calculated at any point in the sub-basins, however, we decided to apply the modeling on a point on the São Lourenço River located at the entrance of the urban area, extending to the Patos Lagoon mouth. A synthetic storm is a design rainfall event, associated with an RP, or a probability to which this event can be matched or surpassed in any one year. The RP is a variable used in hydrology to evaluate extreme events, such as heavy rains, and gives the maximum rain gauge height, determining the specific characteristics of a flood, such as its duration, height, area covered and speed (Collischonn and Tassi 2008).

To estimate the maximum flow, the duration of the synthetic storm must be defined so that the entire basin contributes at the same time to the flow reaching the selected point. Therefore, it should be considered that the rain duration is equal to or greater than the longest time of concentration of the delimited sub-basins. The synthetic storm is usually obtained from the curves that relate average intensity, duration and frequency (IDF curves) (Paola et al. 2014). The IDF curves are generated from the statistical analysis of the most intense rains measured in rain gauges, or from disaggregated rain gauge data for durations shorter than one day. However, the IDF curves for the municipality of São Lourenço do Sul, calculated for the return periods of 2, 5, 10, 15, 20, 25, 50 and 100 years, were generated using the IDF Equation coefficients of the region of interest, proposed by Sampaio (2011).

For the temporal distribution of rainfall, a *Specified Hyetograph* was adopted, in which rains were spatialized in time, at 10-minute intervals, in incremental millimeter units, and their intensities were distributed according to Huff distributions (1990). Because the longest lag time obtained was 337.11 minutes, that is, less than six hours, we chose to select Huff's first quartile distribution to spatialize the rainfall. Among the defined RP, 10, 25 and 50 years were selected, the latter being the most extreme event. In this step, HEC-HMS was populated with the data presented in Table 1 and from the synthetic storm. As a result of the hydrological model, the following maximum flows were obtained for the selected point in the São Lourenço River watershed, with their respective RP: 10 years RP = 206 m^3/s; 25 years RP = 318.4 m^3/s; 50 years RP = 345.6 m^3/s.

For the hydraulic simulation of flood in the study area, the HEC-RAS program was used, which uses as input data the Manning's Roughness Coefficients, the maximum flows obtained in the hydrological model, and hydraulic parameters of the river (geometry: drainage,

cross sections, channel boundaries, floodplain). These parameters were previously generated in ArcGIS, with the HEC-GeoRAS extension, from the vectorization on images from the RapidEye satellite, supported in MDT and the detailing of the *GoogleEarth* software images. Some of the delimited cross sections had bathymetry data available, so these sections were manually edited in order to improve the data.

After this stage, the channel geometry, the Manning Coefficients and the flow data obtained by the hydrological model were input into *HEC-RAS*. Thus, the hydrodynamic modeling is implemented for return periods of 10, 25 and 50 years, resulting in the simulation of flood "spots". These spots represent the spatial distribution of the flood, for the synthetic storms with the specified RPs.

Results

In order to better present the data and subsequently process and integrate it with other information, flood spots produced in the *HEC-RAS* were exported to a *raster* format compatible with *ArcGIS 10.4*. The simulated flood areas represent the limit (height) that the flood reaches in the RP of 10, 25 and 50 years, that is, the impacts that an intense rain will cause in the particular area. The extent of these surfaces is related to the terrain elevations obtained in the DTM; therefore, for better understanding, the extent of the water was converted to a range of shades.

Figure 2 shows the spatialization of the simulated flood over a GoogleEarth image, with an RP of 50 years. The darker blue shades represent the highest flood levels, consequently, the first areas to be hit, that is, of higher susceptibility to the phenomenon. The spot for this most extreme case (50 years) resulted in a flood area of 3.84 km^2; for 25 years, 1.64 km^2 and for 10 years, 1.33 km^2.

In general, the intersection of the area susceptible to flooding with the map of land cover and land use revealed that the areas south of the river are made up, for the most part, of rice crops. However, the most worrisome situation concerns the areas located to the north, which concentrate urban use and are consequently more vulnerable due to demographic and economic aspects. We intend to deepen the characterization of the susceptible areas by crossing it with the statistical data on the demographic, social and economic aspects, made available by IBGE. In doing so, the vulnerability of the areas subject to flooding can also be mapped.

In addition, the validation of the used methodology used is in progress, in order to verify the reach of the simulated flood with data that has been collected in the field with GNSS receivers in a detailed study (Sausen et al. 2012) on a flash flood in 2011.

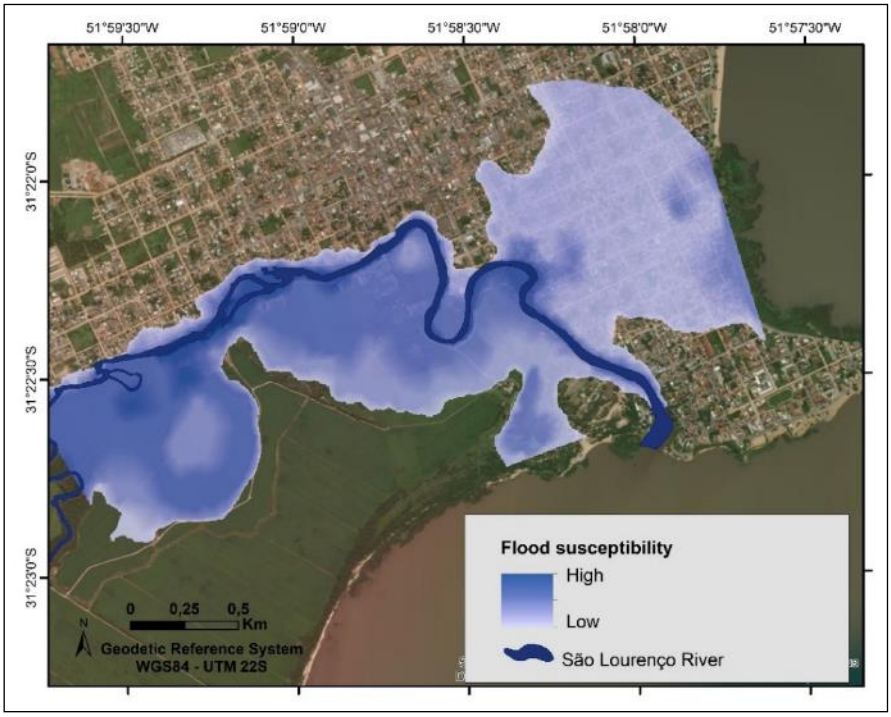

Fig. 2. Susceptibility to the simulated flood for a synthetic storm with a 50-year return period.

Conclusions

In general, it can be concluded that the ideal modeling of areas subject to flooding is less complex when hydrological data from past extreme events, such as rainfall, elevations and time of flooding are available, among others. On the other hand, the obtained results allow concluding that the proposed methodology is suitable for application in any other watershed for which no flow data is available. The integration of hydrological/hydrodynamic modeling software, using the HEC-GeoRAS extension with the ArcGIS GIS, proved to be of great value, allowing the essentially numerical data from the former to be spatialized and subsequently evaluated with other variables of interest.

It was concluded from the analyzes of the generated parameters and the simulated flood surfaces, that the São Lourenço River cannot withstand the intense precipitations associated with the return periods of 10, 25 and 50 years. Therefore, it is expected that the prepared model, the data produced and the information to be still incorporated into the study, could serve as support for preventive measures, in case of extreme events.

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BACK

SURFACE RUNOFF AND INFILTRATION OF MELT WATER ON AGRICULTURAL FIELDS IN FOREST-STEPPE AND STEPPE ZONES OF THE RUSSIAN PLAIN

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In recent years, there have been significant changes, both climatic and in the structure of agricultural land. The estimates of their hydrological role significantly vary among authors, mainly because of the short duration of the considered series of observations. Therefore, results of the long-term studies of spring water balance elements on plowlands should be analyzed with consideration for recent data.

Results of observations performed at the experimental stations of the Federal scientific center of agroecology RAS – Novosil Station (gray forest soils, Greyzemic Phaeozems), Povolzhskaya Station (ordinary chernozems, Haplic Chernozems (Pachic)), and Volgograd Station (light chestnut soils, Eutric Cambisols (Pro-tocalcic)) from the late 1950s to 2016 were analyzed. The experimental data include two periods: before the 1981 and after the 1981 (conditional current period), which differ in climatic conditions (Barabanov 2017; Barabanov et al. 2018). Results of observations performed at the meteorological stations located near the water-balance stations (Ponyri, Sernovodsk, and Volgograd, respectively) during the same periods were used as supplementary information for analysis.

The experimental procedure is reduced to the comparison of water balance elements from two or more runoff plots located under almost similar conditions except for one studied parameter, e.g., agricultural background or ameliorative afforestation, to reveal its water-balance and erosion-preventive role. In our case, water balance elements of lands on the most contrasting agrohydrological positions were considered: fall-plowed soil (loose plowland) and soil compacted to the spring (winter crops, stubble, perennial grasses). In some years, the density of soil under perennial grasses can be lower than that of soil under winter crops and stubble, but it is significantly higher than the density of fall-plowed soil. From our data, the density of the plow layer of fall-plowed light chestnut soils varies within the range of 1.05–1.10 g/cm^3, and that of the soils under perennial grasses is 1.18–1.28 g/cm^3.

At the Novosil station studies are performed on gray forest soils in Orel region. The data generalized for a long period showed that the snowmelt runoff on loose plowland (soil moldboard-plowed in fall) was very high during 3 years, high during 5 years, moderate during 14 years, low during 5 years, and very low during 4 years; no runoff was observed during the resting 27 years. On the plowland more compacted than the fall-plowed land (by 12–15%), no surface runoff was observed during 10 years within this period. In the other years, runoff varied in intensity. The mean value of surface runoff from the fall-plowed soil was 20 mm; the runoff coefficient was 0.20, and the water balance input was 96 mm. These values on the compacted plowland were higher than on the fall-plowed land; the corresponding values were 29 mm, 0.29, and 104 mm, respectively. The runoff from the compacted plowland was higher than from the fall-plowed land by only 9 mm (in 1.45 times). The hydrological role of fall-plowed soil is significantly lower than in the steppe zone.

The surface runoff significantly varies among years, and a pronounced tendency of its steady decrease is observed, especially in the last time.

As follows from the analysis of runoff probability curves, the runoff of 20% likelihood is 39, and the runoff of 70% likelihood is about 1 mm on the fall-plowed land. On the compacted plowland, the runoffs of the same likelihoods are 53 and 6 mm, respectively. Thus, the compacted plowland favors a small increase in the snowmelt runoff compared to the fall-plowed land. The difference in the infiltration of water into the soil is also low: only 2 mm on the average. However, it increases to almost 10 mm during the entire cold season, including the spring flood.

Studies at the Povolzhskaya station in the Samara region on ordinary chernozems show that the values of surface runoff of melt water and other elements of the water balance are highly variable. They show that the snowmelt runoff and other components of water balance are characterized by high variability. Within the 58 years of observations, no runoff from fall-plowed soils was observed for 33 years (57%), a very low runoff was observed for 7 years, and a high runoff was observed for only 2 years. On the compacted plow-land, no surface runoff was observed during 12 out of 51 years of observations (24%). An extremely high runoff was noted only for one year, very high runoff for 4 years, and high runoff for 17 years. The effect of fall plowing on the hydrological regime of land is obvious compared to the compacted lands. The runoff from the fall-plowed soil was 7 mm on the average for the period of observations, and its values on lands with compacted soils were higher by almost 5 times. The fall plowing of soil increased the mean value of water infiltration to 113 mm, which is higher than on the compacted plowland by 15%.

It is established that the surface runoff is formed almost annually on the compacted arable land (about 15% compared to the autumn-arable soil) and only every 4-5 years on the autumn-arable land (where its value is much lower). The difference in runoff increases significantly in high water years.

At the mean plowing depth less than 25 cm, each additional centimeter of depth corresponds to the additional uptake of 1.8–2.2 mm of snowmelt, and the deepening of the subsurface layer by 10–15 cm almost completely prevents runoff from the fall-plowed land. The creation of a thick subsurface horizon is one of the problems faced during the development of soil-protecting and water-saving technologies. On the other hand, methods are necessary for ensuring additional water uptake on lands with compacted soil surface, where the loss of snow water for surface runoff is high. This is a reserve for increasing their bioproductivity.

The dynamics of runoff on chernozems during the period under study tendency of decreasing runoff in the last decades is manifested, as is on gray forest soils.

The mean water infiltration during the spring flood was 113 mm on the fall-plowed land and significantly lower (by 17 mm) on lands with compacted surface. The difference reaches 27 mm for the entire cold season. For winter crops, using mainly spring-winter-autumn precipitation, this can lead to a significant loss of grain.

On light chestnut soils of Volgograd station surface water runoff is much lower than on ordinary chernozems and gray forests. It varies from 0 to 76 mm. In recent decades, there has been a sharp decline in runoff.

A relatively low runoff is observed on fall-plowed soils. The runoff layer from the fall-plowed soil was only 3 mm on the average for the period of observations and 15 mm (5 times higher) on lands with compacted soil. No runoff was observed on the fall-plowed land in 67% of years and significantly more rarely (in 32% of years) on the compacted plowland (by 12–16% compared to the fall-plowed soil). The highest runoff-regulating effect of fall plowing was noted in high-water springs, when the runoff of 1% probability (once every 100 years) could exceed 700 m on the compacted plowland and reached only 40 mm on the fall-plowed soil.

An appreciable difference in snowmelt infiltration is also observed on the lands under consideration. The snow cover on the fall-plowed land is lower than on the compacted plowland; therefore, the difference in spring infiltration in favor of fall-plowed land is relatively low: 5 mm on the average. However, its value for the entire cold season, including the spring flood, increases significantly, to 12 mm. This is related to the earlier appearance of thawed patches on the uneven surface of fall-plowed land during thaw periods, which favors the uptake of snow water. Additional amount of heat is required for the formation of thawed patches on

the compacted plowland because of the large snow amount and the presence of ice crust in some years. In addition, the water permeability of compacted plow-land is generally lower than that of fall-plowed land.

Comparison of surface runoff and water infiltration in different natural zones shows that the runoff-regulating effect of fall plowing increases from north to south and southeast. The runoff decreases under the effect of fall plowing in 1.4 times in the region of Novosil station, in 4.9 times at the Povolzhskaya station, and in 5 times at the Volgograd Station. However, in the absolute values (mm of runoff layer), the highest effect is observed on ordinary chernozems of the Povolzhskaya station (27 mm), while it decreases at the Volgograd Station (12 mm) and the Novosil station (9 mm). A similar tendency is observed for the infiltration of snowmelt during the spring (17, 5, and 2 mm) and the entire cold season (27, 12, and 9 mm, respectively). Thus, the highest water accumulation in the soil under fall plowing is observed for ordinary chernozems in the steppe zone.

This situation has been created during the entire period of observations, but it significantly changed in the last decades.

An abrupt (by tens of percent) reduction of surface runoff was a characteristic tendency in the last decades, which was most manifested on gray forests soils in forest-steppe: 30 mm on the fall-plowed land and 34 mm on the compacted plowland (i.e., 77 and 69%, respectively). On the other hand, the difference in runoff between the considered plowland types decreased universally.

Another tendency was the increase in water infiltration. Within the major part of the area under consideration, water infiltration increased significantly, by 22–41%, and decreased by 30–39% only on light chestnut soils because of the reduction of water reserve in snow and rainfall by 36–50% during the snowmelt period.

The increase in water infiltration during the entire cold season, including the spring flood, was lower. The increase was 13–16% on gray forest soils and 6–16% on ordinary chernozems; however, a slight decrease (by 0.5–6%) was noted on light chestnut soils, because of the reduction in precipitation during the cold season.

Of interest, including for the selection of optimal crop rotation patterns, was the decrease of differences in water infiltration between the considered plowland types on gray forest soils in spring, while the infiltration values slightly increased on fall-plowed light chestnut soils and especially on ordinary chernozems. The decrease of difference in water accumulation between the fall-plowed and compacted plow-lands was most manifested for the entire cold season, including the spring flood. For example, the difference in water infiltration between the fall-

plowed and compacted plowlands decreased during the last decades from 10 to 5 mm on gray forest soils and from 36 to 21 mm on ordinary chernozems; only on light chestnut soils, its value remained almost unchanged. However, the total water infiltration on fall-plowed soils remained higher than on compacted plowlands.

Climate is undoubtedly the main reason for changes in surface runoff and water infiltration. Significant changes in the climatic factors of water balance during the cold season, including the spring flood period, occurred throughout the area under consideration over more than three decades. According to the representative observations of meteorological stations closest to the analyzed runoff stations (Ponyri, Sernovodsk, Volgograd), the mean air temperature during the cold season rose by 1.2–1.4°C, which was accompanied by winter thaws, reduction in snow reserves before the beginning of flood, and decrease in depth of soil freezing. From the Novosil station data, the freezing depth decreased by almost 2 times (from 78 to 38 cm).

On the other hand, the amount of precipitation changed less decisively during the cold season: it decreased by 1.5–8% in the major part of the area considered but increased by 4.5% in the steppe Samara Transvolga region. An analogous situation was also observed for changes in precipitation participating in the formation of spring flood runoff (snow reserves before its beginning and precipitation during the flood period). The input item of water balance changed even more compared to the total precipitation during the entire cold season to the beginning of flood on the analyzed agricultural lands: during the current period, it decreased by 15% in the region of Novosil station and by 35–50% in the region of Volgograd station but increased to 30% in the Samara Transvolga region.

The decrease in precipitation during the cold season (by 18%) and in the input item of water balance to the beginning of spring flood mainly due to more frequent thaws in winter was one of the main reasons for the decrease in total water infiltration in droughty steppes with light chestnut soils.

The decrease in surface runoff in spring and the increase in water infiltration on the major part of the studied area because of climate changes had a largely positive effect on the growth conditions of agricultural crops. Along with the favorable climatic conditions of vegetation period, the removal of low-productive lands from agricultural use, and the improvement of agricultural technologies, this became one of the main reasons for the almost universal increase in crop yield.

The positive consequences of the reduction in surface runoff include the decrease in water erosion intensity on the slopes of river catchments and the amount of pollutants getting

to rivers with their watersheds, as well as the decrease in the peak spring flood and, hence, the probability of extremely high flood formation.

The infiltration of precipitation during the cold period supplements not only the soil water reserve, but also the water reserves in the underground water levels. Our calculations for the Oka River at the city of Belev showed that, in the last decades, the ground-water f low significantly increased (by 34–43%) due to the increased infiltration to water-bearing horizons in all phases of the water regime, including the spring flood, while the surface component of river runoff decreased abruptly, especially during the f lood period (by 24 mm or 36%).

The situation created in the last years has uncertain hydro- and agroecological consequences. Climate changes resulted in a significant reduction of surface runoff from agricultural fields, frequently down to zero, especially in the southern steppe regions, and finally in a decrease of annual water resources, at least in the Don basin. The total decrease in surface runoff is partially balanced by the reduction in the proportion of the fall-plowed area, which has lower runoff coefficients than the compacted plowland, in the total plowland area (in 1.6–1.9 times compared to the early 1990s).

In years with low flood levels, the hydroecological situation can be aggravated because of the necessary filling of water reservoirs to the target level, as well as the significantly lower volumes of spring snowmelt, which removes the accumulated plant residues and pollutants from the river network. Leaching of chernozems on slopes and an increase in the amount of pollutants arriving to groundwater are possible in some cases.

The current changes in surface runoff and water infiltration into the soil are mainly due to climate transformations. The multidirectional effect of recent climate changes on surface runoff and water infiltration results in an abrupt reduction of spring surface runoff (40–74% on the compacted plowland and 33–83% on the fall-plowed land) and an enhancement of water infiltration (24–32 and 22–41%, respectively, except for the droughty steppe with light chestnut soils, where it decreased).

These changes are related to the decrease in soil freezing depth in almost 2 times caused by the air temperature rise by 1.2–1.4°C in the cold season. On the other hand, the amount of precipitation changed less uniformly over the area: it decreased by 1.5–8% on the major part of the area but increased by 4.5% in the steppe Samara Transvolga region.

Climate changes in the structure of spring water balance on agricultural lands increase the nourishment of rivers by groundwater but reduce the surface component of river runoff in the flood period. The recent increase in the share of compacted plowland also has some balancing effect.

The situation created in the last years due to recent changes in the structure of spring water balance on agricultural fields has uncertain hydro- and agroecological consequences. Along with positive changes (creation of conditions for obtaining higher crop yields, decrease in erosion intensity on the slopes of river catchments, etc.), an aggravation of hydroecological situation is possible, including because of potential lack of spring runoff resources for filling water reservoirs to the target level.

Observations on runoff plots and small watersheds are one of the most efficient and reliable tools for assessing the effect of climate changes and economic activity on surface runoff and water infiltration.

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Keywords: gray forest soils (Greyzemic Phaeozems), light chestnut soils (Eutric Cambisols (Protocalcic)), ordinary chernozem (Haplic Chernozem (Pachic)), spring water balance of lowland, climate, changes, consequences.

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BACK

LONG-TERM CHANGES OF ICE FORMATION DATES ON THE RIVERS

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On the example of the series of observations on the rivers of the Votkinsk reservoir catchment long-term variation in the timing the appearance of ice formations were investigated. We proposed the methodological approach to the assessment of long-term variability of these characteristics, using both parametric and non-parametric statistical tests.

Keywords: river, appearance of ice formations long-term variation, parametric and non-parametric statistical tests.

The research of long-term climate variability is an important and actual problem, because climatic characteristics (air temperature, precipitation, etc.) largely determine the features of the hydrological regime of water bodies. One of the most sensitive elements of the hydrological regime to the air temperature changes is the ice formations dates in autumn and the destruction of ice in spring.

The aim of the article is analysis of the long-term variability in the ice formations dates on the rivers of the Votkinsk reservoir catchment.

To perform the research, a series of observations (1936-2012) was chosen at 12 gauge stations (g/s) located on different rivers of the Votkinsk reservoir catchment. Criteria for selection of the g/s: the long period of observations, the relative uniformity of distribution over the territory with coverage of the northern, middle and southern parts, mountainous and lowland areas, different catchment area, and the absence of factors affecting the ice formations dates (discharges of industrial enterprises, outflows of groundwater upstream).

Analysis of long-term series of observations showed the presence of cyclical fluctuations in the ice formations dates on the rivers, which are a consequence of changes in climatic characteristics and, primarily, air temperature. We identified century cycles, half-century cycles and on their background shorter cycles. The long-term fluctuations in the ice formations dates on the rivers with different characteristics, located in different parts of the

Votkinsk reservoir catchment, are synchronous and in-phase (Fig. 1). The values of linear trends in the series of observations are extremely small and statistically insignificant [4].

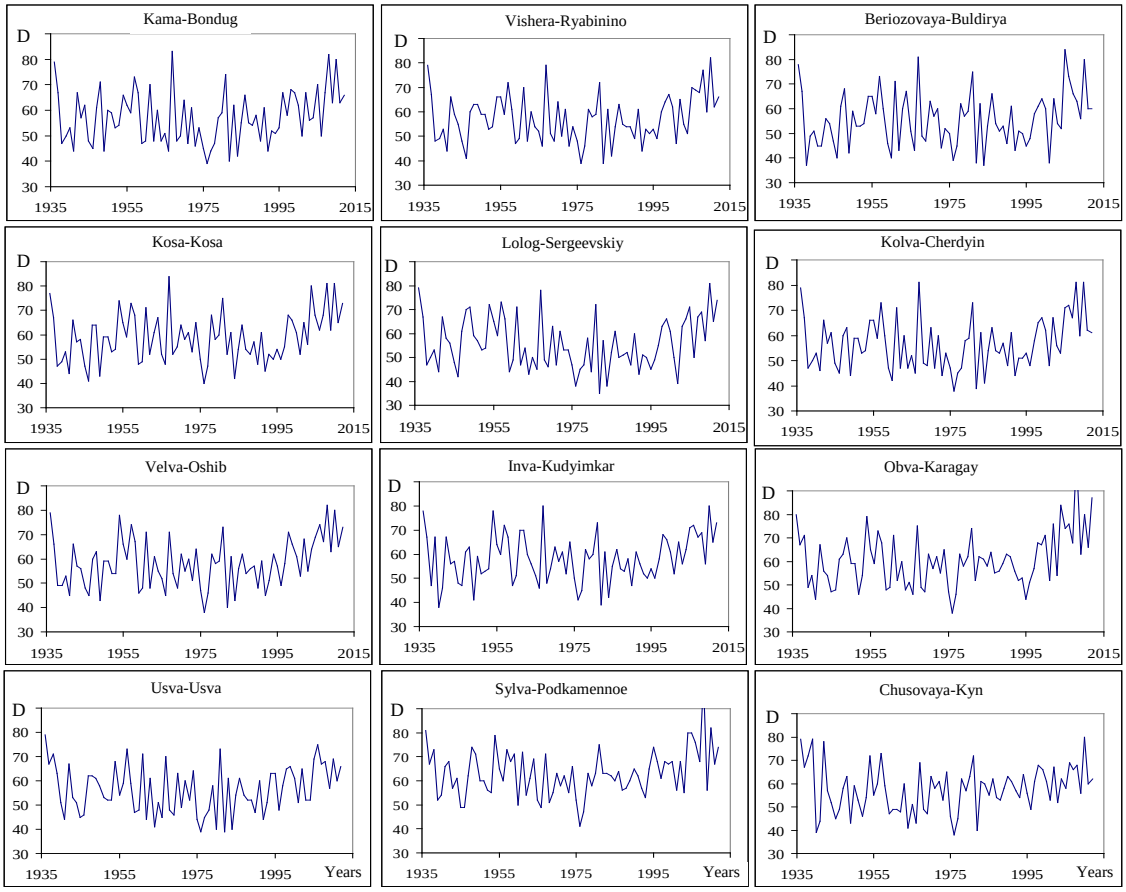

Fig. 1. Long-term variability in the ice formations dates D (in the numbers from September 1) on the rivers of the Votkinsk reservoir catchment

The main problem in analyzing the long-term fluctuations in the ice formations dates on the rivers is whether it is the occurring changes exclusively an accidental, or whether these changes are regular directed and statistically significant.

As the main assumption that was tested, the statement was used that no statistically significant changes in the ice formations dates occurred. Two possible alternatives:

the ice formations dates have changed;

the ice formations dates shifted to later dates (in connection with the warming of the climate that has been observed in recent decades).

To assess the significance of the changes in the characteristics studied, a methodological approach has been proposed [5], which includes:

• checking the randomness hypothesis for the existing series and their individual parts using the series, inversion and Spearman criteria;

• diagnostics of the absence of autocorrelations in time series using the Ljunga-Box test;

• Testing the series of observations using the Student, Fisher, Mann-Whitney, Kolmogorov-Smirnov and Wald-Wolfowitz homogeneity criteria (hereinafter, the criteria of homogeneity) in case of acceptance of the randomness hypothesis for the time series matched parts;

• search for the time of the disruption of the time series (the beginning of intra-row changes) using the randomness criteria by moving one of the boundaries of the observation period.

The calculations were performed using the Statistica 8.0 package, statistical tables and exact distributions of statistics of series criteria and inversions [1, 2, 3].

Conclusions:

1. As a result of the conducted studies on all gauge stations for the entire observation period, no statistically significant changes in the ice formations dates on the rivers have been identified.

2. For the periods of the last 38th (1975-2012 - the period of the so-called "climate change") and 30 years (1983-2012), there was an increase in the median of the ice formations dates in all g/s, with the exception of one, and a significant decrease in the actual significance level of the inversion criterion in all g/s, which may indicate statistically significant changes in the ice formations dates in these periods.

3. For several g/s, 20-year periods (1938 to 1959) were discovered, in which the appearance of autumn ice formations occurred in accordance with the same probabilistic-statistical regularities as in the last 20-year period.

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BACK

MODELING OF RAIN LOSSES ON THE CROWNS OF CONIFEROUS STANDS OF THE URALS

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Rainfall is the main element in the formation of rain floods on small rivers, and a large number of studies have been devoted to the study of the nature of the spatial-temporal distribution of precipitation in different climatic conditions. Forest - as an important link in the formation and redistribution of rainfall, forest canopies contribute both to the redistribution of precipitation in time, and intercept their significant part.

To date, there are various models of interception of precipitation by vegetation for the rainy seasons (Rakhmanov 1981; Chubatyi 1972; Bile J. 1980; Onuchin 2003). Most models do not take into account the individual rains, their intensity, and important taxation characteristics of stands, such as the mass of crowns, needles, leaf surface index, bonitet, etc.

The amount of water spent on wetting the vegetation cover can be determined from the model proposed by American hydrologists: Pp.p = (Pc + LAI * E * t) * (1-exp [(-x) / (Pc + LAI * E * t)]), where Pp.p. and Pc is the height of the retention layer and the maximum water retention by crowns of units. (mm), E is the evaporation rate from the vegetation cover calculated per unit area of this surface (mm / min), LAI is the ratio of the surface area of the vegetation cover to the area covered by vegetation (m^2 / sq. m), t is the duration of the rain (min), x is the amount of precipitation (mm). In this equation, we are interested in the least definite value of the maximum water retention.

In this paper, the authors put forward the hypothesis that moisture is retained on the sheet surface in a drop (due to surface tension forces). The physical nature of the retention of droplets on the surface of the needles is due to the equability of the forces of gravity and surface tension on the drops at the time of their separation (i.e., at the time they are set to their maximum size). It has been experimentally established that the radius of the droplets on the needles ranges from 0.25 to 0.55 mm, and the drop mass at the moment of detachment ranges from 25 to 30 mg. The number of drops is determined both by the orientation of the needles in the crowns, and by the area of the needles and by the number of elementary needles. For the territory of the

Urals, the area of the coniferous surface of Class I trees of bonitet, age 60-80 years, can reach 300 square meters. m, and the number of needles will vary from tens of thousands to 1-2 million.

The maximum water content can not be determined solely by the species composition of the stands of the stand, it is determined by the index of the leaf surface of specific species, depending on the inventory, age and forest class of the forest. Determination of LAI leaf surface indexes, specific areas of the SLA sheet surface, projection coverage areas was made on the basis of the model of the growth and productivity of plantations of the main forest-forming species, using the experimental data of the Institute of Forest Science of the Russian Academy of Sciences on the surface areas of forest plants, as well as space images, large-scale maps and materials forest taxation.

In the framework of the study, the authors carried out experimental work:

• Parallel observations of liquid sediments under tree crowns and in open areas;

• Artificial moistening of needles with an estimate of the maximum water retention value by an analytical weighing method;

• Calculation of areas, masses and volumes of the leaf surface of the analyzed samples of the branches of coniferous rocks in the Urals.

Experiments covered 5 coniferous species, typical for the forests of the Urals: spruce, fir, pine, pine, cedar. The method of production of experimental works was developed directly by the authors on the basis of the concepts of the physical essence of water retention by surfaces of a complex geometric shape.

The results of these studies are empirical dependences of the retention volume from phytomass and the area of the leaf surface; calculated sizes of the sizes of phytomass of coniferous species, sizes of drops on needles.

To assess the phytomass at the present stage, the authors used models of growth and productivity of plantations of the main forest-forming species of Northern Eurasia, developed by the Institute of Forestry of the Russian Academy of Sciences. To estimate the areas of the leaf surface, on the basis of information on the taxation stock, phytomass, and bonitet of forests, the models of the coniferous surface were used, developed by A.I. Utkin and others (Utkin 2008).

According to preliminary estimates of the authors, the amount of sedimentation by the crowns of coniferous species can reach significant values. So, for spruce stands of 1st class of bonitet and age of 60-80 years, the tree can hold 15-30 liters, pine stands of Class I, age 60-80 years - 7.5-15 liters, fir stands of II class of bonitet, age 60-80 years – 17.5-35 liters. In terms of wooded area, the value of interception by coniferous trees can reach 1.7-5.0 mm.

The magnitude of the interception of precipitation should be taken into account when developing models for the formation of a flood flow.

Keywords: rainfall; leaf area index; retention of precipitation on needles; calculations of rainwater runoff; initial rain loss.

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BACK

EXTREME HYDROLOGICAL EVENTS IN THE UPPER OB BASIN: CURRENT TRENDS AND FORECASTING

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Extreme hydrological events pose a significant threat to population and economy of the country. Peculiar hydrological regime determines the high probability of emergent situations rise in the Upper Ob basin caused by high water and floods (Puzanov et al. 2017). For example, in 2014, there were hydrological emergencies generated by extreme, hard to predict floods distinguished by rarely occurred water discharge (Vinokurov et al. 2014). These dangerous hydrological phenomena were induced by a combination of anomalous hydrometeorological conditions, i.e. positive temperature anomaly, which brought to snow and glaciers melting in the mountains as well as to the formation of anomalous by volume, area and duration of the rainfall zone in the Upper Ob basin.

Forecast of such catastrophic processes and study of their dynamics is an important task, the solution of which requires the application of various methods. IWEP SB RAS deals with the development of the following scientific approaches used for prediction of dangerous hydrological phenomena, i.e. the classical stochastic hydrological studies; the study of runoff formation in the basin; mathematical modeling of floods and high water waves; the development of microwave methods for remote space monitoring of precursors of hazardous hydrological events.

The conditions of flood formation are discussed by the example of a small mountain catchment area of Maima river (Katun tributary), where the water volume is formed mostly due to melting snow. The close relationship between the flood volume and the snowfall ratio is established (Galakhov 2015). Spatial differentiation of the main characteristics of a snow cover and the factors affecting the amount of snow accumulation in various geosystems (Chernykh et al. 2017) are considered.

The original software (Zinoviev et al. 2017) was created for calculations of flood waves and floods in the channel systems. Using this software as the base, we developed the computer

models for runoff calculations in the Upper Ob basin, for instance, for the description of floodplains inundation in sites with a complex channel morphometry. The use of mathematical modeling and the data on Ob water rise at gauging station Fominskoye located below town Biysk allowed us to forecast maximum water levels within cities Barnaul and Kamen-on-Ob in advance (lead time -up to 3-5 days).

The algorithm for remote evaluation of occurrence probability of hazardous hydrological phenomena on the basis of remote sensing of the underlying surface in visible, infrared and microwave ranges was developed; the area of flooded land and soil moisture are defined parameters (Romanov et al., 2017).

Keywords: floods, rivers, forecasts, Upper Ob, remote sensing.

BACK

MODERN PROBLEMS OF DEVELOPMENT OF THE TSIMLYANSK RESERVOIR AND THE LOWER DON

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The climate is cyclical, depending on the duration of warm and cold periods, in arid and wet years, the water balance of rivers, the productivity of crops, the reproduction of river and sea ichthyofauna, the migration routes of commercial fish of the Don and the Azov Sea are changing. Intra-century aridization determines the degradation of vegetation, soils, river flow, etc. The accuracy of weather forecasting and forthcoming climate changes depends on the completeness of the physiographic data and the duration of observations of the variability of the environment.

Tsimlyansk reservoir and the Lower Don are areas of conflict of interests of various sectors of the economy related to water use and water consumption, such as fishing, water transport, energy, potable water, agriculture and industry. Another natural consumer of water is the ecosystem of the Azov Sea, and first of all the Taganrog Gulf. However, this fact was never taken into account when distributing water resources among the above-mentioned users. At the same time, the main goal of the operation of the Lower Don system is to ensure sufficient volume and quality of water resources.

In recent decades there have been undesirable changes in the natural and climatic conditions. First of all, the amount of river flow in the Don basin is reduced. As a result, a complex of negative consequences for the ecosystem and the national economy arose, such dangerous hydrological and geographical phenomena as low flow period, extreme surges in the delta of the Don, saltification of the Taganrog Gulf (up to 2-8 ‰), oxygen deficiency, intensive propagation (bloom) of algae.

Separately, it is necessary to highlight the problems of the Tsimlyansk reservoir: coastal abrasion, siltation, shallowing, extreme algal bloom. Currently, the reservoir has a negative impact on the entire system of the Lower Don.

The processes taking place in the basin of the Lower Don are also directly affecting the Taganrog Gulf. The population faces eutrophication, the penetration of saline waters up to

Azov, the destruction of the banks, the siltation, deformation of the Don delta, problems with navigation, extreme wind-surges phenomena.

Keywords: Tsimlyansk reservoir, Lower Don, low-flow period, climate changing.

BACK

WATER PROTECTION ZONE OF LAKE BAIKAL

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The status of world heritage, the Water code of the Russian Federation, Law "On the protection of Lake Baikal" define a special legal regime for the Baikal natural territory and the rules of protection of lake Baikal. Water protection zone of the water body plays the most significant role in the protection of water resources in the structure of legal mechanisms and environmental standards. Within water protection zones, in accordance with article 65 of VC, is established "a special regime of implementation of economic and other activities, to prevent pollution, contamination, silting of these water bodies and depletion of their waters" (Water code... 2006).

For particularly valuable and unique water body of lake Baikal is expected to develop an individual project of water protection zone in accordance with the law "On protection of lake Baikal" (Federal... 1999). However, until 2015 at the lake Baykal has not been legally established water protection zone.

The adoption of water protection zone on the border of the Central ecological zone of the Baikal in 2015, combined limitations the use of natural resources of the two zones on the area more than 50 thousand km^2. This situation has created the need a revision of this decision and the development of science-based project of the water protection zone of lake Baikal. Design of water protection zone should be based on the natural conditions of the coastal area water body.

Landscape-hydrological concept of water protection zoning involves ensuring the optimal state of the ecosystem of the water body through realization of the natural potential of landscapes. The size and configuration of the water protection zone are defined natural processes of self-purification in plant communities and soil layers.

In accordance with landscape-hydrological principles, the water protection zone should include all areas from which runoff drains lake Baikal, includes the watersheds of the rivers of the first order; all flooding zones, as well as valley-floodplain and swamped massifs; dark

coniferous landscapes with high water protection properties; steep hillsides, vulnerable to extreme hydrological and geomorphological processes.

The main criteria for the water protection zone width are the conditions when all pollutants outside the established water protection zone are drained by the tributaries of the lake and do not enter directly into Lake Baikal, as well as the protection of groundwater from vertical penetration of pollutants

On the territories of settlements located on the coast of Lake Baikal, it is planned to develop individual projects of the sections of the lake's water protection zone in accordance with existing and prospective plans of construction and engineering and technical development of the territory (Antipov and Gagarinova 2006).

Keywords: water object, landscape-hydrological concept, natural conditions, pollutants, protection of water resources.

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BACK

TIME-SPACE WATER INTENSITY CHANGE REGULARITIES IN THE ECONOMY OF RUSSIA AND ITS REGIONS

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The main strategic goals for the development of the economy of Russia and its regions should be the improvement of the quality of life of the population, the balance of the social and economic activity of the territories, and the increase of its competitiveness in the domestic and foreign markets. Taking into account the important role of water resource provision of the country's economy, the Water Strategy of the Russian Federation was developed, which sets out the targets to be achieved in water use by 2020. In this document, the water resources as a component of the country's innovative development estimated by the integral indicator - the water-intensity of the gross domestic product (GDP), and for the region's characteristics - by the gross regional product (GRP). The indicator - the water intensity of GDP / GRP contains two parts: 1 - the amount of water resources in the region, the federal district or the Russian Federation as a whole, reflects the natural component of these territories; 2 - the value of GDP/GRP for the country as a whole and its regions, characterizes the state of their economy. It is determined in the Water Strategy of the Russian Federation that the water intensity of the country economy equal to an average amount of 2.4 m^3 / thousand rubles in 2007 is unacceptably high. The main task is to reduce it to 1.4 m^3 / thousand rubles till 2020.

The paper assesses the current state of water resources and their use in Russia and its regions. The dynamics of the water intensity of Russia and the sectors of the economy that determine its economy have been revealed. Estimates of the water intensity of economy of federal districts and constituent entities of the federation are obtained. Prospects of reducing the water intensity of the economy, diversification and development of the Russian economy are shown.

Keywords: water intensity, gross domestic product, gross regional product, water recourses.

BACK

EXTREME PRECIPITATION AND RAINFALL FLOODS IN THE BAIKAL REGION UNDER CLIMATE CHANGE

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Rainfall floods are the most dangerous events among all floods in the Baikal region. The long-term time series of monthly and daily precipitation, monthly, maxima rainfall runoff series during the period 1966-2015, daily (period 2001-2015) and extreme water levels on the river basins of Angara, upper Lena Rivers, and Lake Baikal were initial information. The regime of global atmospheric circulation is characterized by the predominance of the meridional southern circulation. The intensity of zonal air mass transfer is decreased during the study period, and the frequency of circulation blocking processes increases coinciding with the low-water period on the rivers of the Baikal region. There is an increase in the frequency of extreme precipitation. The changes in precipitation did not affect the flood runoff of the rivers of the Baikal region. The frequency of floods has decreased in recent years. The maximum number of rainfall floods events was observed at the gauge stations Iya-Tulun and Vitim-Bodaibo. The method of superimposed epochs was used to determine the time delay of the flooding after extreme precipitation for all cases of expedience of the floods beginning level (Hcr) for the period 2001-2015. The time lag between precipitation and flooding events varies from 2 to 7 days depending on a number of factors. The catchment area covered by precipitation and the intensity of precipitation affect the onset of flooding. The daily precipitation falling in the catchment of a small river can be used to analyse and forecast floods. The medium river basins require analysis of the five-day precipitation total observed (R5d) at weather stations. The same index identifies the conditions associated with rainfall floods. In the Baikal region floods usually occur after the accumulation of an extreme amount of precipitation in five days (at least 40-50% of the monthly rainfall norm) at most weather stations located in the catchment area. The response of the water level to the accumulated 5-day precipitation totals occurs on average in 2-5 days.

The reported study was funded by RFBR according to the research project № 17-05-00400.

Keywords: Global atmospheric circulation, precipitation, rainfall floods, Baikal region.

BACK

LOWER URAL: FROM FLOODS TO LOW WATER LEVEL AND WATER SHORTAGE

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The lower reach of the Ural or Zhaiyk is the main river of West Kazakhstan and one of the major rivers, inflowing to the Caspian Sea. The lower Ural catchment area is characterized by climate aridity, limitations in freshwater resources, which make the river as a very important water body for the region's economy, livelihoods of population, proper functioning of the ecosystems. The Ural waters are long ago and intensively used for the needs of agriculture and fisheries, industry, electricity sector, communal services, etc. Approximately 95 per cent of the lower Ural flow comes from the territory of Russia. Extremely high inter-annual and within-year flow variability distinguishes the river from the other big rivers and makes to take measures to minimize negative implication of such fluctuations. Wide ameliorative network, plenty of ponds and reservoirs were created in the 20th century at the Ural River catchment area. That has significantly changed the value (reduction on 21 per cent) and annual runoff regime of the lower Ural, had negative environmental effect. A powerful contribution to the change of preexisting hydrological conditions was made (since the end of 1970s) by the region's climate change. Statistically significant decline of the discharge characteristics' inter-annual variability, fluvial floods risk reduction occurred, the situation of low water level and water shortage, even at the high water period, has got more complicated. This is detrimental to the water and near-water ecosystems condition, pace of region's economic development, well-being of the population. To address these issues it is necessary to get present knowledge on river runoff, its variability causes, current hydro-climatic assessment, new data, and forecast too.

Keywords: Ural, flood, water shortage, water regime, long-term changes.

BACK

MAXIMUM AND MINIMUM RUNOFF IN THE NORTH CAUCASUS: PRESENT STATE AND CLIMATICALLY INDUCED CHANGES

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A general rise of precipitation in North Caucasus results in directed increase in mean annual river runoff and summer minimum monthly discharge. The main reason of increase in water abundance of winter period is more often winter thawing due to overall warming of winter period. Intensity of these processes substantially varies throughout the study area and generally correlates with spatial distribution of observed trends in climatic characteristics. Thus, the most pronounces changes occurred in the western part of the plain territory. In mountainous part, especially in the areas of certain geological structures expansion, the analyzed characteristics of river runoff remain stable. In the most arid Southeastern part with a negative trend in annual precipitation, a decrease in river runoff during low-flow periods is detected. Positive trend in maximum runoff is observed for one third of gauging stations in Kuban river basin that can be interpreted as a favorable climatic background for an increase in flood hazard. An opposite tendency is observed in Terek river basin for almost 40% of the gauging stations.

This work was supported by the Russian Science Foundation (project no. 17-77-10169).

Keywords: North Caucasus, changes in river runoff, hydrological hazards, mountain hydrology, maximum runoff, minimum runoff.

BACK

ON THE ESTIMATION OF PROBABLE MAXIMUM PRECIPITATION IN THE AMUR RIVER BASIN

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One of the main features of the modern period is an increasing risk of extreme natural phenomena. In hydrology, we come across the problem of extreme floods caused by heavy rainfall. In this connection, estimating probable maximum precipitation (PMP), namely the greatest depth of precipitation for a given duration, meteorologically possible for some catchment at a particular time of the year, is of great importance. On the basis of the PMP values, it is possible to estimate probable maximum flood (RMF) for the rivers having maximum runoff caused by rain storms. There are only few regions in Russia where rivers have water regime of such a type, therefore very few studies on PMP calculations were carried out in this country. The Amur River basin is one of such areas. In this work we estimated PMP values for the Russian part of the Amur River basin.

We used a hydrometeorological approach for estimating PMP. Observation data of the main meteorological characteristics measured on 43 meteorological stations in the Russian part of the Amur basin during a 50-year period were used. The values of dew point temperature and precipitation sums were analyzed. Since for a large river basin the generalized values of PMP are actual for estimating PMF, the calculations were based mainly on the maximum water vapor content determination (the so-called maximization of the atmospheric moisture content), without going into details of the relief features and wind conditions at each meteorological station.

2As the result, we obtained 24-hours PMP estimates for the meteorological stations of the basin of the Amur River for each of the 4 summer months from June to September. The distribution of PMP values along the basin for each summer month and for the whole summer period is analyzed. The reliability of the results obtained is estimated. The maximal values of PMP for 24 hours are about 360 mm, they are confined to the south-eastern part of the basin, the minimal ones - to its western part.

Keywords: probable maximum precipitation, Amur River, extreme floods, atmospheric moisture content.

BACK

THE ENSEMBLE SCENARIOS PROJECTING RUNOFF CHANGES IN LARGE RUSSIAN RIVER BASINS IN THE 21ST CENTURY

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The approach for long-term scenario projection of river runoff changes for Russian large river basins in the first third of XXI century caused by climate warming and social-economic changes is suggested. The approach utilizes a method for scenario estimation of runoff changes with ranging possible climate warming effects. This range is chosen by generalizing calculation results obtained by using an ensemble of global climate models within CMIP 3 and CMIP 5 experiments for two contrasting scenarios (A2/RCP 8.5 and B1/RCP 2.6) of globally averaged air temperature rises. The approach also utilizes a method for alternative scenario water consumption estimation as related to socio-economic changes. The obtained scenario estimates show that expected changes in the Volga and Don annual river runoff and its intra-annual distribution in the first third of this century can be relatively small, while changes in water use characteristics may be in some scenarios extremely negative especially in the Don river basin.

Keywords: scenarios of river runoff changes; global climate warming; large river basins.

BACK

DEVELOPMENT OF HYDROLOGY IN THE INSTITUTE OF GEOGRAPHY RUSSIAN ACADEMY OF SCIENCES

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Hydrological studies at the Institute of Geography began in the 1930th and had a mostly hydrographic character. The geography-hydrological school developed in the 1950-1980 under the leadership of M.I. Lvovich, when anthropogenic hydrology became one of its main lines of research. Experimental observations were organized near Moscow, in the Trans-Volga region, in the Kursk region. The data obtained made it possible to assess the impact of agricultural technology on river runoff, as well as on the material water composition and erosion. A six-component system of water balance equations was developed on the basis of which a balance assessment of water resources of the world, the USSR, a number of regions and river basins was carried out. One of the important achievements was the development of a preventive concept for the control of water pollution. In subsequent years, work was carried out in the following areas: further differentiation of the water balance; assessment of the hydrological role of separate landscapes in the face of climate and economic activity changes; water balance and runoff modeling; revealing the correlation between climate and anthropogenic factors in hydrological changes; assessment of the hydro-ecological state of rivers and water bodies; extreme hydrological situations, including those caused by dams destruction; paleohydrological studies; the role of Russia in the world water economy taking into account the efficiency of water use; scenarios for the future state of water resources; consequences of natural water changes; recommendations for improving the state of water bodies. The results of the investigations are published in a number of monographs and articles.

Keywords: Institute of Geography, geography-hydrological school, water balance, runoff, rivers and water bodies, anthropogenic hydrology, climate and economic activity changes, consequences.

BACK

APPLICATION OF THE SATELLITE SYSTEM OF THE EARTH'S GRAVITY FIELD MEASUREMENT FOR THE EVALUATION OF WATER BALANCE IN RIVER CATCHMENTS

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Possible application of the satellite gravity survey data obtained under the Gravity Recovery and Climate Experiment (GRACE) for solving various hydrological problems is discussed. Former investigations linked the monthly changes of the terrestrial gravity field of the Earth to the movement of water masses within the continental part of the hydrological cycle. The GRACE technology allows obtaining the realistic mean data on the changes of land water resources on continental and regional scale. The technique could be useful for the monitoring of river discharge, snow cover, glacier melting and groundwater level oscillations over vast territories. The specific features of the technique itself and the data processing are described. The GRACE-based monthly gravity field data are transformed into the maps of water level equivalent and averaged for the catchments of the largest rivers of Russia. The temporal variability of the parameter is analyzed. The analysis of their changes in the European part of Russia using the GRACE data showed that its reduction was approximately 150 mm for 2002-2015 for the south of EPR, especially the Don basin, which is caused rather by a reduction in the storages of surface and ground waters, than by a reduction in soil waters. Possible application of the GRACE data for the evaluation of particular components of water balance within the largest river basins of the European part of Russia is discussed.

The study was supported by RFBR grants (projects No. 16-05-00753 - GRACE data processing, No. 17-05-41030 RGO_a - cartographic processing).

Keywords: GRACE, water balance, runoff, European Russia.

BACK

HYDROLOGICAL AND HYDROCHEMICAL SITUATION OF THE UPPER DNIEPER

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That research aimed to assess the environmental conditions of the Upper Dnieper (the reach between the cities of Smolensk and Mogilev), based on the hydrological (depth, width and flow rate of the river), hydrochemical (water temperature, pH, conductivity, and dissolved oxygen). and meteorological (air temperature, atmospheric pressure, and wind speed) data obtained by the Complex Expedition to Explore Historical Waterways of Russia ('KEIVP'), conducted by S.I.Vavilov Institute for the History of Science and Technology of the Russian Academy of Sciences. All measurements were taken at measuring points located 3 to 5 km from each other, and a GPS was used to position each measuring point. The morphometric characteristics of the river were determined with the help of a Lowrance HDS-5x Gen2 echosounder and a Leica Geovid rangefinder binocular. The following portable analyzers were used for hydrochemical assessments: WTW MultiLine pH/Cond 340i for pH and conductivity measurements, WTW MultiLine oxi 340i for dissolved oxygen levels, and YSI 600QS sonde. The complementary meteorological data were obtained using a Kestrel 4500 NV Weather Meter. Based on the results of the study, three stretches were identified in this section of the Dnieper River that differ in the levels of water pollution: from the city of Smolensk to the village of Syrokorenie (class IV: polluted waters); from the village of Syrokorenie to the village of Beketovo (class III: moderately polluted waters); and from the mouth of the River Mereya to the city Mogilev (class II, moderately clean). The results demonstrate that the quality of water in the Dnieper from the city of Smolensk to the city Mogilev is satisfactory and this part of the river may be used for recreation and tourism purposes.

BACK

THE DEVELOPMENT OF THE SIBERIAN LANDSCAPE HYDROLOGICAL SCHOOL

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In the 1970s and 80s in Irkutsk in the Institute of Geography of Siberia and the Far East of the Siberian Branch Academy of Sciences of the USSR, the Siberian school of landscape hydrology began to be formed. Its distinctive features:

- reliance on experimental studies that allow establishing relationships between hydrological quantities and natural factors, elucidating genetic features of runoff formation, on the basis of the theory of geosystems of Academician V.B. Sochava;

- extensive use of methods of hydrological indication, with relationships between natural and hydrological characteristics, taking into account the environment-forming role of the water factor (structural-hydrographic approach, denroindication, regression analysis);

- basin concept, when basins as integral formations, hierarchically constructed, with many types of closed circulation of a substance, separated within precise orographic boundaries, are represented in the form of a multiparametric system, whose elements are the rock development areas with different filtration properties and tectonic features, as well as landscapes;

- landscape-hydrological mapping (methods of indication localization, diagrams along the channels).

The experience of landscape-hydrological research was implemented in many practical works: in the tasks of water conservation zoning, basin management, water depending development of the territory, while performing large regional water-balance generalizations (Western Siberia, Angara-Yenisei region, south of Eastern Siberia, and the Baikal watershed area), in assessing the hydrological consequences of large economic projects (creation of the Kansk-Achinsk fuel and energy complex, the Baikal-Amur Mainline construction, construction of the pipeline Eastern Siberia - the Pacific Ocean, etc.), in environmental support, OVOS and expertise of numerous projects for development of coal, oil, gas, and ore deposits in Eastern

Siberia, as well as in territorial planning projects (hydropower, water management, recreational and environmental areas). In recent decades, the landscape-hydrological approach has been successfully applied in the hydrological-morphological analysis of deltas, in flow simulation and hydrochemical conditions in small river basins, in the study of dangerous hydrological processes, and in the atlas mapping of the Baikal region.

BACK

WATER-RESOURCE POTENTIAL OF BELARUS CITIES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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For the sustainable development of a modern city it is necessary to have enough water to meet the needs of economy and urban residents. Guaranteed provision of a city with water resources is conditioned, first of all, by their quantity and availability. Naturally, the water-resource potential of the city is determined by the quantity and quality of water resources in the country as a whole. According to assessment, available water resources of Belarus are sufficient to meet modern and future needs of the country in water. The degree of use of surface water resources does not exceed 10% of the amount of the river flow that is generated domestically in the low water year (95% provision). The degree of use of predicted groundwater resources intended for extraction does not exceed 6%. The role of surface water resources in the formation of water-resource potential of cities depends primarily on their location in relation to rivers of different water content. The indicator of sufficiency of water supply for a number of cities of the country was calculated using the value of the average river runoff and the number of urban residents. According to the received indicator, the cities are divided into four categories for water supply: insufficiently provided, sufficiently, well and very well provided. A significant deficit of surface water resources was noted for Minsk, the water supply indicator of which is 20 times less than the national average. As a result, 64% of potable water is used for production needs in Minsk, which is irrational and requires improvement of the water use system. The level of development of the city's water management and the degree of water availability for the population is also determined by the indicator "household water consumption per capita" (liter/person/day). In recent years water consumption per capita in large cities has a well-marked downward trend but still exceeds the average for Belarus as a whole. Reducing of the specific water consumption in large cities indicates the process of optimization of the use of water resources, which is characterized by a decrease in water consumption in the sphere of housing and communal services.

BACK

INFLUENCE OF CLIMATIC CHANGES ON THE FORMATION OF INFILTRATION OF GROUNDWATER

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Estimation of the impact of climate change on the formation of infiltration of groundwater is performed for the territory of the Moscow Artesian Basin.

The model for the formation of infiltration on the earth surface consists of two blocks: the first block for transforming precipitation on the earth surface and the second block of moisture transfer in the aeration zone. Modeling of the transformation of precipitation on the earth surface is carried out in the software complex SurfBal, developed by S.P. Pozdnyakov. Modeling of moisture transfer in the aeration zone is carried out in the program HYDRUS 1D.

The basis for calibrating the models are weather data, snow cover height data and data on the temperatures of rocks in the aeration zone at different depths. Calculations are carried out for two landscapes (forest and field) and three types of soils (sands, sandy loams, loams). The model is verified for the period from 1965 to 2015. The forecast calculations were carried out until 2069. Verification of the validity of the evapotranspiration value obtained on the model was carried out using the dependence Fu, as well as the Mezentsev and Zhang formulas. Based on the results of the simulation, the differences in infiltration of groundwater in different landscapes and their predicted changes as a result of the influence of climatic changes are estimated. This work was supported by the grant of the RNF № 16-17-10187.

Key words: groundwater, infiltration, climate change.

BACK

EVALUATING THE STREAMFLOW SENSIVITY UNDER FUTURE CLIMATE CHANGE SCENARIOS IN THE UPPER BEAS BASIN USING THE SWAT MODEL

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Climate is considered as key factor controlling the hydrological behaviour of a watershed as this could make alterations in the components of the hydrological cycle and affect the availability of water resources. Therefore, it is essential to quantify the streamflow sensitivity in the basin under different climate change scenarios for determining water availability. Temperature, rainfall, relative humidity and wind speed data were procured from IMD and IARI. Post monsoon season Landsat image was used for LULC mapping. Cartosat DEM of 30 m spatial resolution was also acquired for obtaining the topographical details of the area and to develop a decision tree to prepare the land cover map. Soil and Water Assessment Tool (SWAT) was employed to estimate the streamflow under different climate change scenarios which was calibrated and validated using the observed streamflow of Thalout station. It has been observed that the streamflow showed large scale fluctuations both in time and space. The streamflow is likely to decline in future if there is a substantial rise in air temperature. The variations in streamflow conditions would adversely influence the water availability conditions in the basin.

Keywords: LULC, climate change, streamflow, sensitivity, SWAT.

BACK

OCCASIONAL FLOODS ON THE RIVERS OF EUROPEAN RUSSIAN AND ITS ROLE IN THE MODERN HYDROLOGICAL REGIME

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Modern changes in the water regime of rivers now are evident. The main tendency, for the most rivers of the European territory of Russia, is smoothing of the annual runoff hydrograph. This leads to a reduction in the flow of spring months associated with the interception of part of melt water by thawing floods. Simultaneously with this process, there is an increase in runoff during the low-flow periods of the year - the summer-autumn and winter. Reducing the depth of freezing of the soil, due to warmer winters, leads to an increase nourishment of the groundwater. Simultaneously, the loss of runoff to surface retention and evaporation during the winter and especially in the spring period is increasing. Almost all seasons, especially in the western part of the Russian Plain, there is an increase in the number of flood peaks. They are superimposed on a wave of main, seasonal melt flood, making it drawing up as separate phase of the water regime in some years practically impossible. A similar situation can be traced for the winter low-flow period, especially for the rivers of the western part of the Russian Plain. Low flow period, which is usually understood as the long period of steadily low discharge, when the rivers are transferred completely to groundwater nourishment, not forming in the last two decades. Throughout the winter, river runoff is increased; the hydrograph has a “piolo-like” shape, associated with precipitation in the mixed or liquid phase. Increasingly, the phenomenon of winter ice drift is observed on the rivers, due also to increased run-off and frequent thaws. These trends are to a lesser extent observed in the north and northeast of the Russian Plain. Significant transformation of the water regime is expressed in the Don and Oka basins.

The study was supported by RFBR grant No. 16-35-60080 in terms of algorithms and RFBR grant No. 17-05-41030 rgo_a for conceptual analysis and mapping.

Keywords: Occasional flood, hydrological regime, climate change, runoff.

BACK

POSTER

ASSESSMENT OF HEAVY METALS IN SURFACE WATER AND BOTTOM SEDIMENTS OF THE SELENGA RIVER

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The Selenga river ecosystem, carrying about 50% of water and chemical runoff of above 50% is a significant factor in the sustainability of the Lake Baikal ecosystem. It is one of such matters requiring special consideration in the Central zone of the Baikal natural area as it relates to climate change and increasing anthropogenic load. The spatiotemporal distribution of heavy metals in surface waters, sediments of the Selenga river and its Delta have been systematically studied in BIP for so many years. According to long-term studies, it is possible to note the significant influence of hydrological conditions on the dynamics of individual concentrations of chemical components in the river and its Delta channels. Seasonal dynamics of metals such as Fe, Mn, Zn, Cu, Cr, Ni, Co, Cd and Pb in surface water and bottom sediments was studied, and trends of their distribution along Delta channels were also determined. Analysis of the distribution of heavy metals in the system of surface water - pore water - sediment in the tributaries of the Delta showed their accumulation in sediments and pore waters during the ice period, and a substantial decrease of the content during the open water period, one associated with the important role of suspended solids in the distribution of heavy metals. The effect of oxidation-reduction medium in pore waters on the differentiation of metals - iron and manganese deposition in areas of increased oxidative potential and retention in migration paths at low potential, and inverse dependence for metals such as lead, chromium, copper and Nickel. During the period of extremely low water content of the Selenga river, 2013 - 2015, along with the rise in concentrations of the main ions, there was a drastic increase in the concentrations of heavy metals, especially copper and zinc, both in surface waters and in bottom sediments to the maximum values typical for low-water periods owing to an increase in the share of underground

runoff in rivers. Generally, the content of heavy metals in the bottom sediments of the Selenga river is relatively stable and is below the main background contents in the bottom sediments and soil clarkes that are not subject to anthropogenic pollution.

Keywords: Selenga River, Heavy metals, Surface waters, Ecosystem, Bottom sediments.

BACK

USING AMELT MODEL TO ESTIMATE GLACIER ICE AND SNOW MELTWATER CONTRIBUTION TO THE UPSTREAMS OF SYR-DARIA

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An energy-balance distributed model A-Melt was used to calculate the meltwater yield from Sary-Tor glacier and Glacier No.354 in the Central Tian Shan, the Ak-Shyirak massif, Syr Daria river headwaters. Rapid and accelerating deglaciation is characteristic of this region. Sary-Tor glacier was chosen as representative for Ak-Shyirak massif in course of International hydrological decade and was an object of direct massbalance measurements in 1985-1991. Glacier No.354 was an object of direct mass-balance measurements for 2011-2016. Validation of modeling results showed a good reproduction of direct ice and snow melting measurements data on the ablation stakes net and mass loss according to geodetic method. The relation between temporal oscillations of modeled water yield from the glaciers to monthly discharges during the warm period in 2003-2014 was drawn for different gauging stations in the upstream of Syr Daria basin. For the small river watersheds of less than 500 km^2 area with more than 10-15 % glacier cover the relation is the strongest, correlation coefficient amounts to 0.86-091. Receding from the alpine headwaters the influence of glacier melt is gradually diminishing. The relation between monthly discharges during the warm period and modelled water yield is strongly significant (R=0.76) for Naryn river at Naryn city gauge with the watershed area of 10 500 km^2.

This work was supported by the Russian Foundation for Basic Research (project No. 16-35-60042).

Keywords: Energy-balance modelling, AMelt, Tian Shan, glacier runoff, changes in river runoff, mountain hydrology.

BACK

INTRA-ANNUAL DISTRIBUTION OF THE RUNOFF IN THE URAL RIVER BASIN

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The article is devoted to the study of intra-annual distribution of runoff in the southern and South-Eastern part of Bashkiria and center of Orenburg government, on the example of a river basin the Ural. For rivers of the area calculated norms, coefficients of variation and average standard deviation of monthly, seasonal, annual, maximum and minimum flow, and the tendencies of its changes. The calculated ratio of average and maximum water discharge spring high water, the ratio of the maximum and minimum monthly and annual discharges, the calculated annual runoff layer. Using the method of wavelet transform in the data flow of the rivers of the study area identified a cyclical pattern of water availability. Moreover, it revealed the narrowness of correlation between average monthly expenditure of each month and annual average water consumption, as well as between the average monthly water costs. Determined the statistical significance of the detected correlations.

Keywords: intra-annual distribution, auto-correlation function, correlation, water discharge, Southern Ural.

BACK

TREE-RING PROXY FOR RUNOFF VARIATIONS IN THE LAKE BALKHASH BASIN

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Change over time of precipitation and temperature constrains variations of spruce growth (Picea schrenkiana) in arid-land headwaters of Central Asia. Records of tree-ring width and maximum wood density from Inner Eurasia are effectively used for tree-ring reconstruction of summer temperature, precipitation and drought indices. Careful selection of tree-ring sampling sites optimizes a hydrological signal in the climate proxy and makes suitable for runoff modeling. We examine the hydrological response of tree-ring width growth from a 43-site network of spruce chronologies developed in the Tian Shan Mountains of Kazakhstan. The study includes principal component analysis of the ring width chronologies, Seascorr analyses of climatic signals and linear stepwise regression of river discharge modeling. An accurate ($R^2_{adj.}$ = 0.53) reconstruction of October-September discharge of the Ili River, 1779–2015 is developed from four composite ring chronologies with strong moisture and temperature signals. The Ili River (length 1439 km, catchment area 140,000 km^2, average discharge 480 m^3/s) drains the Lake Balkhash with the glaciated headwaters in Xinjiang, China. High river flow is consistent with warm air temperature, upsurge of glacier melt, and high snow linked to intensification of the southwestern cyclonic activity driven by the Siberian High oscillations. The fivefold extension of the gauged discharge record reconstructed from the tree rings

represents the variability of runoff in the Lake Balkhash Basin for the last 235 years and identifies highly irregular fluctuations in discharge on decadal and multi-decadal time scales. Only two out of 13 reconstructed flows extremes (± 2σ) occur outside the instrumental record (1936–2015) and predate the start of large dam construction (Kapchagay Dam and Reservoir ca. 1969). Decadal variability of the Ili discharge corresponds well with hydrological records of other Eurasian internal drainages modeled with tree rings. Spectral analysis identifies variance peaks (highest near 42 yr) consistent with main hemispheric oscillations of the Eurasian climatic system. We discuss the contribution of tree-ring proxy of river discharge for water management in the region situated across the internal drainage systems of Inner Eurasia, where water supply shortfalls in conjunction with population growth and rapid economic development are a tangible international problem.

Key words: Water resources, dendrochronology, Siberian High oscillations.

BACK

POSSIBILITIES OF USING REMOTE SENSING DATA FOR ICE MONITORING OF LARGE RIVERS

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The paper discusses the possibility of using optical images and satellite altimetry for river ice monitoring. The object of the study is the Lena river. Ice phenomena on this river are observed most of the year. Due to the severe winter, the river ice thickness reaches 2 m or more. Optical images of Landsat 8 and Sentinel 2 satellites from April 2013 to November 2017 for autumn (October, November) and spring months (March, April, may) were collected for various sections of the Lena river. To control the decoding results, we used data from observations at hydrological gauges. Taking into account the predominance of clear solar weather in the period with ice phenomena, as well as the width of the river from 1.5 km for the studied areas, the use of optical images for river ice monitoring gives good results in this region. Various combinations of bands, including IR and thermal ones, have been worked out. It is revealed that the analysis of the optical images allows mapping the ice situation on the rivers, to fix the border ice, the density of the ice and frazil run, the appearance of water on the ice cover and the spring ice decay. The main features of the ice situation obtained as a result of the analysis of the images are noted. The influence of small tributaries is revealed, especially in the spring period. The different structures of ice cover along the length of the river in the first days of stable ice cover and during the spring breakup period.

The possibility of using satellite radar altimetry data (Jason 2) for the period from 2008 to observation of the ice thickness on several tracks crossing the Lena River is also considered. As ground-based observations, we used data from measurements of ice thickness in hydrological gauges. Optical images are used for more information about the ice cover, which can distort the values of backscatters (presence of polynia, water on the ice).

The study is financially supported by the Russian Foundation for Basic Research (Proj. 16 -05-00753).

Keywords: river ice monitoring, Lena river, satellite data.

BACK

Thematic sessions

Chairperson(s):

Borders and Border Regions in Central-East Europe and the Post-Soviet Space

- *Border Changes In The Post-Soviet Space*
  Vladimir Kolosov
- *Russian Borderlands Symbolic Landscape From Eu To China: Semiotics Of Visibility*
  Olga Vendina
- *«Island Of Crimea»: Re-Bordering In The New Geopolitical Context*
  Maria Zotova
- *Perception Of Neighbours In Border Cities Of Crimea After 2014*
  A. Gritsenko, M. Zotova, O. Vendina
- *New Eastern Member States Of European Union: Conflicts And Disillusions Surrounding Integration And Co-Operation*
  Zoltán Hajdú
- *Russian Borderlands As Tourist Destinations*
  Ekaterina Mikhailova
- *Integration Effects For The Regional Development Of Russian-Belarusian And Russian-Kazakh Borderland*
  K. Morachevskaya, M. Karpenko
- *Underlying Drivers And Spatial Determinants Of Agricultural Land-Use Change In Temperate Eastern Europe*
  A. Prishchepov, F. Schierhorn, V. Butsic, D. Müller
- *Fluid Borders In Western Ukraine*
  Sabine Von Löwis
- *Quasi-States And Quasi-Statehood: Spatial Aspects Of State Degradation And Failure*
  F.A. Popov
- *Institutional Dimension Of Cross-Border Cooperation On Russian Border*
  Alexander Sebentsov
- *They Carry The Border On Their Backs: Embodying And Gendering Spanish-Moroccan Border In Melilla*
  Dina Krichker

BACK

BORDER CHANGES IN THE POST-SOVIET SPACE

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The objective of this paper is to consider the main border issues and cross-border relationships in the post-Soviet space in the context of changing theoretical approaches to border studies. The authors considers the deepening contradiction between economic needs in de-bordering and increasing cross-border circulation and securitization provoked by the worsening geopolitical situation in Europe and in the world, the growing differentiation and volatility of borders' regime and functions depending in particular on the processes of Eurasian integration under the auspices of Russia which determines the balance between de-bordering and re-bordering. The perspectives of relations between Russia and EU, Russia, Georgia, Moldova, Ukraine and self-proclaimed republics in its South-East, between other non-recognized republics and their "mother" countries remain unclear which has a negative impact on cross-border cooperation and does not allow to economic actors, regional and local administrations working out long-term plans. The waves of migrations modified the situation in border areas. Current events are interpreted in the official political discourse in terms of the zero-sum game which increases the pervasiveness of negative stereotypes about each other in neighbouring countries and regions. However, the beginning of a new planning period in cross-border cooperation between Russia and EU countries leaves a modest hope that it can serve a locomotive for restoration of the relations between them. In conclusion the author formulates research questions for future studies of borders and bordering in the post-Soviet space.

BACK

RUSSIAN BORDERLANDS SYMBOLIC LANDSCAPE FROM EU TO CHINA: SEMIOTICS OF VISIBILITY

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The contours of cultural communities rarely coincide with political entities. In most cases the socio-cultural borders are vast zones of smooth transition or cultural patchwork, while the political ones are the lines, the established limits of States' sovereignty. For people living at both sides of the boundary, who share common experience with their neighbors and sometimes values and points of view, this boundary means a difference in nationality, norms, rules, and regulations. The centrally imposed policy is not always welcomed by the inhabitants of borderlands, even if they obey and respect the law. Their historic memory and narratives do not completely fit to the official version of history. The role played by culture in emergence and legitimation of actual Nation-States explains why this situation is generally a matter of a great concern for the Governments; an existence of the trans-border communities culturally different from the "core" population is perceived as a risk of disloyalty and turbulence. The idea to reach the convergence of the cultural and political borders by policy-making is almost as frequently considered as a remedy of situation. Based on the metaphor of a "gardener" who is taking care of his land, pulls out weeds and cultivates useful plants, which described the Nation-State by Z. Bauman, the presentation is focused on the politics of the neighboring "States-gardeners". Nowadays, the areas in Russian borderland are enriched by various signs, monuments and symbols, which are supposed to help strengthening national and local identity and patriotic moods. They are also aimed to refute the claims of political opponents and historical enemies. Analyzing the semiotics of visibility in Russian borderlands the author regards two major trends. One of them is related to the expansion of cultural influence beyond a political border, and the second one reflects the jealous attitude of the authorities towards the signs and symbols of the neighboring political entity represented on their "sovereign" territory. The landscape of Russian borderlands provides plenty of evidences of these scenarios and their mixing.

BACK

«ISLAND OF CRIMEA»: RE-BORDERING IN THE NEW GEOPOLITICAL CONTEXT

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The new practically «closed» border has emerged recently between the Republic of Crimea and Ukraine. It resulted in a radical modification of Crimea's territorial structure. Transit areas transformed into peripheral ones, and peripheral territories acquired central functions. The spatial orientation of the transport network changed from the sub-meridional to the sub-latitudinal. Despite of the total break-up of historical economic relations and transport connections between Crimea and Ukraine many branches of economy have already more or less adapted to new conditions (trade, transport, agriculture, tourism). But there remain considerable risks for the functioning of engineering and chemical plants. Their problems are partly related with chronic underinvestment in the Ukrainian period, which provoked the destruction of old Soviet infrastructure, partly with the sanctions complicating the use of foreign markets and investments, and the acquisition of contemporary technologies. This paper is aimed to analyze the impact of recent geopolitical changes on the processes of re-bordering in Crimea. It is based on the materials of field studies conducted in 2017 in Crimea resulted in interviews with regional and local officials, high level managers and businessmen, journalists, NGOs' leaders, etc.

The research was supported by Russian Science Foundation, grant No14-18-03621 "Russian Borderland: Challenges of Neighbourhood".

BACK

PERCEPTION OF NEIGHBOURS IN BORDER CITIES OF CRIMEA AFTER 2014

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The Ukrainian political crisis in 2014 has led to significant shifts in the life of the Crimean peninsula, leaving a deep trace on the memory and feelings of the local population. The events of the Crimean Spring at that time caused a different reaction in local communities depending on political views, values and identity. Most people mobilized around Russian idea have supported the movement for holding a referendum on independence and accession to Russia. At the same time, in another part of society, primarily among ethnic minorities - Ukrainians and Crimean Tatars, but also among dominant Russians, the events have induced sharply negative attitude, up to departure from the Crimea.

In the north of peninsula the situation was especially ambivalent and dramatic because of close economic and social ties with neighbouring regions of Ukraine and complex ethnic composition. The established Russian-Ukrainian state border in the Crimea and its rigid regime have created many difficulties for the people and local enterprises, radically changing their everyday lives.

The research is focused on following issues: what transformation have occurred in inter-ethnic relations after 2014, what is perception of neighboring "mainland" regions and the established state border with Ukraine in the local communities, what means Russia and Ukraine for them today? The authors have analyze the results of sociological survey (six focus groups) and expert interviews held in November 2017 in the two northern border cities of the Crimea - Dzhankoy and Armyansk.

The research was supported by Russian Science Foundation, grant No14-18-03621 "Russian Borderland: Challenges of Neighbourhood".

BACK

NEW EASTERN MEMBER STATES OF EUROPEAN UNION: CONFLICTS AND DISILLUSIONS SURROUNDING INTEGRATION AND CO-OPERATION

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After the regime changes in 1989–1991 some the former Eastern Socialist countries almost immediately expressed their wishes to join the European Union. The German Democratic Republic's merger with the Federal Republic of Germany was a unique process that had its internal German consequences later on. The consequent phases on enlargement – first the largest expansion in 2004 with states that had very different recent pasts (post-Soviet Baltic States – Estonia, Latvia, Lithuania, Slovakia and the Czech Republic as successor states of Czechoslovakia, Slovenia as one of the successor states of Yugoslavia, Poland, Hungary), then Bulgaria and Romania joining in 2007, and finally with Croatia joining in 2014 – resulted in a specific Eastern internal periphery of the EU. Each country's comformation to the EU has been formed by their historic integration experiences, their situations at the time of the enlargements, their intentions to have their envisioned national state and political systems enforced.

These countries have their distinct internal political developments, their different governments, governmental coalitions after national elections that have been forming different emphases towards the European Union. Under the governments considered to be left-wing, the co-operations with the EU ran more "smoothly" than under nationalist-conservative governments. Almost all ex-Socialist countries developed certained "conflicts" in their relationship with the Union, but the most pronounced ones with several factors entailed Hungary and then Poland after 2010. The "Article 7 TEU procedure" initiated in December 2017 against Poland showcases the differences regarding the values and concepts of democracy in a new way.

If the problematic parts of the relationship between the "core areas" and the "Eastern periphery" cannot be resolved in every sense, that would bring serious consequences to the Eastern peripherical area of the European Union already in the medium term.

For a wider region (16 cointries) a new economic and financial partner appeared, China. In the 16+1 construction connections are develop for China, and not firts mainly for each others.

BACK

RUSSIAN BORDERLANDS AS TOURIST DESTINATIONS

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In this presentation I will share my observations on Russian tourist industry development as seen from the country's borderlands. Based on interviews with tourist companies, municipal servants and regional authorities collected during multiple fieldtrips in 2013-2017, I will portray what Russian border regions are doing to develop the regions as tourism destinations and how successful such attempts have been so far. Particular attention will be given to the Russian-Norwegian and Russian-Chinese border regions.

How is Russianness instrumentalised and staged in the High North and in the Far East? What is perceived as key attractions in Russian borderlands? How has Russian ruble devaluation influenced the intensity of tourist flows? To which extent are they (un)organized? Answering these questions will lead us to better understanding of what role Russian border regions play in the country's international tourist reception today and why.

BACK

INTEGRATION EFFECTS FOR THE REGIONAL DEVELOPMENT OF RUSSIAN-BELARUSIAN AND RUSSIAN-KAZAKH BORDERLAND

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Integration process at the state level – the creation of the Eurasian Economic Union in 2015 – should first and foremost have a positive impact on the economic development of the border areas. Worldwide integration initiatives contribute to the increase of trade turnover between the border regions, and intensify economic cooperation on the whole. However, the integration between Russia, Belarus and Kazakhstan along with positive effects led to some negative processes in the borderlands related to the increased rivalry of producers in local and regional markets, the problems of re-exporting of agricultural raw materials and foodstuffs banned for import in Russia since 2014, etc. The aim of our research was to identify the effects of Eurasian integration in the Russian-Kazakh and Russian-Belarusian borderlands. We evaluated statistical data as well as the results of expert interviews conducted during the field researches in 2016-2017. It was found out that the main effects of the Eurasian Economic Union formation were institutional effects. The new legislation allowed to create a single legal field; however, no unity of approaches to solve common problems has been found. The consequences of such transformations varied at different parts of the border and strongly depended on the combination of national and local factors. Thus, the differences in product output (local factor) under the influence of Customs Union would have to open export opportunities for some enterprises in the Russian border regions to Belarus, but different types of state regulation and protectionism of the Belarusian economy (national factor) restricted the import of goods from Russia to Belarus. Another example was the Russian-Kazakh border where Russian entrepreneurs often preferred Kazakhstan business registration because of different tax laws (national factor) and availability of free niches in the market of goods and services (local factor). The economic effect of the Eurasian integration should have led to the increase of the volume of mutual trade. In most border regions until 2013 the volume of foreign trade with the neighbour country has increased. But further dynamics was determined more by the global

conjuncture in the raw materials sectors and the economic crisis rather than by integration effects.

Keywords: Eurasian integration, border regions, institutional effects, economic effects.

BACK

UNDERLYING DRIVERS AND SPATIAL DETERMINANTS OF AGRICULTURAL LAND-USE CHANGE IN TEMPERATE EASTERN EUROPE

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The transitioning from state-command to market-driven economy following the collapse of the Soviet Union in 1991 drastically shaped agricultural land use. Our goal was to understand the underlying drivers and spatial determinants of agricultural land abandonment and recultivation from 1990 to 2015.We brought an example of agricultural land-use change in one agro-climatic zone stretching in cross-border Lithuania, Belarus, and Russia. We estimated the rates and patterns of agricultural land abandonment based on Landsat TM/ETM+ satellite images with support vector machines and linked these data with institutional changes regarding land use. Using spatially explicit econometric models with boosted regression trees and propensity score matching techniques, we assessed spatial determinants of agricultural land abandonment and recultivation. The highest rates of land abandonment from 1990 to 2000 were observed in studied part Russia (31 %), followed by Lithuania (19 %), and Belarus (13 %). After 2010 abandonment rates increased in Russia and Belarus, but heavily declined in Lithuania. Our regression models and propensity score matching results revealed, the differences in land abandonment and recultivation rates reflected the contrasting strategies for transitioning toward a market economy. For instance, from 1990 to 2000, the spatial patterns of agricultural land abandonment across Lithuania and Russia corresponded to the land rent theory of von Thünen, as sites with low crop yields that were distant from markets had higher

rates of abandonment. However, this was not the case for Belarus, where the institutional environment regarding agricultural land use differed from neighboring Lithuania and Russia. Similarly, propensity score matching revealed a strong agricultural policy influence on recultivation patterns in Lithuania after 2000, but this was not the case in Belarus and Russia. In sum, our study showed how institutional changes drastically shaped agricultural land use in cross-border regions, but also how econometric techniques and remote sensing can be efficiently used to disentangle environmental and location-based characteristics from the impacts of land-use policies on land-use.

BACK

FLUID BORDERS IN WESTERN UKRAINE

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The presentation deals with the returning and vanishing historical border inWestern Ukraine. Looking at recent electoral maps of Ukraine, the line where the historical border between Russian and Habsburg Empire and in the interwar period between Poland and Soviet Ukraine has been re-emerges systematically. It is the same line where the small river Zbruč takes its way and a border had been established by the end of the 18th century. Since the end of WWII, i,e, for more than 70 years now, there is no state border anymore, but only a border between amdinistrative entities. But somehow the old border turns up like a phantom on election day. Historical reminiscences can also be observed in religious institutions, memory landscapes or economic assignments.

Between 2012 and 2016 I conducted a case study in two local communities on both sides of the historical border (and the electoral divide) to analyse how and why people behave differently when it comes to elections and other aspects of symbolic behaviour, and what role past delimitations really play in their identities and their daily lifes.

I shall show that references to the past are made in very different situations and for very different reasons: Not always indicates a reference to the past a persistence of some kind of political identity, more often it is a reaction towards very current public discourses. Nevertheless there are persistent religious or economic practices that relate back to different historical developments. But even then they are reactions to current Ukrainian religious and economic politics. In my presentation I will discuss some empirical cases and show how fluid borders are and how much the relevance ot their historic foundation depends from very contemporary contexts.

BACK

QUASI-STATES AND QUASI-STATEHOOD: SPATIAL ASPECTS OF STATE DEGRADATION AND FAILURE

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This paper highlights an essential link between two meanings of a term “quasi-state”. As Pål Kolstø once noticed, we have here a kind of terminological confusion. Some authors use this term as a synonym for “failed state” (Robert H. Jackson, Christopher Morris), others use it to mean “de facto state” (Gail Lapidus, Michael Rywkin). That seems paradoxical but is not accidental. Both failed states and de facto states appear to be products of the same but two-faced process – state weakening and degradation up to state failure on the one hand and de facto fragmentation of its political space followed by the localized shift of power to some non-state actors on the other. Quasi-states A directly create quasi-states B and vice versa.

This process is not always abnormal. Even the strongest states often cannot retain the full control over urban slums or ghettos. As for weaker ones they never lose the power over the whole territory in a moment. State degradation usually expands from most vulnerable areas such as remote regions, ethnic or religious enclaves etc. Sometimes it goes further resulting in de facto secession of significant ungoverned territories that may form spatial limits for different state-like entities. Finally the state may completely collapse and turn into quasi-state A breaking up into a number of quasi-states B, such it was in Somali.

Both the weakening states and non-sovereign local state substitutes may be defined by a measure of quasi-statehood that means similarity to sovereign state. There is no point to distinguish two types of quasi-statehood. They should be both considered as a single phenomenon that accompanies de facto fragmentation of state political space and reflects state inability to function properly over the whole territory and cope with state-like structures that substitute it within ungoverned areas.

Keywords: quasi-states, quasi-statehood, state failure, de facto states, failed states, sovereignty, de facto secession, political space fragmentation.

BACK

INSTITUTIONAL DIMENSION OF CROSS-BORDER COOPERATION ON RUSSIAN BORDER

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Institutionalization of cross-border cooperation in modern Russian and foreign studies is usually considered as a necessary condition for effective cross-border cooperation. At the same there is no generally accepted definition of institutions of cross-border cooperation. Usually, institutions of cross-border cooperation are understood as a set of "rules of the game", which are shared by the majority of participants of cross-border interactions. Despite the fact that the legal registration of institutions is not a prerequisite for their formation, the legal environment influences on cross-border cooperation, reducing transaction costs for cross-border actors.

The study of legal acts and interviews with the actors of cross-border cooperation allowed analyzing the following institutions of cross-border cooperation: agreements on cross-border and trade and economic cooperation, Councils of border regions, Commissions on cross-border cooperation, Euroregions and similar entities, programs of cross-border cooperation, etc. The analysis of the specific practice of cross-border cooperation has allowed to distinguish 5 types of cross-border cooperation, typical for the Russian border: European, post-Soviet (including the Eurasian and post-Soviet), Chinese, Mongolian and North Korean.

BACK

THEY CARRY THE BORDER ON THEIR BACKS: EMBODYING AND GENDERING SPANISH-MOROCCAN BORDER IN MELILLA

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This paper exemplifies how embodied vision of borders can problematize border violence and open a way for imagining peaceful frontiers. It throws light on the construction of spaces of violence in border zones in the context of the exploitation of the bodies of porteadoras (cross-border workers in Melilla, Spanish enclave in North Africa). Narratives of border guards, porteadoras and Melillan citizens demonstrate how violent discourse around the border pass of Barrio Chino is produced and normalised. These narratives were collected over 6 months of fieldwork in the city in 2016 and 2017. The paper argues that a set of behaviours contributes to the social construction of Barrio Chino as a space of normalised violence, and this space is consequently employed to convey messages of Spanish territoriality in North Africa. The paper makes this case in three ways. First, it elaborates how the Spanish-Moroccan border is embodied by porteadoras, and how this process is gendered. Then, I analyse how border violence is spatial and how it is normalised in a particular territorial setting. Finally, I explain how the state utilises such spaces of normalised violence to strengthen its borders, and to reinforce its territoriality. By problematising spaces of normalised violence, the paper provides an alternative vision of border zone construction. Such vision challenges the dominant image of the border as inherently violent, and opens a conversation on construction of peaceful Euro-African frontier spaces.

Keywords: Melilla, Spanish-Moroccan border, cross-border trade, violence, embodied border, qualitative methodology.

BACK

Cities: Environmental Challenges in the Backdrop of Climate Change

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  Omvir Singh, Pankaj Bhardwaj

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- Green Construction As A Method Of Normalizing Atmospheric Pollution In Grozny
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BACK

URBAN VULNERABILITY TO EXTREME HEAT IN A CHANGING CLIMATE

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Extreme heat is major public health concern. Despite significant progress in epidemiological and vulnerability research, weather forecasting, and urban heat island characterization, extreme heat continues to be a leading cause of weather-related human mortality in the United States and in many countries world-wide. Climate change is projected to increase the severity, frequency and duration of extreme heat events, which may put even more populations at risk for heat-related mortality and morbidity. Understanding and characterizing current and future risks of heat-related health outcomes requires interdisciplinary approaches and effective risk communication strategies. This presentation will introduce research conducted at the National Center for Atmospheric Research (NCAR) on the interactions among physical, social and behavioral dimensions of extreme heat vulnerability and risk in an urban context. I will discuss concepts and methods for characterizing and modeling extreme heat-health risks at regional and local scales in North American cities. The presentation will outline the conceptual framework for studying extreme heat vulnerability and adaptive capacity, present results from the spatio-temporal analysis of extreme heat risk in current and future climates in Houston, Texas, and demonstrate GIS-based tools for extreme heat preparedness and response.

BACK

URBANIZATION EFFECTS ON AIR TEMPERATURE TRENDS AT CAPITAL CITY OF NEW DELHI, INDIA

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The knowledge of surface air temperature is important to a range of issues and themes in earth sciences central to urban climatology, global environmental change, and human-environment interactions. In addition, change in temperature of a place may be a function of natural and anthropogenic factors. As the majority of the world's population is living in urban environments, there is growing interest in studying local urban climates because urban areas hold the most modified climate characteristics by human activities. This paper, therefore, attempts to study long-term temporal variations of surface air temperature at New Delhi brought about by urbanization and industrialization. The long-term change in the temperature at New Delhi has been evaluated by linear trends. The analysis revealed that annual maximum, minimum and mean temperature has shown warming trends over New Delhi. Pre-monsoon, post-monsoon and winter season showed almost the same pattern whereas monsoon season temperatures showed an overall decreasing tendency. This decreasing tendency in monsoon surface air temperature can be ascribed to a significant increase in the suspended particulate matter in the ambient air during the second half of the last century due to rapid industrialization and vehicular traffic movement. The presence of suspended particulate matter leads to cooling by increased albedo. However, the increasing and decreasing trends in annual, seasonal and monthly maximum, minimum and mean temperatures are not found to be significant.

Keywords: Surface air temperature, urban climate, trend, suspended particulate matter, Delhi.

BACK

HEAT WAVES, TEMPERATURE EXTREMES AND THERMAL DISCOMFORT: OBSERVATIONS FROM COASTAL CITIES OF INDIA

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The modification of climate system and more particularly the microclimate of the area is been investigated by climatologists that has lead to the concept of 'urban heat island' (UHI). On the other hand, increasing climate variability has lead to increase in temperature extremes. Temperature extremes not only have adverse effect on human health but also deteriorate occupational productivity where manual work is involved, as well as increase cooling energy demand. Microclimate modifications and rising temperature extremes increase thermal discomfort, particularly in the urban areas. Therefore, this paper attempts to investigate changes in heat waves, temperature extremes and thermal discomfort at seven coastal cities of southern India, which are: Mumbai, Panaji, Mangalore, Thiruvananthapuram, Chennai, Machilipatnam and Kolkata. All of these cities are characterized by tropical hot and humid climate. Daily data of maximum temperature, minimum temperature, dry bulb temperature, wet bulb temperature, dew point temperature, relative humidity was collected for the period, 1969-2015. Thermal discomfort caused due to heat stress was calculated by Heat Index (HI) and Wet Bulb Globe Temperature (WBGT). The results indicated rising trend in hot extreme days, heat index and occupational heat stress index WBGT during the months of summer and monsoon seasons at all selected stations. The study further inferred that temperature increase is not the only reason for thermal discomfort and related heat stress, though it certainly aggravates heat stress

conditions, but high temperatures combined with other meteorological factors are causative factors for significant increase in thermal discomfort.

Keywords: Temperature Extremes, Thermal Discomfort, Heat Index, Wet Bulb Globe Temperature.

BACK

URBAN EXPANSION IN A LATIN AMERICAN CONTEXT: THE CASE OF MEXICO CITY

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The urban expansion of large cities in Latin America are immersed in different processes since the mid-twentieth century. In a first phase, with the development of industrial activity in Latin American capital cities (Buenos Aires, Santiago de Chile, Sao Paulo, Mexico), a large part of the expansion was due to migratory movements from the countryside to the city, and this, from the informal settlements. Towards the last quarter of the last century, and particularly in the last two decades, a large part of the recent expansion is due to the formal housing market, particularly social housing.

The reform of the constitutional article 27, reforms in housing policy, moving from an interventionist state to a facilitating state in access to housing, resulted, in the case of Mexico City, in a growing real estate dynamic. The recent expansion, characterized by the massive

construction of social housing, largely took place on "social property" land (land used for agricultural and livestock activities), changing land use and impacting the environment.

Keywords: urban expansion, Mexico city, social housing, social property.

BACK

URBAN FLOODING: PERIL OF IMPERVIOUSNESS

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Urbanization is necessarily a process which is directly related to development. Urbanization brings about changes in varied sectors like social, economic, demographic, etc. and transforms the land use pattern of the area. At present the ever-increasing pressure of population on the cities coupled with development in these varied sectors, have literally altered the urban surfaces into paved areas. The present paper attempts at addressing the issue of paving of urban areas and the threat of increased imperviousness. Impervious surface areas (ISA) are defined as any impenetrable material that prevents infiltration of water into the soil. The manifestations of increased imperviousness have been witnessed in different metros such as Mumbai, Pune and recently Chennai. The increased impervious surfaces are responsible for causing flash floods in urban areas leading to inundations, which have given rise to several issues for the urban dwellers. In this study a case study of Pune city is taken up to address the peril of imperviousness to urban environment. Using satellite data, to assess imperviousness, it is shown that how these surfaces have led to increased runoff and increased Land Surface Temperature (LST). Ramnadi, a small watershed covering the western part of Pune city was assessed for the impact of imperviousness on runoff. It was observed that net growth in built up area between 1989 and 2011 was about 24%. Impervious surfaces have also increased above 25%. The simulated results for the basin indicated an increase of about 100 MCM in runoff for the year 2011 as against 1989. Similarly an increase of about 8 to 12 ^{o}C in LST was observed

at different locations within the city. Thus it can be concluded that the increase in built up area has led to increase in runoff and also affected the land surface temperature.

Keywords: Impervious surfaces, surface runoff, LST.

BACK

TRENDS, CYCLES, "LEAPS" AND PAUSES IN CLIMATE CHANGE AND THEIR POSSIBLE CAUSES

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Based on the analysis of trends, "leaps" and pauses in the changes of Earth's climate, contradictions in the evidence base of modern estimates of spatiotemporal climate changes were considered. Due to closing of weather stations in inaccessible areas of the Earth, the ratio between number of weather stations in urbanized areas and total number of weather stations has changed. Thus, the "adjustment for urbanization influence" in large areas in the general Earth's temperature data series has increased leading to overestimation of the role of greenhouse gases in temperature change. Internal and external causes of "leaps" and pauses on the background of long-term climate change trend connected with increase of concentration of greenhouse gases in the atmosphere and decrease of their sinks were considered. It was shown that sustainable and statistically significant quasi 22-year, 60-year and 70-year cycles in Earth's temperature changes are connected with solar activity and, probably, gravitational influence of the largest planets of Solar System, i.e. Jupiter and Saturn. These cycles of temperature change were the most sustainable in the period before 1970s.

The results of statistical assessment of contribution of natural (volcanic) and anthropogenic aerosols and "minor" climate-forming factors such as solar activity were shown. It turned out that the influence of 22-year cycle of solar activity was the strongest in the regions of Earth that are the least affected by anthropogenic influence (oceanic areas of the Southern hemisphere). Estimation of the role of solar activity in climate change turned out to be higher than estimation of the IPCC. The probable explanation for this is that in our assessment we considered not only the influence of electromagnetic radiation, but also the influence of charged particles coning from the Sun and space.

Keywords: climate change, trends, cycles, pauses, solar activity, urbanization.

BACK

APPROACHES FOR AN ASSESSMENT OF THE IMPORTANCE OF LANDSCAPE-RECREATIONAL TERRITORIES FOR THE ALLOCATION OF NATURAL FRAMEWORKS IN CITIES

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Increasing loads on the environment and rising requirements for the quality of the urban environment calls for the formation of natural frameworks in cities. Their main role is to ensure an improvement of the state of environment and to create favorable conditions for people's recreation. A certain experience of the allocation of a natural framework was obtained while adjustment of the general plan of the city of Minsk. Nodal structures (nucleuses), transport (ecological) corridors, buffer zones and territories of ecological rehabilitation were determined as the main structural elements of the natural framework of the city. The following basic functions were taken into account while determining the importance of the territories for inclusion in the natural framework: sanitary and hygienic (assimilation/accumulation of pollutants, sanitation of atmospheric air, climate-regulation), recreational, water regulation and protection, conservation of biological and landscape diversity. Qualitative scoring scales were developed for the ranking of territories by their value in performance of these functions. The assessments took into account the ecological and recreational potential of the territory as well as the conditions for the implementation of such potential. An integral assessment of the ecological and recreational importance of territories for their inclusion in the natural framework was carried out by calculating of the average score for a group of criteria. Landscape-planning plots were used as spatial units of analysis and mapping taking into account the boundaries of landscape and recreational areas (forests, plantings of various types and functional purpose, reserve territories). The assessments required a comprehensive analysis of topographic, geological, geomorphological and landscape maps, as well as data on the structure and state of green areas and plant communities and a number of town-planning data (functional zoning of urban areas, boundaries of sanitary protection zones, water protection zones, flooding zones etc.).

BACK

RECEDING URBAN WETLANDS AND URBAN VULNERABILITY TO CLIMATE CHANGE: A STUDY OF LUCKNOW CITY, INDIA

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Urban land transformation has significance influence on changing wetland ecosystem surrounded to the city area over the world. Land use/land cover change affects the spatial landscape of the wetland as well as the total ecology of wetlands. Wetlands across over the genetic plains are under increasing stress due to infrastructural development, rapid population growth, economic and urbanization growth, especially the wetlands around the Indian mega cities and peri-urban areas of the urban centers. Lucknow city is one of the important growing mega cities in upper Ganga plain with many important wetlands. In this context we investigated the impact of urban sprawling and land transformation on degradation of wetland ecology of peri-urban areas and associated climate change vulnerability in study area. For this purpose we used sensed data and Geographical Information Systems (GIS) techniques to estimate land transformation for the period of 1990 and 2015. Urban patches were generated to understand the impact of these urban patches on spatial dimension of wetlands. Form the Spatio-temporal analysis of remotely sensed data it was observed that the urban expansion have a influence to decrease permanent open water surface over the study periods. The analysis has shown that increasing anthropogenic pressure coming from over exploitation; encroachment and reclamation of vast wetland areas for residential, commercial and industrial development have

led to fast shrinking of wetlands and have altered wetland functions and have increased urban vulnerability to Environmental Degradation and Climate Change.

Keywords: Urban sprawling, Urban area, Wetland ecology, Lucknow City & Environmental Degradation.

BACK

IMMEDIATE IN-CYCLE REUSE OF URBAN RUN-OFF WATER BASED ON URBAN LAND USE AND WATER QUALITY AS NEW URBAN WATER SUPPLY

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This research aims to consider the urban run-off as a new urban water resource before exit from sub-basin. In the first phase of this research six urban characteristics and land use indices was define concerning all parameters which may have direct and indirect effects on urban water quality. Population, hourly in-city immigration, urban heals islands, land use type, meteorological factors, local physiographical parameters; urban patterns etc. were considered in developing the new indices.

Four study area including different urban land uses were selected in Tehran Metropolitan. All urban land uses recorded considering the probable effects on water quality. All water demands were estimated including the minimum and maximum quality and amount and current supplement. Urban drainage maps and structures were studies and sampling points were determined. Water sampling in specific points was carried out 10 minutes after precipitation regarding to concentration time of each micro urban sub-basin. Samples transferred to environmental chemistry laboratory and water quality variations such as NSF variations, heave metals, Asbestos, soot and hydrocarbons were measures via in-situ equipments, spectrophotometers, ICP, HPLC and GC devices.

Multi-statistical analysis, discriminate analysis and multi-linear regression analysis were applied to all water quality results and urban indices in each site. Results revealed very strong relation between urban land use and water quality variation. Temporary population especially in downtown site was effective temporal factor how even public transport didn't have any significant affects. In case, population density didn't have not much influences on water quality since all sanitary waste water in selected sites was collected through urban wastewater systems. General slop was a significant factor in hydrocarbons and heavy metals once they were

not alongside the streets route. Northern parts with high level altitude have gotten lower impacts from urban land use.

General water demand including fire fighting, green space irrigation, street clean up water were found as the main costumers of urban run-off with out any primary treatment. These new water sources can supply 20% and 70% all mentioned general demands in dry seasons and wet seasons respectively by regional local collection system in local reuse cycle.

New consumption potential will reduces the costs of urban drainage system and eliminate urban run-off collection and transfer demand while it decrease water withdraw from regular sources and develop a new perspective of new water resources according to sustainable development goals (SDGs).

Keywords: Urban land use, Run off, Water quality, Water resource, Consumption.

BACK

THE GEOCHEMICAL RECORD OF POZNAN MOAT, AREA OF THE WATER GATE

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The convenient location along the crossing river valleys of the Warta and Cybina favoured defence conditions and had initiated the creation of one of the most beautiful cities in Poland. Poznan, in question, surrounded by city walls and a moat, was recognised as an essential military centre that serves the defence of our country to modern times. Unfortunately, as a result of devastation and neglect, the fortification was dismantled, and the moat was filled up in the eighteenth and nineteenth centuries. Today, we can read about them in books and ancient engravings (Pilarczyk, Karolczak 1996, Wiesiołowski 1996).

In connection with the revitalisation of Kolegiacki Square preliminary research has been carried out. One of their components was the execution of a series geotechnical wells in Kolegiacki Square, near the Water Gate. That made it possible to reach layers and sediments associated with the beginnings of the city. The research aimed to determine how the most important events in the city's history were recorded in the lithology and geochemistry of the moat sediments. The previously performed grain size analysis was used for this purpose, which was compared with the results of tests determining the content of organic matter and CaCO3.

Obtained in 2017 (Galas 2017) grain size parameters allowed to determine the boundaries between the existing series of sediments, which differ in the sedimentation environment. In turn, granulometric analyses have shown that the ground of the studied area is mainly composed of sandy sediments, which build the second level of Warta terrace. The ceiling is made of anthropogenic deposits.

Research on geochemical features confirmed the sedimentological differences of the sediments. Distribution of curves obtained from measurements the content of organic matter and CaCO3 in anthropogenic layers showed the higher proportion of them about natural sediments. The cause is large occurrence accumulation of debris and a brick piston. The occurrence of this material proves to cover the moat as a result of the demolition of city walls during the Prussian rule (Ryżycki 1996). The artefacts found in the profile, i.e. fragments of

bones, vessels, chain and leather, confirm the theory that the moat also has a utility function. Also, bone fragments in the profile may come from the cemetery around Collegiate, which

during the demolition of the temple has been destroyed and the bones could be dislocated as a result of levelling the square.

Keywords: Moat, geochemical research, Water Gate, Kolegiacki Square, Poznan.

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BACK

POSTER

GREEN CONSTRUCTION AS A METHOD OF NORMALIZING ATMOSPHERIC POLLUTION IN GROZNY

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One of the most serious environmental problems in Grozny is air pollution. The main pollution is produced by industrial enterprises, housing and communal services, motor transport, associated petroleum gas combustion, fires, etc. Many of these pollution sources remain unaccounted for.

Against the background of a decline in gross emissions of pollutants into the atmosphere, there has been an increase in the release of carcinogens by 2%. The greatest pollution of atmospheric air within Grozny is explained by the historical location of industrial enterprises in the past and now, as well as by the greatest concentration of road, rail and air transport.

The leading factors of atmospheric air pollution in the above listed settlements in the country as a whole and in Grozny are emissions from vehicles and weather conditions. Inversions with stagnation of air and low wind speed, lead to a weakening of dispersion of low unorganized emissions from motor vehicles, which creates favorable conditions for the accumulation of exhaust gases in the surface layer of the atmosphere.

The modern look of the city of Grozny is characterized by a low level of gardening. For each resident of Grozny, there is 9 square meters of a green zone, while sanitary and hygienic standards require 25-30 m^2.

Among the activities aimed at improving the environment, in particular the protection of atmospheric air, the most effective is the intensive gardening of the urban environment, areas of the industrial zone, along the highways and in general the urban landscape. Active measures should be taken to restore the green capital of the capital and be carried out taking into account the following criteria: the environment-forming potential of plants, the degree of its resistance

to man-made pollution of the environment, the dust-collecting and getter capacity, the ability to neutralize and neutralize contaminants.

Keywords: Oil, transport concentration, air stagnation, weather conditions, green zone, gardening, neutralization.

BACK

Cross-border Cooperation: Challenges, Opportunities, Institutions

BACK

MIGRATION CHALLENGES TO SOCIO-CULTURAL SPACE: POLITICAL COMMUNCATION OF RUSSIAN MIGRANTS LIVING IN FINLAND

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The article deals with peculiar traits of Russian migrants' political communication in Finland, the second largest migration group after Estonians that influences greatly the recipient country's political process. Authors scrutinize migrants' interaction with the environment, outline cause-and-effect links of this interaction, unveil external factors that influence the respondents' political behavior. The research is based upon interviews, which result in respondents' typology development, political information channels were defined, and the influence of education and social inclusion upon political communication was characterized. Thus, the research results help to perceive Finnish migrants' integration policy, the fourth most attractive country in the world in accordance with the Migrant Integration Policy Index. Besides, migrants' interviews dealing with political communication trends will help to perform the projections on various shifts in the society. Finnish experience might be highly useful for Russia in terms of both national migration policy development and optimization.

Introduction

In accordance with the Migrant integration policy index – developed by Barcelona Center for International Affairs and Migration Policy Group – Finland remains a country with favorable integration policies scoring 4th overall behind Sweden, Portugal, and Canada. This methodology embraces 7 areas of migrants' integration – labour market mobility, family reunion, education, political participation, long-term residence, access to nationality, anti-discrimination [Migrant integration policy index 2013]. Migrant integration policy index helps

us to evaluate migrants' rights and wellbeing, analyze state migration policy, state's responsibility as well as develop recommendations on migrants' integration policy.

Finland's attractiveness for migrants doesn't raise a doubt. For example, Future Strategy of Migration 2020 has been recently adopted and announces the following principles[Future Strategy of Migration 2020]:

- Diversity will be valued as Finland's internationalization continues.
- Equality and equal opportunities will apply to everyone.
- Migration will enhance the wellbeing of the population and boost Finland's competitiveness.
- Migrants will be able to use their skills and contribute to the future development of society.
- Migration will be foreseeable and controlled.

Starting from the 1st of January 2015 an updatedFinnish Non-Discrimination Actcame into force authorizing *the Non-Discrimination Ombudsman*. Nowadays in Finland there are *Non-Discrimination Ombudsman, Equality Ombudsman and Ombudsman for children*, all three institutions are also aimed at migration policy regulation.

This article deals with the one of the 7th integration areas in accordance with the Migrant integration policy index – migrants' political participation, in particular, Russian migrants' political communication in Finland.

The article is analyzing interaction of the target group with ambient environment, cause-and-effect relationship together with factors influencing respondents' behavior are outlined.

Russian migrants interview in Finland

In accordance with Finnish statistics Russians were the largest migration group till 2010 (29,500) [Statistics Finland 2010]. Nowadays the situation has changed. Russians (29,800) are the second largest groups after Estonians (38,000) [International Migration Outlook 2013].Todaymigration flow in Finland is mainly represented with 2 largest groups of migrants – 49% of Estonians and 39% of Russians. [International Migration Outlook 2013].

This witnesses that for the last 5 years (2010 – 2015) migration outflow from Russia to Finland has dried out. For a long period starting from 1990-ies and till 2010 (about 20 years) basic reasons for active labour migrationin Finland are: InkeriFinns remigration, international marriages, refugees. However currently Finnish immigration policy is changing drastically– foreign labour migration flows from Russia are significantly reducing. One of the basic reasons

is thatFinnish government has fully stopped Inkeri Finns repatriation from Russia starting from 1 July 2011. As aresult Finnish migration policy has changed significantly.

Currently Russian diaspora in Finland is not studied well, especially their peculiar traits of political communication. In this term, thischaracteristics are highly valuable from the point of view of migration policy regulation.

Outlining basic factors that would influence inter-personal communication on politics among Russian migrants in Finland.

Key factors identification that would influence interpersonal communication among Russian immigrants in Finland is important due to the fact that:

1) there is lack of research on the topic of migrants political communication. Thus, in Russia political communication isscrutinized in the following areas: power as a political communication (L.Timofeeva), political communication theory (M.Grachev), sociology of political communication (G.Diligensky), psychological aspects of political communication (A.Zimichev, D.Olshansky, E.Shestopal, A.Yurev), information security impact on political communication (I.Panarin), political communication as a way to deploy political order events (N.Anohina, O. Malakanova); political communication as an independent phenomenon not as a function, but as a process (A.Soloviev); use of information and communication technologies (N.Zazaeva). There are no papers devoted to political communication of migrants in Russia.

2) Russian migrants are the second largest group of migrants in Finland influencing potentially the political process. Here we have in mind that Russian migrants in Finland have a very strong instrument of influence - right to vote in municipal elections. According to Finnish law – the Election Act – any citizen of any state has a right to take part in municipal elections. There are however additional two conditions, according to the Finnish law, which are living in the municipality in which the vote is held (at least 51 days before election day) and stay in Finland for at least two years.

Research methodology

Conducting migrants' surveys is the most important tool that allows you to identify structural changes in society and to assess the reasons for these changes. Migrants' surveys allow to supplement and provide more details upon statistics obtained from public information sources. Thus, for example, in Finland, migrants' personal dataupon age, gender, country of origin, immigration country, religion, marriage, date of entry is obtained from a variety of sources accumulated in one information system "Population Information System" under Statistical Agency of Finland. Information on migrants is accumulating from different confessions' parishes, hospitals and the Migration Service of Finland. In Finland, migrants need

to obtain ID card necessary for work or medical assistance, and for this each migrant has to undergo a mandatory registration procedure in “Population Information System”. Every year “Population Information System” staff is serving migrants and thus checking their residential address. In 2014 it turned out that 99% of migrantshve the same address. Each month the information system generates final reports on changes occurred for the last month - «Population statistics service». At the end of each quarter the information system provides provisional statistics on population changes for the year («Quarterly population statistics»). Statistics on migrants is published annually: in electronic form in May and in paper form in June of each year («Population structure and vital statistics by municipality»).

Migrants’ surveys allow to supplement the information system data from open sources and are used to achieve the following objectives:

1. to access detailed information on various parameters

2. to identify migrants sentiments

3. to define migrant problems

4. to get information that demands theresponse (for example, which materials migrants are reading).

Migrants’ surveys are highly important in terms of migration policies analysis in the OECD countries. The OECD is performing migrants’ surveysregularly for accessing their living conditions, political preferences etc.

The best foreign experience has shown that migrants’ surveys arehighly important in terms of society structural changes projection.

As an example, let’s consider Russian migrants’ survey results living in Finland in order to identify their political communication characteristics. The research of Russian migrants in Finland is the qualitative one that allows both to develop and prepare the basis for the more in-depth study. The aim of the study is to identify the main trends in relations with politics of the Russian migrants living in Finland.

The authors developed a questionnaire in order to achieve the purpose of the study. The questionnaire included 30 questions and was divided into five main categories: political information sources, political dialogue, use of sources of information through the Internet, political participation, social status etc. Secondary questions were related to international news, national government, economic news, community events, editorial columns of the local news.

Migrants survey results have showed that migrants political communication assessment is very important because it allows you to identify the underlying trends in political preferences,

to obtain information for a rapid response in certain cases as well as identify areas where migrant needs help.

Respondents profile

In general, 122 respondents took part in interviews. No doubt the obtained data demands further approval by quantitative data but this research is mainly qualitative and aimed at analyzing interaction of the target group with an ambient environment.

Respondents were selected in accordance with the snowball effect. The respondent profile is presented with a Russian migrant living in Finland for more than 3 years, of Russian nationality, of full legal age. Age, education level and income level were not taken into consideration. The interview also revealed some additional characteristics of the sample.

After interview it became clear that 55 respondents were not interested in politics ("idle respondents"), 55 respondents ("active respondents") were actively using political communication channels (media, social networks, internet, TV, social circles (family, job)). Twelve respondents were rather negative towards politics ("blocking respondents"): "I am interested only in my close people, I do not see any reason to spend my time on politics".16 respondents out of 122 participated in municipal voting. Finnish law is ensuring migrants' participation in municipal elections – "for those migrants who live at least 2 years in Finland and at least 51 days in the commune in order to involve them in the processes of integration" [Election Act].

The most popular expression that served as a motive forrespondentsselection was the phrase "try to follow all the news". Thus, the respondents ranged from actively watching political events "to be in the swim" to never participating in elections, signing/creating petitions "because that doesn't help", and never be interested in news but participating in elections "of course it's my duty, I have to vote" or "it is necessary to do something,cose if you remain silent this will happen all the time". In summary, 3 main types of respondents can be identified based upon their interest in politics: active, idle and blocking.

• **Active respondent**. Most active respondents have aspiration to compare different sources of information, interest in politics of both Finland and Russia, as well as international and local political issues. Those, whose interest in political issues is high, can be divided to two further groups:

-those, who actually like to discuss politics with peers;

- and those, who are actively looking for political news but they are not that open to discussions and consider this knowledge only for their personal development.

Moreover, willingness to compare different sources of information often correlate with higher education.

• **Idle respondents** are those, who would listen about political issues in the general daily news flow but would not try to find information about political topics themselves. They would listen to political discussion and even might slightly participate to it but would not initiate it themselves.Politics for them is a parallel world to which they never seek to interfere, but always watch it how it changes.

Blocking respondent. Mentioning politics brings negative emotions to members of this group. They generally have a skeptic approach towards political affairs. They would not participate to political discussions and would try to avoid them.

Thus, respondents' answers gave us an opportunity to categorize migrants' in accordance with the above mentioned types.

Political information channels for migrants

There were outlined 4 main channels of receiving political information by Russian migrants in Finland – internet, TV, newspapers and social circles. It should be noted that information obtained by Russian migrants living in Finland is performed through a wide range of channels. However, it should also be mentioned another peculiar feature. Thus, for some respondents who don't know Finnish language or possess low knowledge itis difficult to access news in Finnish. Despite this, it is still believed that the most favorable conditions for migrants are established in Finland which is actively working on migrants integration including Russian migrants also.

This is also proved by a wide range of news presented in Russian, for example, Internet news resources "YLE" and "Spectrum", information portals «Russian.fi», "Fontanka.fi", "Russian Finland", radio news in Russian language – "Sputnik".

Thus, the variety of sources from which the respondents received information on political events is reduced to the following basic 4 channels:

1.Newspapers (both printed and electronic) are divided in 3 groups:

- Russian newspapers: «Novaya gazeta», «Argumenty I facty», «Snob»;

- Finnish daily newspaper «Aamulehti» (second popular newspaper in Finland after «HelsinkinSanomat» and «TurunSanomat»);

- Finnihs resources in Russian language «Spector» и «Yle».

2. Television – respondents prefer watching Russian channels such as ORT, NTV, RTR, TNT, Channel 5, the channel "Spas". Respondents particularly noted such political programs browsing as "K Bariery" on RTR channel and "Pyaterkapoekonomike" on "Spas" channel.

3. Internet sources used by respondents in order to learn political news – Newsru.com, Yandex.ru, Euronews, Facebook, Vkontakte, Odnoklassniki.

4. Small groups – another popular method of respondents political communication with co-workers and family members.

Migrants' surveys results draw the following conclusion – newspapers (in electronic and printed form) were used by active and idle respondents. There is also a study outlining that newspapers reading as well as participation in discussions motivate to participate in political activities [Sotirovic, McLeod 2001: 287]. At the same time it prevents from entertainment television programs viewing. Thus, according to the results people with higher interest in political events prefer to read newspapers and analytical articles, but refuse to participate in any political activity. Those who prefer TV programs to newspapers are trying to participate in the elections.

Different channels influence upon political communication intensity was also studied.

Frequency of turning to different information sources (number of days per year when sources were viewed in relation with the total number of days) was used as an indicator characterizing migrants' political communication intensity. Thus,"1" ispresented as a maximum (daily frequency) and minimum is corresponding to "0.03" which is several times per year.

The Figure 1 shows the mean intensity of migrants political communication depending on the type of source.

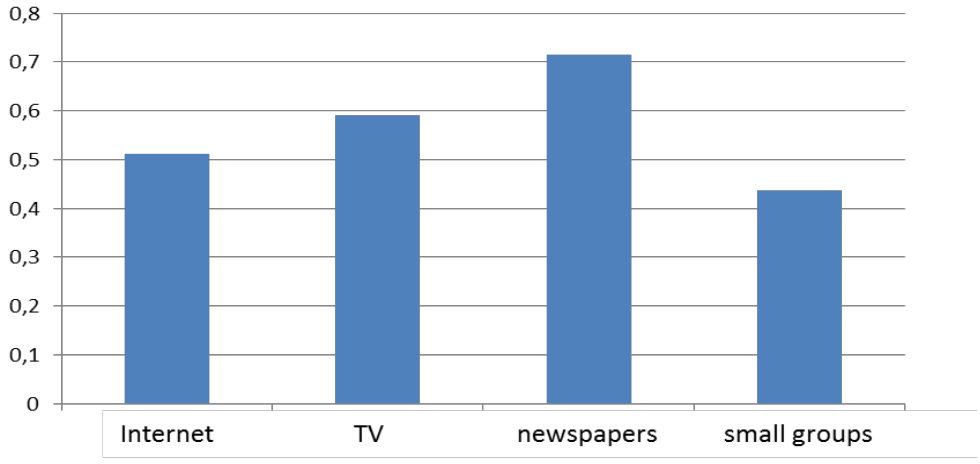

Fig. 1. Political communication intensity of Russian migrants in Finland based upon information channels

It is visible from the Figure 1 that political communication is getting more intensive when migrants get their information from newspapers. In part this may be due to the

predominant position of Finnish newspapers in Finland that publish detailed information on municipality / city life. Second place goes to TV, on the third – Internet.

Under the interview it was also defined that the role of small groups has an impact on Russian migrants political communication in Finland.

According to study of J. D. Mutz and Mondak, the most likely place for the policy debate is a working place [Mutz, Mondak 2006]. However, data obtained under the interview indicates that the situation has some limitations for Russian migrants in Finland. In the workplace, both in mixed teams (with Russian and Finnish colleagues) and in teams where only Russian migrants work there are some discussions on political topics. Colleagues discuss political events not only in Russia and Finland but also on international arena, however, in companies with international staff political themes often get avoid.

The probability of discussion upon conflicting topics is much higher within the family members, since the level of trust is high. In the workplace, employees often prefer to avoid such issues, though it is not an absolute rule, and if there's trusting relationship between colleagues it is quite possible to exchange opinions.

Migrants' social inclusion in society

Under the interview, the correlation between level of integration into the host society and choice of an interesting events in Russian and Finnish societies was found. For example, young migrants (students, young migrants in a labour market), who grew up in Finland and are fluent in Finnish language, have a higher degree of social inclusion, which allows them to understand more easily what is happening in political arena.

Senior migrants often lack language skills, socialization experience in the new society (no work, no new education), often prefer to concentrate on Russian political events, obtaining information mainly from Russian media. However, this is not a widespread rule. In Finland there are Russian migrants who are active in the pre-retirement and retirement age. They continue to familiarize themselves with the host society, and to stay up to date with its main events. For some Russian migrants Finnish news daily newspaper "Aamulehti" is the main source of information, and they read it, even if you have to use the dictionary constantly.

Migrants survey's results confirmed the previously identified relationship between level of education and breadth of political interests [see. Eg, Hillygus. 2005; Price, Zaller 1993] and have showed that migrants with higher education seek to educate a wider range of political topics. They used a wider range of information, including analytical programs and magazines. These respondents refer to news critically and compare news from various sources. The results of conducted migrants' interviews confirm this relationship again. Thus, "active" respondents

with higher education are more eager to talk about information analysis from different (or even multilingual) sources (“I compare information from different sources, in particular, the Finnish sources – YLE, Russian news channels in Internet, British sources, then I can skype with my friends and ask how it is in reality”). Thus, the analysis of a wide range of news gives a clearer picture of the situation in a political world, and can provide a more solid basis for political communication and political participation later.

The research also proved the fact that migrants social inclusion into host society is highly dependent on language knowledge. For confirmation of the hypothesis a causal analysis of the social inclusion impact upon political communication intensity was conducted. As an indicator, which characterizes Russian migrants’ social inclusion we use factor of foreign languages knowledge, including Finnish and English. The final indicator for political communication intensity became the frequency of interaction with information sources (access to Internet sources, reading newspapers, watching TV, small group discussion etc.)

Knowledge of Russian language is accepted as a minimum factor of migrants’ social inclusion. Knowledge of one foreign language (English or Finnish) correlated to average value of migrants’ social inclusion. The maximum value of the factor is the knowledge of two or more foreign languages.

Figure 2 below shows migrants’ political communication intensity depending on foreign language knowledge.

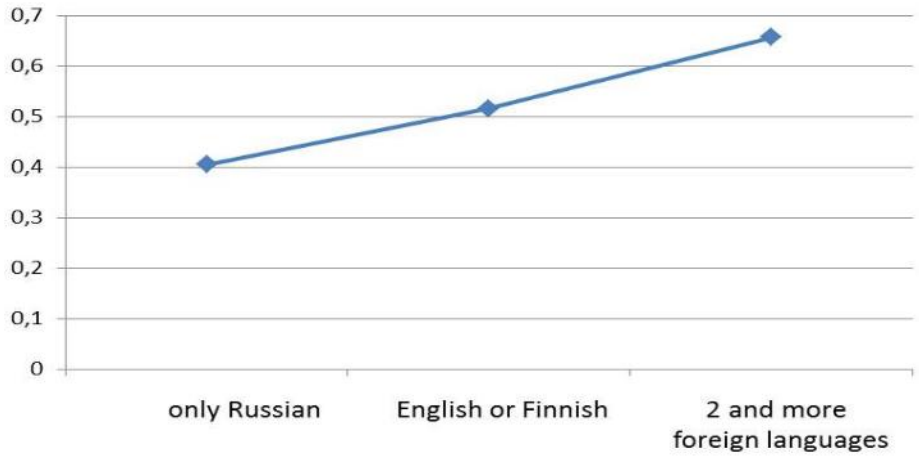

Fig. 2. Political communication intensity of Russian migrants in Finland depending on foreign language knowledge.

Figure 2 shows that migrants political communication intensity is higher if a migrant knows one or more foreign languages, accordingly, he/she has an opportunity to get acquainted with a wide range of multilingual sources.

These results confirm the theory Sotirovich and McLeod that: “Education provides both knowledge and skills to work with information, and therefore, improves access to political process, at least, makes political participation more likely”. [Sotirovic, McLeod 2001: 273-300].

The survey results have showed that workers with higher education in general, seek to familiarize with a wide spectrum of political topics, and thus analyze events critically.

In conclusion, it is worth noting that research has proved the fact that migrants social inclusion into society is heavily dependent upon foreign language skills.

Conclusion

In this study we’ve investigated some unknown features of Russian migrants’ political communication in Finland. We’ve identified some characteristics of political communication by applying interview method embracing 122 respondents.

The following characteristics of migrants’ political communication were outlined as a result of survey data processing:

- respondents are distributed according to the following types of political communication: «active» – 45%; «idle» – 45%; «blocking» – 10%;

- relationship is found between level of education and both quantity and quality of media sources accessed by respondents, for example, only migrants with higher education accessed analytical journals;

- positive correlation between number of foreign languages and migrants’ political communication intensity is found;

- following priorities for the use of political information sources among migrants is identified: Internet – 64%; TV – 45%, newspapers – 27%; small groups – 18%;

- impact of various information channels on political communication intensity of Russian immigrants in Finland is estimated;

- role of small groups in migrants’ political communication is discovered.

So, at the workplace and, in particular, in companies with an international team, despite the presence of small groups (colleagues), political topics are shot out by tolerant reasons. On the contrary, political situation is discussedmore frequently within the family.

Theoretically the research allowed both to analyze suchan important aspect of migration policy as migrants’ political communication and identify its key features.

The resulting characteristics of migrants’ political communication might be of high interest in terms of migration policy regulation and understanding the issue of migration quotas.

The findings would also help to predict structural changes in society, to assess the level of radicalization in society, provide the basis for decision-making.

Keywords: political communication; migrants' interview; migration policy; integration policy; Finland; migrants' survey.

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BACK

FACTORS AND MEASURES OF CROSS-BORDER SOCIAL COHESION: A CASE STUDY IN CENTRAL EUROPE

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The paper will present both past developments and recent situations concerning border structure and cross-border social cohesion in Slovenia, one of the most typical Central European contact regions. For Centuries it represented the southern borderland of the Austrian Empire in the Balkans, whilst in the Yugoslav period, following WW 1 and in particular WW 2, it assumed the function of northern link with Western Europe. After achieving independence in 1991, it became, after Luxembourg, the European state with the most pronounced border character and a real laboratory for studying border issues and cross-border integration processes.

However, its border structure vary in a quite extensive way. From a historical perspective, there are border sections, which remained almost unchanged from the 10th-12th Century (the central part of the current boundary with Croatia and the western part of the current boundary with Austria), or from the 16th Century (the central part of the current boundary with Italy), even though they changed their function from inner regional borders to international boundaries. Other border sections were fixed after WW 1 (the eastern part of the current boundary with Austria and the current boundary with Hungary, but also the eastern part of the current boundary with Croatia – at that time as an administrative inner borderline in the Yugoslav Kingdom) and WW 2 (the southern part of the current boundary with Italy and the western part of the current boundary with Croatia in Istria – at that time as a republic border in the Yugoslav federation).

We may observe thus the different “philosophy” related to the different periods within which these borders were created. The oldest boundaries mostly followed orographic border-lines, as in the case of borders with Austria and Italy, or are antecedent to the creation of the creation of the social spaces and ethno-linguistic organization of space, which actually helped to construct, as in the case of the border with Croatia. These “old” boundaries tend to separate social spaces, whilst “new” borders, as a result of the WW 1 and WW 2 partitions followed a

quite different vision. They basically lean on ethno-linguistic borders but at the same time run within an already constructed social and functional space and divide long-lasting multicultural regional organizations. We may therefore observe that potentials for cross-border (re)integration are generally much greater in the typology of “new” boundaries, in particular in those border areas, characterized by functional co-dependence and inhabited by national minorities.

The author developed a special methodology, permitting to “measure” the level of social cross-border cohesion and also to compare the various border sections, using a series of variables, divided in some clusters and indexes: the index of cross-border expectation, the index of potential cross-border cohesion, the index of social-cultural affinity and the index of functional cross-border co-dependence. The paper will thus discuss the results of this analysis and both differences and developments emerged from researches conducted first in 2007, before Slovenia entered into the Schengen space of free circulation in the EU, and then repeated almost ten years later. The results fully support the thesis that the elimination of political and administrative barriers to cross-border circulation represent a key-factor for strengthening cross-border cooperation and social (re)integration. They may also use as a lesson for all those in Central Europe that would like to return to an “iron curtain” border organization and management.

BACK

CONTRIBUTION OF INTERNATIONAL SCIENTIFIC COOPERATION INTO CROSS-BORDER DEVELOPMENT (CASE OF THE REPUBLIC OF KARELIA)

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It is recognized that international cooperation in science and technology is needed to deal with global and local challenges. Nowadays, there are new motivations and opportunities to support scientific collaboration for developmental goals and to strengthen research capacity.

In this article we will discuss how potential of regional research institutes in international scientific cooperation can contribute to the territorial development goals. The first part of our paper is dedicated to different levels of scientific cooperation in general. The case of the Republic of Karelia demonstrates that border regions possess much of the expertise, data and resources that are needed for finding effective solutions. Undoubtedly, geographic proximity and common interests remain important for cooperation. For instance, Nordic countries have vital research and educational experience in a wide range of spheres.

Besides, there is an existing tool for supporting cross-border initiatives with Russia, namely, European Neighbourhood Instrument. Its main aim is the reduction of the problems related to the periphery as well as creation of the attractive and comfortable environment for the people. However, cross-border projects may be more likely to succeed if they are followed by scientific evidence and further integrated into regional growth strategies.

This paper identifies good practices and new ideas, and presents options for concrete actions, accumulated during international cooperation of the Institute of economics of the Karelian Research Centre of the Russian Academy of Sciences.

BACK

CROSS-BORDER TOURISM DEVELOPMENT IN THE FINNISH-RUSSIAN BORDERLAND: HISTORICAL, CULTURAL AND ECONOMIC ASPECTS

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As a result of the socioeconomic transformations in the Russian Federation, the openness of border regions under the influence of integration process taking place in the world community facilitates tourist mobility between neighboring countries.

The article explores the practices of tourism and recreation development in a historical perspective and examines the effect of barrier and contact functions of state borders on tourism in the Finnish-Russian borderland.

The author describes an approach that considers the border regions of Northwest Russia (Murmansk region, Republic of Karelia, Leningrad region) as attractive destinations for tourists from Finland. The article presents the development of shopping tourism and nostalgic tourism as types of cross-border tourism in the Finnish-Russian borderland. The development of cross-border shopping in the Finnish-Russian borderland can significantly influence the development of local commerce and the territory as a whole on the both sides of the border.

Developing cross-border tourist routes is an effective way of developing cooperation between border regions of Russia and the neighboring countries. The author presents an approach that interprets cross-border tourist routes as an instrument for the conservation, reproduction, and promotion of natural, cultural, and historical potential and as a means to boost business activities in border regions. The article presents the theoretical and practical aspects of designing and developing cross-border tourist routes in the Finnish-Russian borderland. Particular attention is paid to the routes of the Republic of Karelia — the Blue Road, the White Road, and the Mining Road.

The author analyses statistical and analytical data and does the content analysis of regional strategies for tourism and socioeconomic development. The article identifies factors hindering tourism development, presents the prospects of developing cross-border tourism in

the border regions of Russian North-West and suggests measures to stimulate tourism as a regional economic activity.
Keywords: cross-border tourism development, Finnish-Russian borderland, border regions of Northwest Russia, cross-border shopping, cross-border tourist routes.

BACK

FINNISH-RUSSIAN CROSS-BORDER CO-OPERATION: LESSONS FROM THE FIRST 25 YEARS

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Cross-border co-operation on the Finnish-Russian border can look back at a 25 year history starting from a bilateral treaty between the two countries signed in 1992. Since then, several phases of co-operation - signified by changes in funding instruments, in the intensity of cross-border flows and in geopolitical framework conditions - can be distinguished. This paper will shed light on the varying ways the border has been perceived as a resource by the key actors and stakeholders involved in cross-border co-operation and interaction along the different phases of co-operation. We also examine how these varying perceptions are reflected in the strategies and priorities for cross-border co-operation, which have been adjusted over time.

BACK

BETWEEN BORDERS AND CAPITALS: PECULIARITIES OF DEVELOPMENT OF BELARUSSIAN-RUSSIAN BORDER

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The space under consideration is typical peripheral territories between Moscow and Minsk, which were established in the USSR. The demand and supply of the Moscow market has a great influence on the development of the borderland. But its effect is due to the liberalization of trade, mutual transport, rules for finding, living, working, training the population within the framework of the EAEC and the Union State.

In 2010-2016 years the Pskov, Smolensk and Bryansk regions developed at about the average Russian pace, while the Vitebsk, Mogilev and Gomel oblasts are below the average for the Republic of Belarus. An important factor in the development of the eastern regions of the RB is access to the Russian market. For this purpose, the leadership of the country carried out special measures to create commodity distribution networks in the Russian regions, the creation of assembly plants, and a wide subsidization of industries oriented to the Russian market. This system worked well before the crisis of 2009. But then the slower market transformation in the RB started to show itself, the growing competition in Russia, which forced to offer goods at lower prices at higher energy prices, and a more acute shortage of financial resources. Now in the Russian and Belarusian regions, agroproduction is rapidly growing, which can lead to its overproduction and problems in relations between the RF and the RB.

Social ties in the border region are gradually weakening: only 10-15% of the border population regularly visit neighboring regions. 25-30% have never been to neighboring areas. The cooperation in industry is based on the Soviet legacy and does not generate an increase in cross-border ties. Gravity of capitals is much stronger than borderline. The main contact zone is not along the border, but a strip along the transport corridors: Moscow-Minsk and Smolensk-Vitebsk. The framework of Russian-Belarusian integration create the capital cities. Their economic "shadow" restrains border regionalization. But the prerequisites for creating a border integration region can be revived as a result of coordinated modernization of the economies of Belarus and Russia.

Keywords: border regions Belarus Russia position Minsk Moscow market growth regionalization.

BACK

TRANS-BORDER DIVISION MEASURED: A CASE OF RUSSIAN-FINNISH BORDER

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Division is one of the three key spatial dimensions profoundly introduced within the New Economic Geography (the others are Distance and Density). Rephrasing the basic definition of the term Trans-Border Division could be defined as barriers to trans-border economic interactions created by economic regulations, political restrictions and socio-cultural differences.

The idea of the current research is to examine how trans-border economic interaction of the Republic of Karelia, Russia with Finland differs from Karelia's interaction with the rest of Russia. The research is focused on the analysis of out-bound flows of goods and services from the Republic of Karelia. The exports to Finland and out-bound flows to Russian regions from Karelia are compared by their composition. Prior to comparison, the flows are cleared from goods and services items that are not consumed in Finland. The aim of the comparative analysis is to try to reveal the share of exports lost by the Republic of Karelia due to trans-border division.

As a result of the comparative analysis the impact of the trans-border division on economic interaction is assessed, while factors that cause the division are not touched within the current work. In terms of methodology, the current work is headed towards a tool for assessing trans-border division.

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BACK

MODELING OF DJANKUAT GLACIER EVOLUTION UNDER CLIMATE CHANGE

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In general, Caucasus glaciers lost approximately one-third of the area and half of the volume during the 20th century. Prediction of their further degradation in changing environment is a challenging task because rivers fed by glacier melt water provide up to 70% of the total river run-off in the adjacent piedmont territories. Therefore accurate assessment of future glacial run-off is a key problem of sustainable development in the regions where hydrological regime is dependent on glacial run-off. The problem is solved by dynamical modeling of mountain glaciers. Because of lack of regular observations, it is feasible to focus on several reference glaciers in the region and to further extrapolate modeling results on the whole glaciated area.

We employ a 3D higher-order ice flow model coupled with a surface mass-balance model to perform prognostic numerical experiments aimed at simulation of future dynamics of Djankuat Glacier. It is a typical valley glacier on the northern slope of the main Caucasus chain. Djankuat is one of the most well studied glaciers in Russia (and, perhaps, in the World) which has been continuously monitored during the last fifty years. Considerable parts of the ablation zones of Djankuat are covered with debris. Heat and physical properties of the debris layer are very different from those of ice. Debris layer determines ablation rate and ice run-off regime. Dependently on thickness, it can accelerate ablation or totally isolate ice cover from melting.

To correctly describe ablation rate, we incorporated an algorithm for calculation of ablation rate under the layer of debris.

To validate the model, we utilize observations from the nearest weather stations (Terskol and Mestia), as well as flow velocity, radio echo-sounding, accumulation and ablation measurements. In the prognostic numerical experiments, we simulated possible Djankuat evolution until the year 2100.

BACK

CLIMATE OF THE EEMIAN INTERGLACIAL AS REVEALED BY THE EARTH SYSTEM MODEL

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Earth system models (ESM) are now widely used for palaeoreconstructions. In this study, we analyze results of the numerical experiment aiming at simulation of climate of the penultimate (Eemian) interglacial (last interglacial, LIG). Numerical experiment was carried out using an ESM designed in the Institute of Numerical Mathematics of RAS. Orbital parameters were set with 1 kyr periodicity and were further interpolated with the time step of 100 years. Assuming concentrations of greenhouse gases during the LIG were not very much different from the preindustrial values, this potential forcing was neglected. Climatic block of the ESM was called every 100 model years to follow changes in orbital forcing. Sub-models of ice sheets were asynchronously coupled to sub-models of the atmosphere and the ocean with the ratio of model years as 100 to 1. Obtained anomaly (Eemian vs preindustrial) fields of surface air temperature correspond in general to the results of the earlier studies. Changes in the structure of the global atmospheric circulation yeilded in transformation of the precipitation field in certain regions of the world. In particular, precipitation growth in Northern Africa was the reason for the radical change of landscapes.

In the frameworks of the study, we evaluated the role of the Greenland ice sheet in the rise of the mean level of the World Ocean. Its estimated contribution (2 m) confirms the newest estimates based on the model results and analysis of the proxy data. In the beginning of the Eemian interglacial (until 126 years before present) mass lost occurs across the marine boundary of the sheet. During the next five millennia, negative surface mass balance plays the leading role. Taking into account contributions of the Greenland ice sheet, ocean thermal expansion and melting of mountain glaciers and ice caps, it is very probable that the main source the global sea level growth to 6-9 m compared to present was the West Antarctic ice sheet.

Keywords: climate, palaeoclimate, mathematical model, glacial-interglacial cycles, Eemian interglacial.

BACK

CHANGING FIRN PROPERTIES ON GLACIERS IN CENTRAL ASIA

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Several mass balance studies indicate that glacier mass loss in certain areas of Central Asia is low compared to global average. However, the reasons for this behaviour are still unresolved and uncertainties especially for the accumulation zones are high. In-situ measurements of mass balance and detailed observations from the accumulation zones may contribute to a better understanding of the relevant processes and allow for the detection of possible changes, which are currently unknown.

Here, we focus on two glaciers located in Kyrgyzstan: Gregoriev Ice cap located in the Inner Tien Shan and Abramov Glacier situated in the Pamir Alay. Abramov glacier is located close to regions of low glacier mass loss while Gregoriev is located in an area of pronounced glacier decline. On both glaciers, firn properties were investigated in the past. Additionally, mass balance measurements and meteorological data from nearby weather stations are available. In January and February 2018, we drilled several shallow firn cores on Abramov glacier and Gregoriev ice cap. Furthermore, we installed thermistor chains and performed GPR measurements on both glaciers. Data from these recent campaigns are compared to historic data. First results indicate contrasting changes in firn properties of the two glaciers.

Keywords: mountain glaciers, firn, cores, GPR, accumulation.

BACK

NEW DATA ON GLACIER THICKNESS IN CENTRAL CAUCASUS FROM RECENT RADAR SURVEYS

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Radio-echo sounding (RES) is a widely used method to assess glacier thickness and bedrock topography providing high (2–3 %) accuracy of measurements using ground-based or airborne radars. Reliable ice thickness assessments play important role in a number of glaciological objectives. Data on ice thickness are highly essential for glacier volume and runoff estimations as well as for modelling of future glacier lakes formation what is crucial for natural hazard assessments. However direct ice thickness measurements are rare due to high costs and time consuming.

The Central Caucasus is one of glacierized mountain regions with lack of direct ice thickness measurements. Such data is available for several glaciers from more than 1.7 thousand located in these mountains. Here we present new detailed ice thickness dataset for two valley glaciers in the Central Caucasus from recent field campaigns. During summer 2017 radar ice thickness measurements were performed for Bashkara and Bezengi glaciers situated in Adyl-Su and Cherek catchments, respectively. Ice thickness and bedrock topography maps were compiled and ice volume was estimated. Bashkara is relatively small (3 km^2 area and ~4 km long) valley glacier with 3 moraine-dammed lakes in front of its terminus was covered by 8 km of radar profiles across 1.2 km^2 area of its snout. Maximum and mean measured ice thickness reaches 217 and 109 m respectively. Modelling of bedrock overdeepings revealed no serious “lakes” underneath modern glacier terminus which can pose a danger.

Bezengi, the largest glacier in the Caucasus, was covered by almost 60 km of radar profiles totally covering 9 km length and 7.2 km^2 area snout. Obtained ice thickness data revealed the thickest ice measured in the Caucasus – up to 425 m and 197 as mean value. Ice volume of investigated part of Bezengi glacier reaches 1.4 km^3.

This research was supported by RFBR grant № 16-05-45045.

BACK

SNOW THICKNESS AND DENSITY ON AUSTRE GRØNFJORDBREEN, SVALBARD, FROM RADAR MEASUREMENTS AND STANDARD SNOW SURVEY

I.I. Lavrentiev, S. S. Kutuzov, A.F. Glazovsky, Yu.Ya. Macheret, N.I. Osokin, A.V. Sosnovsky, R.A. Chernov, G.A. Cherniakov

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Ground-based radar measurements at 500 MHz, performed in the spring of 2014 on Austre Grønfjordbreen, Svalbard, along a dense network of profiles at 34754 points with interval ~ 2 m, showed a close relationship ($R^2 = 0.98$) with data of standard measurements of the snow cover thickness at 77 points and a similar but more detailed picture of its spatial distribution. The average discrepancy of radar and standard measurements is within 30 cm and equal to 18.8 % and 9.4 % for average and maximum snow thickness of 160 cm and 320 cm respectively. The standard interpolation error of radar snow thickness data for the entire glacier was on average 18 cm. The distance between the radar measurement points at which the spatial covariance of the snow thickness disappears was on average 236 to 283 m along the glacier, and from 117 up to 165 m across the glacier. Comparison of the delay time of radar reflections from the base of the snow cover with standard snow thickness measurements at 10 points gave the average radio wave velocity in the snow cover V_{av} = 23.4 ±0.2 cm ns^{-1}. This velocity was used to estimate the average density ρ of snow cover applying the Looyenga and Kovacs formulas: ρ_L = 353.1 ± 13.1 kg m^{-3}and ρ_K = 337.4 ±12.9 kg m^{-3}. The difference of these values from average density $\rho_{av\ meas}$ = 387.4 ±12.9 kg m^{-3} measured in 12 pits was -10.8 % and -14.8 %. According to snow thickness probing and radar measurements, the altitudinal snow accumulation gradient at the glacier in 2014 was 0.21 m/100 m. Snow thickness probing shown that the average thickness of winter snow cover in 2011-2014 was bigger by 17 cm than in 1979. In the snowiest year 2012 it was 21.5 cm bigger than in 1979, and its spatial variability (the standard deviation σ_H) increased by 25.6 cm. Estimation of spatial and temporal variability of snow thickness and density on the glacier can be used to estimate their influence on mass balance and hydrothermal state of the glacier due to climate changes.

BACK

SURGE DYNAMICS OF THE WESTERN BASIN OF VAVILOV ICE CAP, SEVERNAYA ZEMLYA, DETECTED FROM REMOTE SENSING DATA

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Here we present data on a large-scale surge in the western basin of the Vavilov ice cap on Severnaya Zemlya, derived from satellite imagery (Landsat-1, 5, 7, 8, Terra ASTER, Sentinel-1 and Corona), and supported by airborne RES-2014. Analysis of 28 space images from 1963 to 2018 showed that front advance has evolved during all this period. In the first decade from 1963 to 1973 the advance was very slow from 2-5 to 12 m a^{-1}. Since the 1980s, the advance began to accelerate from the first tens of m a^{-1} to the first of hundreds m^{-1} in the 2000s, the turning point came in 2012, when the front was advancing with a velocity about 0.5 km/year. In 2014 the volume of advanced snout was at least 4 km^3. The rate of advance reached the maximum of 9.2 km a^{-1} in 2016. From 1963 to 2017 the glacier margin moved forward by 11.7 km and its area increased by 134,1 km^2 (by 47 % relative to basin area in1963), that was accompanied by spreading of crevasse zone up the glacier. Ice surface velocity reached a maximum of 25.4 m d^{-1} in 2016, and in 2017 reduced to 6.8 m d^{-1}. We assume that the initial activation of the southern and western margins of the ice cap in second half of XX c. was a response to the climate signal occurred possibly several centuries ago. As a result, the ice crevassing accompanied with cryo-hydrologic warming and reinforced by positive feedback, led to the instability of the glacier and displacement of the marginal stagnant belt of debris-laden ice frozen to the bed. The surge was facilitated by change of bedrock conditions as the ice lobe progressed offshore from permafrost coastal zone to the area of soft marine bottom sediments with low shear strength. The surge seems to be also stimulated by anomalously warm summer of 2012.

This study is supported by the Russian Foundation for Basic Research, grant 16-35-00333, by Russian National Foundation, grant 14-37-00038 and grant № 01201352474.

Keywords: Arctic, glacier surge, ice cap, ice velocity, Severnaya Zemlya.

BACK

MASS BALANCE MEASUREMENTS OF ELBRUS GLACIERS, CURRENT STATE AND FUTURE PROSPECTIVE

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The ice-covered volcanic massif Elbrus (5,642 m) is a unique object for studying the reaction of mountain glaciers to climate changes. Elbrus glaciers contain more than 10% of the total ice volume in the Greater Caucasus. Garabashi glacier was the subject of glaciological studies of the Institute of Geography RAS, Moscow starting in the 1982. The components of the glacier mass balance are determined annually by direct measurements. In recent years the mass balance values were strongly negative, the glacier loses mass faster than during the entire period of direct observations. Over the last 20 years since 1997 the cumulative mass balance reached -12.4 m. w.e. The average annual mass balance was -0.6 m. w.e. The rate of mass loss has almost doubled in recent decade (2007-2017) compare to 1997-2007. Glacier surface area reduced by 0.5 km2 over the 20 years. Here we present a recent mass balance data as well as the geodetic mass balance changes. Two high resolution DEMs were used: 1997 DEM completed by the Moscow State University from the aerial photography and the Pléiades stereo-pair of 2017. In coming 3 years a new project for Elbrus glacier mass balance measurements is proposed. It will include new stake network on several glaciers, AWS installation, runoff measurements and modelling. The accumulation will be measured every year using high frequency GPR.

The Pléiades stereo-pair used in this study was provided by the Pléiades Glacier Observatory initiative of the French Space Agency (CNES) This study was supported by the Russian Foundation for basic research grant 18-05-00838.

Keywords: Mass balance, Caucasus, DEM.

BACK

STRUCTURE AND HYDROTHERMAL STATE OF GLACIERS ON THE NORDENSKIOLD LAND (SVALBARD) BY GROUNDBASED RADIOECHOSOUNDING DATA

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In 1999 and 2010-2013 ground-based radio-echo sounding measurements were performed on 15 glaciers of Nordenskiöld Land in Svalbard. This data together with total thickness and volume of glaciers published earlier in 2013 and 2016, were used to estimate the distribution of thickness and volume of cold and temperate ice.

Strong scattering of radio waves on water inclusions in temperate ice and strong extended radar reflections from internal reflecting horizon (IRH) correspond to cold-temperate transition ice surface (CTS), where ice temperature reaches 0°C, were used to identify 12 glaciers as polythermal ones with upper cold ice layer and lower temperate ice layer at pressure-melting point.

For 11 of polythermal glaciers delay time from IRH was used to calculate thickness and volume of cold ice. Correct estimation of CTS depth were performed using difference in power reflection form IRH and bed. Thickness and volume of temperate ice were calculated as difference between total and cold ice thickness and volume.

Remaining 3 glaciers were identified as cold type glaciers due to lack of internal reflections except of buried crevasses and glacial moulines. Also sites of meltwater input into glaciers temperate core and bed were revealed.

Keywords: Glaciers, radioechosounding, cold-temperate ice, Svalbard.

BACK

DYNAMICS OF GLACIERS IN BENCHMARK AREAS, PROJECT INT5153

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IAEA Project INT5153 (2014-2018) has allowed us to acquaint with a condition of glaciers in different places of our planet in polar and high-mountainous regions: Spitsbergen, Caucasus, Gongushan (SE Tibet), Cordillera Blanca and Cordillera Real, Antarctic Peninsula. The analysis of the received data during time of the project has shown that almost all observed glaciers situated in a degradation stage and have negative ice mass balance during long time. And only in one place, in Antarctic Peninsula (King George Island), which was considered until recently as a place of the biggest climate warming on a planet, cooling has began, which possibly has led to the beginning of the period with positive ice mass balance on glaciers. Analyzing the obtained data we cannot unequivocally tell that degradation of all observed glaciers is connected only with climate warming. Three benchmarks do not belong to this line: King George Island (Antarctic), Spitsbergen Archipelago and Mount Elbrus (Caucasus). On King George Island since 2009 the climate begins to cool (in particular, air temperature during summer seasons decrease and glaciers begin to grow). On Spitsbergen Archipelago from 2006 there was a lowering of Equilibrium Line Altitude (ELA) to level of about 400-450 m asl (ELA was before on 300 m and more above modern one) and its stabilization at the same level till now. It is equivalent to climate cooling in mountains on 2°C and more. In area of Elbrus (Caucasus) retreating of glaciers occurs against invariable air temperature throughout last 200 years. One of the reasons of possible modern glaciers retreating could be because ice mass which now arrives to tongues of glaciers was accumulated 200-300 years ago, i.e. during time of Little Ice Age (LIA). At this time climate was colder and quantity of precipitation was less. Thus, modern glaciers retreating can be connected with adverse conditions of glaciers feeding 200-300 years ago. In 2016/2017 changes have concerned also with glaciers of Bolivia where probably snow mass accumulation on glaciers also has begun.

BACK

SEASONALLY FROZEN LAYER OF PEATLANDS IN SOUTH TAIGA ZONE OF WEST SIBERIA

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The results of the study studies of the seasonally frozen layer and the temperature regime of peat soils of oligotrophic bogs in the south taiga zone of West Siberia in 2011 – 2017 are presented. The soil temperature regime was studied using the atmospheric-soil measuring complex at different depths from surface down to 240 cm. All sites were divided into two groups according to the bog water level: flooded sites (hollow and open fen) and drained sites (ridge, tall and low ryam – pine-shrub-sphagnum community). Analysis of the results showed significant differences in the temperature regime of the peat soils and the seasonal freezing on sites with high and low levels of bog water. The proposed regression model allows to predict the maximum depth of freezing, using data on the maximum snow height and the average winter air temperature.

The reported study was funded by RFBR according to the research project 18-05-00306.

Keywords: Peatlands ecosystems, microclimate, soil temperature regime, seasonal freeze layer, freezing depth, snow cover, West Siberia.

BACK

MONITORING OF SEASONALLY-FROZEN AND SEASONALLY-THAWED SOILS IN THE SOUTH-WEST PRIBAIKALIE

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The study area (Tunkinskaya depression) located at the junction of the Tunkinsky Goltsy and the Khamar-Daban ridges, in the zone of island permafrost and is characterized by extreme continental climate. The territory has a variety of landscape conditions (from steppe to mountain taiga in the altitude range 700-3500 m a.s.l.), relief forms and soil-forming rocks.

IG SB RAS (Irkutsk) in 2007 started monitoring of nature-climatic characteristics in the landscapes of South-West Pribaiaklie. In 2011-2012 year-round observations of the temperature and moisture of soil (from the underlying surface to 10 m) started. Monitoring is carried out automatically in 1 hour on 21 observation sites using the atmospheric-soil measuring complex (IMCES SB RAS). Sites are located on seasonally-thawing soils (wetland) and seasonally freezing soils (sand massif, taiga and steppe patches). On the model sites, soil sections and boreholes are laid on various underlying rocks to estimate the effect of soils physical and chemical properties on the features of the hydrothermal regime. More than 200 soil samples were collected and analyzed.

Fluctuations in the average daily air temperatures at the sites are synchronous during the year. But due to differences in the vegetation cover, microclimatic differences in daily air temperatures reach 4-5°C. Differences between the mean daily temperatures of the soil surface are slightly higher (7-9°C). The propagation of heat in the soil on the sites is also different. Absorption of solar radiation by soil surface depends on a number of factors. Factors determining the temperature regime of soils include: the color of the surface horizons, moisture and aeration, which depends on the granulometric composition and structure of the soil, the exposure of slopes, the type of vegetation cover or its absence.

Keywords: monitoring, permafrost, seasonally freezing/thawing soils, temperature, South-West Pribaiaklie.

BACK

CHANGING REGIMES OF GLACIERS IN GARHWAL HIMALAYA REGION USING REMOTE SENSING

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Change in spatial and temporal distribution of the cryosphere influences the water flow in the world's major rivers. In the present study, 16 selected glaciers including Gangotri and surrounding covering an area of 2982.14 sq.km., Garhwal Himalaya (Uttrakhand) India were mapped and their boundaries were delineated using the Landsat MSS (3rd November, 1976) , TM (16th October, 1990), ETM+ (18th October, 1999 and) and OLI-TIRS (29th Oct., 2013)) and ASTER images. In this study a total of 101 glacial lakes are identified in 2013 while the number of identified glacial lakes was 69 and 128 in 1990 and 1999. The valley of Gangotri glacier and Satopanth glacier show huge increase in number and area of glacial lakes especially supraglacial lakes. Several morphometric parameters like length, width, total area, perimeter, accumulation area, ablation area, area accumulation ratio (AAR), thickness etc. were estimated for detailed morphometric analysis among the mapped glaciers. The mapping of selected 16 glaciers during the period 1972–2013 reveals that the glacier covered area reduced from 409.08 to 377.83 sq.km. observing approx. 7.63% deglaciation in the Gangotri and surrounding area. Gangotri glacier shown a net loss of 4.68% area during 1972 to 2013 while it shows a net gain of 1.32% area during 1999 to 2013. Advancement in the total glacier area was also recorded during 1979 to 1999. The average elevation of the ablation zone of Gangotri glacier show an upward shift from 3944 m (1972) to 4033 m (2013) which may be a consequence of a shift in equilibrium line altitude (ELA) reflecting imbalance. In this study, it is estimated that the Gangotri glacier was retreated 1.60 km. between 1972 to 2013.

Keywords: Glacier retreat, ablation area, accumulation area, Gangotri glacier, Garhwal Himalaya.

BACK

INFLUENCE OF NATURAL FACTORS ON PERMAFROST STABILITY ON SVALBARD IN THE CURRENT CLIMATE

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One of the components of the natural environment of Svalbard is the permafrost. Its degradation can lead to negative phenomena, both for the natural environment, and for engineering structures and communications due to the loss of strength of the foundations of structures and activation of slope processes. The loss of stability of permafrost is caused by the formation of non-merging permafrost transient to talik. This occurs with incomplete freezing of the seasonally thawed layer due to climatic changes and variability of the surface cover and soil parameters.

The formation of non-merging permafrost is due to both climatic changes and a number of natural factors affecting the soil thermal regime. The influence of the snow and moss cover parameters on the temperature regime, soil freezing and melting, both separately and in combination with climatic changes, is considered. The studies show the need for interdisciplinary research (glaciological, botanical, climatic, soil) on the effect of climatic changes on the parameters and thermal characteristics of the snow cover, vegetation and soil.

To determine the time of the beginning of the formation of non-merging permafrost under current climatic changes, calculations were made on the mathematical model. For calculations, the forecast values of air temperature from the global and regional climate models were used. The time of the beginning of the formation of non-merging permafrost is determined depending on the thickness of snow and moss cover, and soil moisture content.

Keywords: permafrost, degradation, climatic changes, snow and moss cover, mathematical model.

BACK

VARIABILITY AND TRENDS IN TEMPERATURE, RAINFALL AND DISCHARGE IN PARVATI BASIN OF HIMACHAL PRADESH, INDIA

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As per IPCC report the mean annual temperature of Earth's surface has increased by 0.74±0.18ºC over the last century and it is expected that by 2100 the increase in temperature could be 1.4°C to 5.8°C. Therefore, the present study has been undertaken in the Parbati catchment of upper Beas basin to know the long term variability of temperature, rainfall and discharge in the light of the global warming. The Parbati catchment is elongated in shape and covers an area of about 1940 km^2. The investigation revealed that the rainfall amount in the catchment have not changed significantly during different seasons. Temperature trends in the basin clearly demonstrated a slight increase during all the seasons but only the winter season temperature has demonstrated a significant positive change. Further global warming reflections on the water discharge have not been observed accordingly and a significant decrease has been observed in the annual, seasonal and monthly flow pattern of the catchment from 1968-2005. This declining trend in the discharge of the Parbati catchment can be largely attributed to changing nature of rainfall, lesser snow cover in the lower and middle reaches, thinning of small glaciers and ice patches over the study period. This reduction in water availability from the Parbati catchment will influence agricultural activities in the downstream areas and thus affecting local as well as national economy.

BACK

MASS BALANCE MODELLING OF AUSTRE GRONFJØRDBREEN GLACIER, SVALBARD

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Recent efforts by the Institute of Geography RAS have been aimed at establishing mass balance observation at Austre Grønfjordbreen (7,6 km2) located 16 km south of Barentsburg, Svalbard. The glaciers of Svalbard have already experienced an unprecedented increase in average summer temperatures, melt periods, and rainfall in late autumn and early summer. Noteworthy a full absence of Austre Grønfjordbreen accumulation zone was pointed out in recent years.

Current goal is to determine the approach for mass balance simulations of Austre Grønfjordbreen and model application for long time periods assessments.

The physical and mathematical modelling of the internal and external mass transfer of Austre Grønfjordbreen glacier were carried out using the field work data and remote observations. The dependence of the mass balance from the certain climatic factors is revealed. We apply spatially distributed model A-MELT (Rets et al., 2012) using all available glaciological and meteorological measurements carried out since 2012 and energy balance determination according to spatial grid. The snow line level has been reconstructed using all available satellite images from 1986 to 2016.

The obtained mass balance gradients are compared with the results of temperature-index simulations and traditional glaciological methods.

Keywords: glacier mass balance, ablation, accumulation, melt modelling, temperature-index model.

BACK

POSTER

SUBARCTIC GLACIERS OF THE BAIKAL REGION, NEW FINDINGS

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Introduction

In 2017, a group of glaciers was found on the northwestern spur of the Verkhneangarsky (Upper Angara) Range. It includes three glaciers and other small forms (perennial snow patches, glacial stone glaciers). One glacier was measured at place, two more later found by satellite images. Previously described the Baikal and Barguzin ranges glacier groups, which together with Verkhneangarsky Range group are related to the Baikal basin by climate links. They exist in dry, sharply continental climate due to precipitation from the Atlantic and Arctic oceans similar to Subarctic low-mountain glaciers of the Urals, Western Putorana Plateau and Eastern Chukotka.

Common features of the glacier groups: small size; location on shaded slopes of the NW aspect; glaciers are composed of firn, not glacier ice; they do not have a division of accumulation and ablation areas; quite slow movement is characteristic for them; the accumulation area is located much lower than the snow line. Glaciers of these regions have reserve of coldness and are able to restrain the heating effect of rainwater by the mechanism of formation of superimposed ice (Ivanov, 2013).

The history of the discovery and description of the glaciers of the Verkhneangarsky Range

At the end of 2016, when looking at LandSat images, objects similar to small glaciers were discovered in the NW spur of the Verkhneangarsk**y** Range, in the sources of the Kichera and Left Mama rivers and its right tributary - Ogdynda-Maskit River. The extensive mountain knot in the central part of the Verkhneangarsk**y** Range has a barrier function when carrying sediments along the valley of the Kichera River from the Baikal basin and serves as a moisture condenser. The whole massif is distinguished by a pronounced glacial relief, sharp alpine outlines of peaks, complex topography. Often there are peaks-carlings with 2300-2400 m a.s.l.,

with steep smooth walls of great length. When carrying out surveys along the future route of the Baikal-Amur Mainline, special glaciological studies were not carried out on the Verkhneangarsky Range. Topographers and geologists also worked only along the well-known routes along the rivers and streams, so many of the ravines and passes are completely unexplored.

On the topographical maps of the study area, perennial snow patches are designated in the sources of the Left Mama and Kichera rivers. The presence of snow patches under the passes, "firn fields" in the middle of summer is often mentioned in the materials of tourist reports of the 1970-90s. On satellite images of high resolution (1-10 m) on glacier circuses surface, terminal and lateral moraines, a network of transverse cracks and open ice are visible. The contours of these objects do not reach the final and lateral moraines that indicate their reduction. These objects are located away from the usual tourist routes; therefore there is no information about them in the special literature.

In summer of 2017 Gleb Yu. Pakin described *at pla*ce the largest of the Verkhneangarsky glacier group – Ogdynda-Maskit Glacier. Its location: Stanovye Highlands, NW spur of the central part of the Verkhneangarsky Range. Coordinates: latitude: 56 ° 12`20 ", longitude: 110 ° 53`51", aspect of the glacier - northern.

Photo 1: General view of the Ogdynda-Maskit Glacier from Otrog-Ozerny Pass (1A, 2150 m).

Length, width and area of the Glacier

Images of Landsat/Copernicus, July 2016, which are in open access, were used to determine the parameters of the glacier (Photo 2). Its total area is 0.36 km^2, the area of the open part is 0.068 km^2, the area of the ablation area is 0.166 km^2. The length of the glacier is 0.65 km, the width is 0.56 km, the largest width is 0.6 km, the width of the open part is 0.5 km, and width of the end of the glacial tongue is 0.33 km. The highest point of the glacier is 2150 m a.s.l., the average altitude is 2070 m, and the lowest one is 1900 m. The glacier is *corrie* by morphological type being in degradation stage. The presence of an elongated surface moraine in the right part of the image indicates the movement of the glacier. In the left part of the tongue,

transverse divergent fissures of the ice core are visible. The altitude of the firn line is 2070 m a.s.l.

a) b)

Photo 2 Ogdynda-Maskit Glacier in LandSat, July 2016, from a height of 5,000 m (a) and 200 m (b)

The firn basin is a simple single-chamber circus, deeply embedded, in the eastern part expanded by the formation of a stone glacier within it. Slopes are very steep, especially at the back wall, in many places they are covered with screes. The glacier occupies only part of the circus and the lower parts of the slopes. Above them climb rock walls up to 300 m high. The degree of snow cover is up to half of the slopes' elevation, the steepness of the slopes surrounding firn basin is 60-70°. The relief of the firn basin is a concave bowl with a slightly elevated central part; permanent avalanches ("trays") are not traced. Firn is dense, coarse-grained.

Accumulative forms: the lateral moraine in the western part is practically absent; the glacier closely adjoins the wall of the circus. In the eastern part it is buried under the frontal mound of the advancing stone glacier. The terminal moraine is smoothed and hidden beneath the channel snow patch, which adjoins the lower part of the glacier and extends 300 m to the lake.

Forms created by the movement of the glacier and ablation: transverse cracks are in the western part of the glacier in the form of divergent rays directed toward the wall of the circus. They are of several tens m in length of and in width of no more than 0.5 m. The depth does not exceed 1 m (Photo 3).

Photo 3: Cross cracks and ogives in the western part of the glacial tongue.

Glacial glasses are absent, erosion channels and hollows on the very surface of the glacier are weakly expressed. Glacial wells and mills are also absent, cavities are filled with freezing melt water.

The glacial tongue is not dismembered; the end of the glacier looks like an inclined wall, in the lower part of there is a riverbed snow patch that stretches for another 300 m to the lake below. The steepness of the slope increases from 15-20° in the eastern part to 30-35° in the west. The length of the moraine is 110 m, the width is up to 20 m. Glacial streams in shallow channels drain along the line of water drop perpendicular to the lower edge of the glacier, then go under the snow below (Photo 4).

Photo 4: Riverbeds of streams on the surface of the glacial tongue.

The ice is transparent, of gray-blue color. The external manifestation of stratification on the surface of the glacier in the form of a system of ice ridges separated by narrow furrows (ogives) is noticeable throughout the glacial tongue, see photo 3.

Ogdynda-Maskit Glacier is today the only glacier described on the Verkhneangarsky Range. There are here many small forms of glaciation, mainly dense firn snow patches with marginal ice and underlying ice base. Some of them are perennial.

Later, ***two more glaciers in the same area*** were found on LandSat images:

The Kichera Glacier: it is also located in the Stanovoe Highlands, in the central part of the Verkhneangarsky Range in the left source of the Kichera River, in the NE circus, the height is 2200 m a s l.

Surprise Glacier located in the Stanovoe Highlands as well, in the Verkhneangarsky Range central part, in the NW spur, on a rock wall in the southeastern circus of 2460 m a. s.l., north of the Surprise pass (Table 1).

Table 1 Parameters of the glaciers found in the Verkhneangarsky Range (from images)

Glacier	Latitude, N	Longitude, E	Area of glacier/its open part, km^2	Lengh of glacier/its open part, km	As-pect	Highest point, m	Lowest point, m	Morphological type
Kichera	56°10’ 26,49”	110°51’ 41,40”	0.04 /0,036	0.23/0.18	NE	2050	1940	Corrie
Surprise	56°15’ 39,40"	110°51’ 54,10"	0.08/0.03	0.2/0.08	NE	2450	1900	Hanging

Note: Passports for November 2017

Orographic and climatic reasons for the existence of glaciers

The Verkhneangarskiy Range, on which the glaciers are found, extends over 200 km and from the south it separates Verkhneangarskiy Range basin from the North Baikal Highlands. Its spurs stretch to the north for 100-120 km and form its southern part. The range divides the water basins of the Angara and Lena rivers, has a whimsical convoluted line. Its southern spurs, facing the Verkhneangarskiy Range basin reach the highest altitude over 2600 m a. s. l. The range relief is of the Alpine-type, characterized by narrow ridges, with pointed peaks, troughs and punches. The glaciers described earlier are located in the northern and northeastern cars of the Baikal and Barguzin ranges ((about the Bakal Range is in (E.N. Ivanov, 2011), about the Barguzin Ridge - in the paper of Ivanov E.N. et al., 2011)), see Fig. 1. The authors refer the region of the Northern and Middle Baikal to the screes belt. Nival-glacial processes that take place in this belt are diverse: under the influence of snow and ice on mountain slopes and in valleys, niches, nival and glacial carvings, nival-erosion troughs are formed. Carlings, circuses, characteristic for the area of accumulation of firn and glaciers, are expressed at more than 1200 m a s l.

Fig. 1. Baikal glacial region. The red dots are the glaciers.

The upper boundary of the accumulation area of the Baikal glaciers is 1000 m below the snow line and on average of 500 m lower than on the Kodar Range, however, at the same latitude.

The climate of the southern part of Eastern Siberia, where Lake Baikal and existing glaciers are located, is sharply continental with a cold long winter and a relatively warm summer due to considerable distance from the oceans. The area of the Northern Baikal, the Verkhneangarsky Range is completely in the permafrost zone. The glaciers in question are thus located in the sharply continental climate of the North Baikal region. Fig. 2 reflects the spatial temperature distributions of T_{year} -mean annual, T_{sum} -mean summer, and sums of precipitation for the year- P_{year}, and for the cold period - P_{sol} over 1966-2015. The estimates are made by about 10 weather stations; the series of meteorological parameters are available on the website of Obninsk Data Center: www.meteo.ru. T_{year} decreases from the southwest to the northeast,

T_{sum} - from west to east, towards greater continence, P_{year}r increases to greater altitudes of the Northern Transbaikal, and P_{sol} decreases from west to east, reflecting the macroscale western circulation.

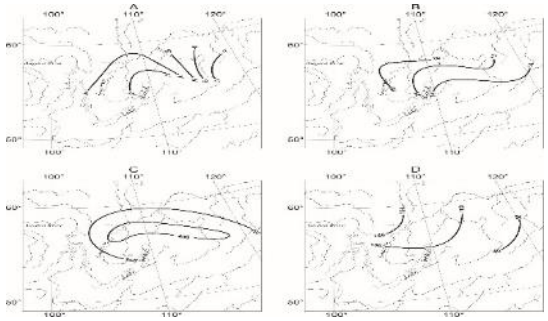


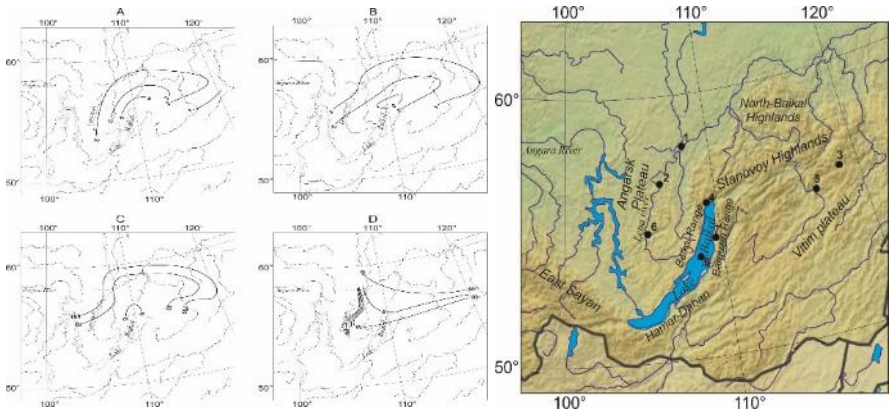
Fig 2. Spatial pattern of T_{year} – mean annual (A), T_{sum} – mean summer temperatures (B) and precipitation sums for a year - P_{year} (C), and for cold period P_{sol} (D) for 1966-2015.

The climate in the studied region varies; the data for the two stations closest to the studied area from the book (Baykalovedeniye, 2009) is as follows:

Weather stations	Year of observations	Mean T_{year} from the beginning of observations to 1965	Mean T_{year} 1966 to 2006 г	**Temperature increase**	Station coordinates
Davsha	1954	-4,1	-3,4	**0,7**	54°21′ N.
Big Ushkaniy	1950	-2,0	-1,1	**0,9**	108° 36' E.;

Here are given the comparative characteristics of mean annual air temperatures, ºC, averaged over periods: from the beginning of observations to 1965 and for the period from 1966 to 2006.

Fig. 3 shows the spatial distribution of the trends of the parameters, the same as in Fig.2. Trends of T_{year} from 1 to 4 ºC/50 years, T_{sum} is less – from 1 to 3°/50 years, however there is not big difference in their spatial patterns. The other picture in spatial patterns of and P_{sol}: total precipitation trends decreases towards Baikal Lake, and precipitation of cold period on the contrary increases toward the lake but the trend are small 10 mm per 50 years.



a) b)

Fig. 3 The spatial distribution of the trends of a) T_{year} (A), T_{sum} (B), P_{year} (C), P_{sol} (D); b) Map of Baikal region with location of weather stations

There is large number of sunny days over Baikal Lake due to by ridges surrounded it and the specifics of atmospheric circulation. The processes of condensation occur under ascending air up the ridges windward slopes. The period from the beginning of freezing to the establishment of freeze-up (January), when intensive cloud formation occurs because of the evaporation of moisture from its ice-free water surface, may be important for supplementary feeding of glaciers that are located on mountain rises

Atmospheric precipitation in the Baikal region is formed mainly due to the Atlantic invasion, which even reflected in Fig. 2. Stations near the lake fix low precipitation (from 200 to 300 mm), P_{year} reaches large values on the mountains around, for example, on Barguzinsky Range, up to 1200 mm/year. When achieve the windward slopes of the Khamar-Daban, moisture of the air masses condenses and falls out in the form of abundant precipitation, reaching the maximum values for the entire Baikal basin (Khamar-Daban-1443, Snezhnaya-1437, Vydrino-1101, Tanghoi-939 mm (Baikalovedenie, 2009). Baikal moisture goes to the formation of a powerful snow cover on the slopes of ridges - more than 1 m. Winter tourist reports give descriptions of many-meter snow blowing. One of them, of more than 3 m in July 2017, was discovered by one of the authors at the Ogdynda-Maskit pass-southern. Snow patches melt in August, and glaciers exist where the relief forms (deep crust on the northern, northeastern slopes, under the shaded rock wall) allowed them.

Ways of main and additional the Ogdynda-Maskit Glacier nourishment: wet air of the Baikal basin along the valley of the Kichera River skirts the Verkhneangarsky Range and in the watershed area with the Left Mama River basin collides with cold masses of Arctic air, providing fogs and a large amount of precipitation (1000 mm per year and more), from mid-August to June falling in the form of snow in the upper reaches of the Ogdynda-Maskit River valley. The area of perennial snowfields reaches 1 km^2 or more, they almost completely fill the bottom and the slopes of the circus, glaciers and stone glaciers are found everywhere, Fig 4.

Fig 4. Small glacial forms within Verhneangarsky Range region

Glacier regime and conclusion about Baikal center of modern glaciation allocation

Due to climatic conditions and ubiquitous permafrost, glaciers of the Verkhneangarsky Range refer to *cold* glaciers. As there are no historical satellite images of this region, we can judge the movement of the Ogdydda-Maskit Glacier by the last glaciation moraines. Three factors that ensure the existence of the Baikal glaciers: 1) Relief: the glacier is in the upper reaches of the deep trough valley, the hollows are filled with glacial lakes, and a number of moraines of the previous glaciation are traced). 2) Low temperature of the underlying rocks: although the upper boundary of the accumulation area is 1000 m below the snow line, which passes here at an altitude of about 3200 m, it lies in the permafrost zone, which provides a year-round negative temperature of the underlying layers (-7-12°), (Popovnin, 1981). It gives it a view of glacier located much higher than the snow line. All melted water flows down the surface along shallow trails, and do not penetrate into the glacier body. 3) Mountain massifs serve as centers for the precipitation condensation from the Baikal basin. Ogdynda-Maskit Glacier is a snow drifting-avalanche glacier. It gets nourishment with snow, blown off from the surrounding mountains and arising due to the collapse of the cast cornices and the abundant frost that forms on the slopes of the circus.

The independence of the Baikal physics-geographical country is noted in major part of research studies. Influence of Lake Baikal on its coast extends to the peaks of the mountain ranges surrounding the lake. In the warm half-year in quiet weather, the cooling effect of Lake Baikal appears on average up to 250-500 m along the coastal slopes facing it. But it can significantly increase or decrease under the influence of wind currents. In the cold season, Baikal's warm effect reaches 2-2.5 km above its surface, and along the river valleys it reaches 30-50 km and more (Galaziy, 1987). Over the basin of Baikal Lake with air masses; about 100 km3 of moisture permeates throughout the year. Upper Koldas and Asikta rivers, located farther to the east, the effect of the Baikal air masses does not take place. Therefore there is no modern glaciation, although there is a similar Alpine type of relief. A sharp continental climate with less rain does not allow glaciers to exist in these dry, frozen valleys.

Conclusions

1. Work with satellite images in conjunction with research and verification *in situ* gives us the right to declare discovering of the Verkhneangarsky Range group of glaciers.

2. The connection with the glaciers of the Baikal and Barguzin ranges reveals common features of climatic conditioning with the Baikal basin as an additional source of glacier feeding.

3. We have identified a new Baikal glacial system, which includes three groups of glaciers: the Baikal, Barguzin and Verhneangarsky ones.

4. Prospects for the existence of a small glaciation of the Northern Baikal in the face of climate change: now they are in a mothballed state, under conditions of warming the climate they are subject to a slow regression.

5. The study of these objects, in addition to geographical discovery, will allow to determine their age and to obtain new data on how the relief affects the existence conditions of glacial small forms located below the snow line under cold climatic conditions.

Keywords: Mountain glaciers, Verkhneangarsky Range, trends, precipitation, Baikal glacier region.

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BACK

CHANGE OF GLACIER'S SUMMER MASS BALANCE AND RUNOFF IN MOUNTAIN RIVER BASINS

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Introduction and objective of the study

In accordance with the definitions in (Kotlyakov1984, Cogley et al. 2011), the summer balance Bs is equal to the change in the glacier's mass starting from the maximum of snow accumulation to the end of the ablation period. During this interval, it is possible to determine the integral value of Bs as a whole for the season, or for the characteristic ten days/months inside the year. In the case of using the best methods and techniques of measurements, the obtained volume of Bs characterizes output of melt water from the area of glacier, which is necessary to calculate and forecast the river's runoff related to the melted snow and ice type of feeding. Currently, the continuous measurement Bs with the number of yearly measurements ≥ 5 are performing on a 65 continental glaciers, which distributed extremely unevenly on the Earth (Fig. 1.). These glaciers are considered (Dyurgerov and Meier 2005; Fluctuations of Glaciers Database 2017) a priori as typical or representative for regional/global monitoring of changes in the annual mass balance Ba and its components (balances for periods of winter Bw and for summer Bs) in glacier populations. Analysis in the papers (Kotlyakov et al. 1997; Braithwaite 2009; Fountain 2009; Konovalov 2015; Zemp et al. 2009) of the 60-years information on Ba, Bw and Bs on such typical glaciers revealed the following properties in the system (Fluctuations of Glaciers Database 2017; Zemp et al. 2009) measurements of glacier mass balance. 1) Selection of the so-called "typical" glaciers is often basing on the principle of lowest cost for fieldwork instead of previous analyzing the spatial distribution of area, altitude-morphological and other characteristics of glaciers in the corresponding population. 2) Predominance of European data leads to distortion of global average values of annual and summer mass balances of glaciers. The amount of distortion is unknown because averaging

measurements on "typical" glaciers ignores regional accumulation and ablation patterns. 3) Completeness of the series and the timing of observations is very low, due to many omissions.

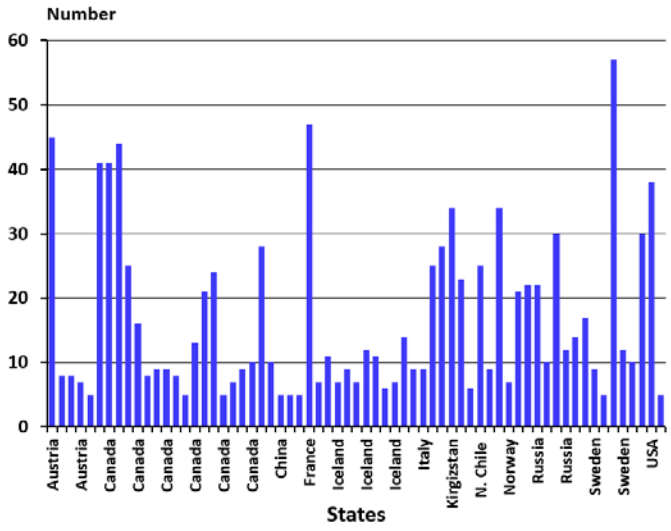

Fig. 1. Distribution of glaciers with Bs data in 1946-2003

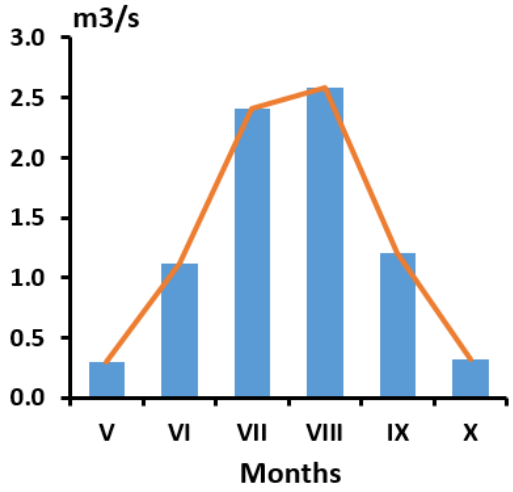

Fig. 2. Runoff of Vernagnferner River

Currently, the vast majority of glaciological publications contain climatic, physical and dynamic characteristics on the regime of individual glaciers having local spatial and temporal distribution. The peculiarity of calculations and forecasts of glacial runoff or Bs is the necessity of estimating the annual/seasonal volume of melt water Wbas=Wsnow+Bs from the total area of Fbas river basin, above the outlet hydrologic station. Here Wsnow – is the volume of snowmelt. In models (e.g. Borovikova et al. 1972; Rets et al. 2011; WaSiM Model 2015) for rivers of snow-glacial type, the catchment area is given in the form of a set of elementary sites with the given plane and altitude coordinates, exposure and slope of the surface. The total volume of water formed at all elementary sites is used to transform it into a flow hydrograph. In order to assess the quality of modeled Bs we may use the initial measurements of ablation/summer mass balance. Similar assessment the modeled values of Wbas can be performed by comparing the measured runoff and calculated one on the basis of application the equation of the annual water balance (Konovalov 2014; Konovalov 2015; Konovalov and Pimankina 2016). The objective of our research is to study physically based relationships between Wbas and Bs on the one hand as an alternative to checking modeled values of Wbas, on the other – to use Bs temporal series to evaluate norms and extremums of Wbas.

Study region, objects and methods

The region of study and objects are continental glaciers of the Earth contained in the system of World Glaciers Monitoring Service (Fluctuations of Glaciers Database 2017; Zemp

et al. 2009). Number the cases of analysis suitable for inclusion in table 1 is mainly limited to extremely rare or inaccessible hydrological information at runoff measurement stations, which located near glaciers with Ba, Bw and Bs data. Information on the runoff for the rivers of snow-glacial type extracted from the special glaciological editions and hydrological reference books. (Bodo 2000; Dahlke et al. 2012; Escher-Vetter and Reinwarth 1994; Kamnyanskiy 2001; Krimmel 2000; Lednik Djankuat 1978; Lednik Aktru 1987; USGS Alaska Water Science Center; Vilesov and Uvarov 2001). When selecting the time interval for averaging the runoff and Bs data, the interannual distribution of runoff at the hydrological sites near the glaciers is taken into account. A typical example of such distribution is shown in Fig. 2.

Table 1. Studied glaciers and correlation between runoff Q and Bs

State	Glacier name	F bas	Fgl 1	Fgl 2	N	R^2			
						Q_1	Q_2	Q_3	Q_4
Kyrgyzstan	Abramova	55.5	26.1	47.0	21	0.80	0.84	0.84	0.89
Austria	Vernagtferner	11.4	9.3	81.6	31	0.82	0.91	0.92	0.91
Russia	Djankuat	8.0	3.1	38.8	6	0.80	0.87	0.95	
Russia	Maly Aktru	36.0	2.5	6.9	7	0.56	0.85	0.85	
Kazakhstan	Centralny Tyuksu	21.0	2.9	13.7	22	0.36	0.22	0.31	0.22
USA	Wolverine	31.3	18.0	57.5	37	0.22	0.25	0.26	0.27
Sweden	Stor	19.6	3.12	15.9	16	0.15	0.15	0.15	0.12

Definition of symbols: R^2 is coefficient of determination; F bas is area of basin, km^2;
Fgl 1 is area of glacier, km^2; Fgl 2= Fgl 2/Fgl 1 в %; N is nimber of measurement years;
Q_1 is average of Q(VI-VIII) as f(B_s), Q_2 is average of Q(VI-IX) as f(B_s),
Q_3 is average of Q(VI-X) as f(B_s), Q4 is average of Q(V-X) as f(B_s), V-X are months from May till October.

High level correlation dependences Q =f (Bs) presented in table 1 serve as a basis for obtaining empirical functions of distribution Q and Bs, building links between statistical probabbility (Prob) of flow and summer mass balance, and ultimately assessing the probability of extreme flow values.

The calculation of probability Q and Bs (empirical non-exceedance) $X>x_i$ was done by the method from (Alexeev 1971):

$$p_i(x_i) = \frac{m(x_i) - 0.25}{N_i + 0.5} * 100, \quad (1)$$

where $m(x_i) = 1, 2, ..., N_i$ the sequence numbers of the values x_i after their arrangement in descending order.

In addition to the empirical functions of distribution Q and Bs, the method for estimating the probability of flow extremes also includes selection of the most appropriate type of standard function of probability distribution (see Freq Bs in the table 2).

Results and discussion

In principle, the process of runoff formation from the glacier area and from the not glaciated surface measured on a outlet site, located near the end of the glacier, includes such closely related characteristics as the intensity of melting, air temperature, solar radiation, clouds, water vapor pressure in the air. This fact serves as a justification for the search for correlation Q=f(Bs), which turned out to be quite successful on the example of four glaciers from seven in the table 1. Deviations in the coefficient R^2 for Q=f (Bs) in three cases need further study, they may be due to inaccuracies in determining the flow and/or summer balance of the mass of glaciers, which was corrected (Dyurgerov and Meier 2005; Fluctuations of Glaciers Database 2017) and are not compatible from different sources.

Examples of subsequent use of Q=f(Bs) dependencies on the Vernagtferner and Abramova glaciers to obtain equations Prob=f(Bs), FreqBs=f(Bs), Prob Y1÷Y4=f(Prob Bs) are presented in the table 2. Here Prob is statistical probability, FreqBs is the equation of the chosen standard function of probability distribution.

Table 2. Formulas for calculating the distribution functions of the mass balance Bs

Abramova Glacier			**Vernagtferner Glacier**		
Prob B_s / Freq B_s	Prob $Y_1 \div Y_4$= =f(Prob B_s)	R^2	Prob Bs / Freq B_s	Prob $Y_1 \div Y_4$= =f(Prob B_s)	R^2
Prob B_s = -0.05B_s + +137.1 R^2 =0.97	Y_1 = 0.89 Prob B_s + 5.5	0.79	Prob B_s = -0.05 B_s + +126.0 R^2= 0.98	Y_1 = 0.92 B_s + 3.9	0.85
	Y_2 = 0.85 Prob B_s + 7.6	0.72		Y_2 = 0.93 B_s + 3.5	0.86
Freq B_s = =1/{1+ +exp(A B_s+B)}	Y_3 = 0.86 Prob B_s + 6.9	0.74	Freq B_s = =1/{1+ +exp(A B_s^E+B)}	Y_3 = 0.95 B_s + 2.5	0.90
A= -0.00246 B=4.6	Y_4= 0.85 Prob B_s + 7.5	0.72	E = 0.750 A= -2.29E-002 B=5.13	Y_4 = 0.94 B_s + 2.9	0.89

Definition of symbols: Bs is summer mass balance, mm; Prob Bs is Bs statistical probability by formula (1),%; Freq Bs is integral function of distribution,%; R^2 is coefficient of determination; Y_1 is equation to calculate Prob Q(Jun-Aug) as function of Prob Bs, Y_2 is equation to calculate Prob Q(Jun-Sep) as function of Prob Bs, Y_3 is equation to calculate Prob Q(Jun-Oct) as function of Prob Bs, Y_4 is equation to calculate Prob Q(May-Oct) as function of Prob Bs.

As an analogue of the glacial flow Bs, it is also possible to use other known characteristics: data on the annual mass balance Ba, AAR – relationships between areas of accumulation and the entire glacier, and ELA – altitudinal boundary of equality between accumulation and ablation at the end of the ablation period. Annual information on the listed variables (except ELA) for 1971-2010 is contained in the work (Mernild et al. 2013). Performed replacing Bs with Ba for glaciers in table 1 did not reveal the advantages of such an option.

Conclusion

Results of study the outlined problem, presented in tables 1-2 serve as the basis for the practically important transition from the local to the regional level by using the relationship between runoff and summer balance of glaciers, in other words, calculating functions the temporal distribution of Bs for groups of glaciers and their populations. In this case, as repeatedly shown, the contribution of Bs in the formation of the river flow and, accordingly, the correlation Q=f(Bs) become weaker as the relative area of the glaciation decreases above the site of runoff measurement. However, it is still possible to use parameters (mean, extremums, coefficient of variation, etc.) of empirical functions of spatial and temporal distributions of Bs and Prob Bs, regardless of flow data and data from the World Glaciers Monitoring Service. Source of getting wide spread information about Bs will serve the results of the calculation of the seasonal/annual ablation at the altitude of nourishment boundary as a function of average air temperature and the method of (Davaze et al. 2018) evaluation of Bs as a function of remote sensing determination the surface albedo of the glacier at the end of ablation season.

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Keywords: summer mass balance, glacier runoff, glaciers representativeness, extremes and norm of the multi-year series.

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BACK

SATELLITE MICROWAVE RADIOMETRY OF THE EARTH'S CRYOSPHERE

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The paper presents results of the studies of snow cover, sea and lake ice, and the Antarctic ice sheet based on satellite microwave radiometry data that have been performed by the authors for the past 25 years. The results were obtained by comparing model calculations with satellite data, ground contact measurements at meteorological stations and ship observations during Arctic cruises.

Introduction

Climate change is a crucial problem faced by humanity in the 21st century. Permafrost, sea ice, snow and ice covers, continental ice sheets, mountain glaciers and ice cloud systems are key components of the Earth's cryosphere. Its studies contribute to solving issues relating to climate change, management of regional water resources, permafrost degrading and ocean level change. Cryosphere studies are at the forefront of a wide range of disciplines including glaciology, hydrology, climatology, geology, ecology, geography and others. Satellite microwave radiometry is widely employed in cryosphere studies to analyze ice concentration in polar regions, retrieve snow cover properties, investigate glacier masses of Greenland and Antarctica, determine permafrost areas and soil freezing depth, observe ice phenology phases at large lakes, etc. (Tedesco, 2015).

The paper discusses some aspects of cryosphere studies that employ satellite microwave radiometry data. Based on these data and theoretical modeling, we analyze the utility of satellite radiometers in estimating snow water equivalent and ice concentration in polar regions, observing ice phenology stages at large lakes, and investigating the Antarctic ice sheet.

Snow cover

Interaction between microwave radiation and snow cover was analyzed with the aim to improve the methods for estimating snow water equivalent spatial distribution. Approaches to modeling surface brightness temperature variations depending on the structure of snow cover were developed for local conditions (Kitaev et al., 2012). A model of snow cover considering physical and structural properties of the snow mass was created (Boyarskii et al., 1994; Tikhonov et al., 2008). It was established that the accuracy of snow water equivalent estimation from satellite data can be raised by taking into account snow cover stratigraphy (Boyarskii and Tikhonov, 2000). A spatiotemporal assessment of the accuracy of existing algorithms for the retrieval of snow water equivalent depending on near-surface air temperature and precipitation in winter was performed. The analysis encompasses the territory of Eurasia within the borders of Russia and the period 1979−2007 (Kitaev et al., 2017).

Sea ice of polar regions

A model of microwave emission of the system "sea surface - sea ice – snow cover – atmosphere" was devised (Tikhonov et al., 2013; Tikhonov et al., 2014). On its basis, a new algorithm to retrieve sea ice concentration and cover area in polar regions from satellite microwave radiometry data was developed. This algorithm does not use tie points, where values (characteristics of sea ice and open water emission) need to be experimentally predefined, which is an important advantage in contrast to other algorithms. In addition to sea ice concentration and cover area, the new algorithm also identifies areas occupied by meltwater puddles (areas of slush and melt snow on ice) that significantly influence ice cover thermodynamics and interaction between ocean and atmosphere (Tikhonov(1) et al., 2015; Tikhonov(2) et al., 2015; Tikhonov et al., 2016).

A technique developed by the authors to process quasi-harmonic time series using high-order regression models was employed to assess the evolution of the Arctic ice cover area. The assessment was performed at different time scales: a 30-year period, one year period, and, in more detail, summer and winter periods with an averaging of 24h to one month (Raev et al., 2015). It was shown that the widely employed model of a linear trend with a negative time gradient defining September as the month of minimal ice cover area was incorrect both mathematically and physically. This has been vividly demonstrated since September 2012. That was the month of a dramatic shrinking of the north polar cap. However in a year, there was a considerable increase in the area of the Arctic ice cover that continued up to 2017, just in line with the nonlinear regression model. Our forecast proved true. Consequently, the role of the

area of ice cover of the north polar cap and its stochastic regime in the global warming paradigm remains uncertain (Raev et al., 2015).

Freshwater ice of large lakes

Based on the author's original model of microwave emission of inhomogeneous non-isothermal flat-parallel layered medium, an analysis of phenology phases of ice cover of large freshwater bodies was performed using SMOS MIRAS satellite radiometer data (1.4 GHz) by the example of lakes Baikal, Ladoga, Great Bear, Great Slave, and Huron. Comparison of the satellite data and model calculations revealed three time phases of brightness temperature typical of freezing lakes. The first phase marks water surface clear of ice, the second complete ice cover, and the third, characterized by an abrupt and short-lasting rise in brightness temperature by 40-90 K, indicates a drastic change in the structure of ice cover (break-up and melt period). The found regularities of seasonal brightness temperature variations and associated ice cover phenology phases can be utilized for assessing the hydrological regimes of freezing inner freshwater bodies (lakes, reservoirs) based on microwave satellite data. The studies allowed us to develop a technique to determine the start of springtime ice break-up at large lakes using satellite data (Khvostov et al., 2017; Tikhonov(1) et al., 2017). The obtained results are helpful in setting the terms of operation of winter roads on ice across rivers, lakes or reservoirs, since with the beginning of the third phase it becomes less and less secure to use them.

Antarctica

A microwave emission model of the glacier and snow/firn covers of Antarctica was also developed. It takes into account their layered nature and structural properties of each layer (ice crust, density, ice grain size and size variability, wetness, etc.). The model brightness temperatures calculated for various Antarctic regions (polar cap, area of katabatic winds, coastal area) agree well with DMSP SSM/I, SSMI/S and SMOS MIRAS satellite data (Tikhonov(2) et al., 2017). For model input parameters (air temperature and physical and structural properties of layers) we used the data obtained during the 2007/2008 Sweedish-Japanese expedition held in the vast region of the Dronning Maud Land (Sugiyama et al., 2010; Sugiyama et al., 2012). Analysis of model results and their comparison with brightness temperatures in different channels of the satellite radiometers (1.4, 19.35, 22.24, 37.0, 85.5, and 91.655 GHz) showed that seasonal variation of brightness temperature strongly depends on thickness and structure of the snow/firn layers. Also, a high correlation is observed between brightness temperature and air temperature. However, the correlation weakens as frequency decreases and completely vanishes at 1.4 GHz. This fact is explained by the increase in penetration depth of the

microwaves into the glacier cover with decreasing frequency. The obtained dependencies can be used to analyze snow accumulation and mass balance in various regions of Antarctica.

Conclusions

The cryosphere of the Earth is the most sensible indicator of climate change, both at regional and global scales. Because the majority of the cryosphere formations are located in hard-to-reach regions with severe climates, the role of remote sensing methods in their study is very important. Satellite remote sensing instruments (active and passive) operating in the microwave range enable daylight and cloud independent surveys of the Earth's surface. Microwave radiometry techniques are very promising monitoring methods in terms of temporal (duration and frequency) and spatial (coverage and overlapping) parameters. The study results presented in this paper contribute to the value and accuracy of information on processes in the Earth's cryosphere that can be derived from satellite data, as well as the quality of climate change analysis.

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Keywords: satellite microwave radiometry, Arctic, Antarctica, snow cover, firn, sea ice, lake ice, ice sheet, glacier, cryosphere.

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BACK

CAVES GLACIATION IN THE PAST

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On the examples of all three main types of caves with permanent snow and ice formations caves glaciation dynamics during last several centuries is discussed. Glaciation in all caves types have very close connection with outside climate and first of all from air temperature without dependence of cave location. As caves glaciation change almost synchronously in all types of caves during last several centuries it allows to say that in the past caves glaciation changes also synchronously. It opens favourable possibilities for cave glaciation modeling in more far past.

Introduction

Caves glaciation dynamics is studied still very poor. It is connected with: 1) weak investigation level of caves snow-ice formations (SIF), 2) laboriousness of SIF studying in caves, 3) absence of regular SIF observations, 4) absence of good observation principles, 5) ambiguity of received results interpretation, 6) boundary position of cave glaciation between a ground and underground glaciation, between glaciology and speleology, 7) insufficient understanding of importance of ice mass balance studying in caves, 8) generalizing conclusions and global interpretations on the base of individual measurements results.

Available data

Despite of an abundance of caves with permanent SIF (Persǫiu and Lauritzen 2018) only in some cavities cave glaciation dynamics during enough long time was studied.

To receive some general tendencies in caves glaciation dynamics in the recent past we need to use some limitations. We need to use only cavities where glaciation not depends from cavity form, i.e. cavities does not block by ice for some time. If ice blocks cave channels its latest development will have cyclic tendency not completely depending from outside climate (Mavlyudov 2008).

We analyzed historical data about changes of ice in caves of different morphology in different countries (Table 1) and compare them with climate data interpretation received from borehole data analyze in Europe (Bodri and Cermak 1999).

Table 1. Data about historical sequences of ice in caves

Country	Cave	Type of cavity	Data period, years	Kind of data	Author
Russia	Kungurskaya	Horizontal	300	Historical	Lukin, 1965; Dorofeyev and Mavlyudov, 1993; Kadebskaya, 2005
Slovakia	Dobshina	incline descending	645	borehole	Clausen et al., 2007
Romania	Scărişoara	vertical / incline descending	155	Historical	Silvestru, 1999
Russia	Askinskaya	incline descending	94	Historical	Kudryashov and Salikhov, 1968
Poland	Chimniaku	incline descending	96	Historical, ice mass balance	Rachlewicz and Szczuciński, 2004
Switzerland	Caves of Ridge Jura	vertical	up to 110	Historical	Leutscher, 2005

We find enough good agreements between periods of warm climate outside caves and inside caves when quantity of ice in them decrease and periods of cool climate outside of caves and inside caves when quantity of ice in caves increase (Fig. 1).

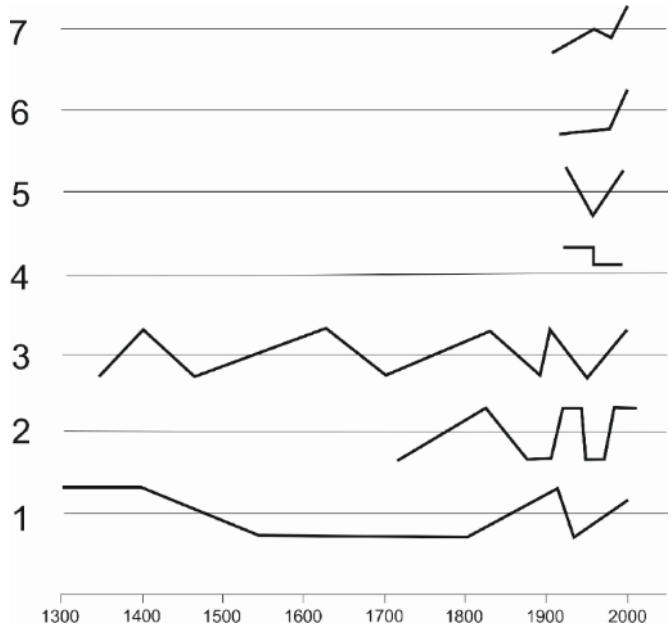

Fig.1. Comparison of climate change: 1 – outside caves (Bodri and Cermak 1999), 2- in

Kungurskaya Cave, 3 – in Dobshina Cave, 4 – in Scărişoara Cave, 5 – in Askinskaya Cave, 6 – in Chimniaku Cave, 7 – in caves of Ridge Jura. Thick line above thin line – warm climate, thick line below thin line – cold climste.

Discussion

We shall consider general regularities of caves glaciation dynamics of different morphological groups: horizontal with entrances at different elevations, inclined descending caves, vertical cavities (Mavlyudov 2008).

Horizontal caves. A criterion of caves glaciation dynamics in this type of cavities is ice mass balance and length of area of negative temperature anomaly in cavities (Mavlyudov 2008). On example of Kungurskaya Cave in Ural it is possible to see that caves glaciation very precisely reacts to climate change. Climate cooling lead to growth of area of glaciation distribution in cavity and to increase of ice quantity in cave, but climate warming - to reduction of glaciation distribution area in cavity and to decreasing of ice quantity in it.

Unfortunately in other caves of this morphology there are no measurments of changing of glaciation areas or negative temperature anomalies or study of ice mass balance. Nevertheless the same regularities, which were received for Kungurskaya Cave in Ural, concern also to other caves of similar morphology. Therefore the general climate change on our planet affects on character of glaciation in horizontal caves of different regions by the same way. General degradation of glaciation begun recently in Eisriesenwelt Cave in Austria has been reduced by artificial regulation of heat exchange in cave. It was made by doors placing in cave entrance and by control for air ventilation in cavity during different seasons of year. In Kinderlinskaya Cave (Pobeda) in Ural where artificial regulation of cave climate is absent ice quantity year from a year a little decreases. In Pinezh'e (Arkhangelsk Region) in connection with a lot of narrow or low cave galleries there are cyclic changes of caves glaciation with duration 9-25 years (Shavrina & Guk, 2005) therefore the tendency of glaciation change in caves of this region is not clear.

Inclined descending caves. Criterions of caves glaciation dynamics in this type of cavities are changes of ice mass balance and depth of ice ledge closely cave entrance. If ice quantity in cave grows this ledge remove closer to cave entrance, and at reduction of ice quantity in cavity – removes away from cave entrance (Mavlyudov, 2008). Unfortunately we have no descending caves where position of ice ledge for understanding of caves glaciation dynamics is used. In the majority of the analyzed caves of this morphology cave SIF volume remains at a former level (Dobshina Cave in Slovakia, Besançon Grotto in France), or decreases (Cave Chimniaku in

Poland, Cave Scărişoara in Romania, Askinskaya Cave in Ural) that possibly is connected with modern climate change. On a background of the general reduction of ice quantity in many of inclined descending caves within 20 century there is some fluctuation of ice volume when its reduction increases or decreases. It can be connected both with features of local climate fluctuations and with the general tendencies of climate fluctuations - relative warming and cooling. It is well illustrated by fluctuations of ice chemistry in one arbitrary point in Dobshina Cave in Slovakia, which can be seen within the limits of area 'I' which approximately corresponds to 20 century (Fig. 2).

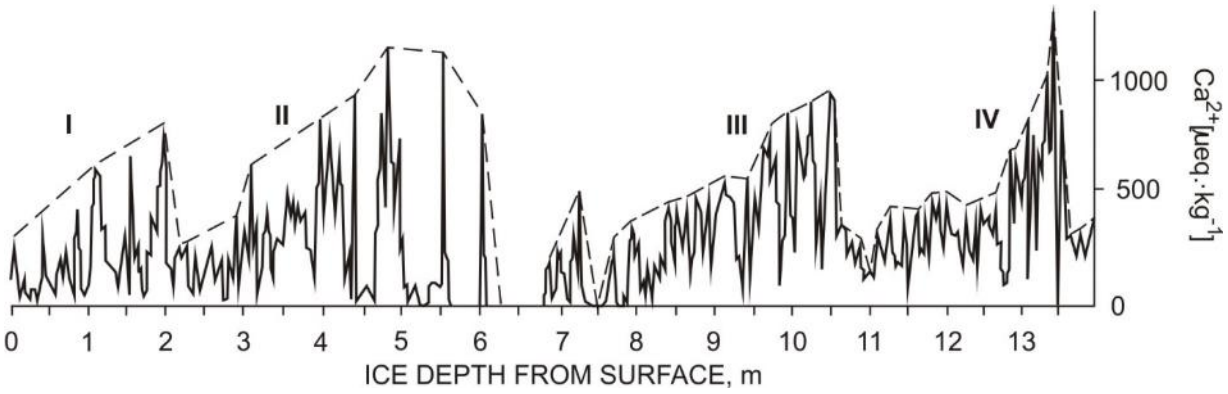

Fig. 2. Change of Ca^{2+} concentration along ice core received in borehole in Dobshina Cave (Clausen et al. 2007). Dotted line – enveloping curve, roman numerals - numbers of time periods.

Vertical cavities. Criterions of glaciation dynamics of caves of this type are changes of ice mass balance and depth of pits snow line (Mavlyudov 2008). Unfortunately we have no vertical caves where pits snow line for understanding of caves glaciation dynamics changes is used. Now in many karst vertical caves degradation of glaciation during historical time is noted (cavity of Jura Mountains, cavities in Caucasus). It is connected from dependence of these cavities glaciation both from air temperature and from quantity of solid precipitation collecting in cavities. Warming of winters leads as to decreasing of cold reserve in cavities, and to reduction of snow quantity collecting inside of cavities.

Especially it would be desirable to stop on the analysis paleogeographical information, which can be received from the ice cores from caves with permanent ice. As it has been shown above for Dobshina Cave in Slovakia the analysis of ice core is quite competent and yields some positive results. In spite of the fact that attempts to analyze of similar ice cores are not numerous for present (Citterio et al. 2005; Clausen et al. 2007; Leutscher 2005) only in some cases the analysis of these data can be used for paleogeographical reconstructions. Why it is

necessary to concern to such interpretations with the big care? The matter is that ice cores far not from all caves can be used for paleogeographical reconstructions. For this purpose ice cores are favorable from cavities where occurred in the past and there is now regular accumulation of SIF, i.e. there where in layers of SIF have no temporary breaks. Ice massif from Dobshina Cave in Slovakia belongs for such objects. Our researches have shown that such layered ice thicknesses without breaks in caves are very uncommon. For this reason the wide usage of this method for paleogeographical reconstructions is improbable. Nevertheless usage of this method for studying of caves glaciation dynamics has not passing value especially if it will accompanied by other proxy data.

As to modeling calculations they are devoted basically to the analysis of modern conditions of caves glaciation. Basically models are constructed for horizontal caves (Golod and Golod 1974; Jancarik 1978; Mavlyudov 1985). Models can give also picture of glaciation dynamics in the past. At the given stage of researches this picture is very schematical. Nevertheless if we have reliable scenarios of climate change they can be used for restoration of glaciation dynamics in the past and the future. The more detailed prognoses of climatic data the will be closer results of modeling to the characteristic of natural processes. However now scenarios of climate in the past and the future are very schematical that means an opportunity to receive picture of caves glaciation dynamics in the past only in extremely schematized kind and only for the separate points located through big time intervals (sometimes thousands years) and unfortunately cannot be useful in the present research. Thus modeling calculations also demand additional study and this area of scientific activity still waits of the researchers.

From mention above follows that caves glaciation of all basic morphological caves types very sensitively reacts to change of an external climate. Thus inertial possibilities of perennial SIF in caves smooth influence of sharp climate changes (intra-seasonal and inter-annual fluctuations of air temperatures and quantity of precipitation), allowing for caves glaciation to react only to the general tendency of climate changes (trend of climate change). Processes inertia of caves glaciation is clear. It is connected by that caves glaciation arises in the uppermost layers of an earth's crust in conditions of constant geothermal flux but under the overwhelming control of an external climate. Therefore ice massifs available in caves and cold reserve in rocks surrounding cave channels in an overwhelming degree are control by an external climate instead of geothermal heat. For this reason glaciation can appear in volcanic cavities located in regions with the increased geothermal flux (Ohata et al. 1994). For this reason glaciation originally appeared in caves in the further starts «to work on itself», controlling field of low temperatures around of cavity.

As caves glaciation so sensitively reacts only to average values of climatic changes that means it can be used as averaged parameter of external climate changes, tendencies of its changes. It is act as the original filter, the indicator, showing not momentary changes but direction of these changes. By this reason it is very important to carry out researches of caves glaciation dynamics in different regions of our planet. At the same time big help for organization of regime researches of caves glaciation dynamics can give simple glaciation parameters for each type of caves with permanent SIF, which have been mentioned above.

In spite of the fact that historical certificates frequently very not concrete and also give usually minimal information on character of caves glaciation changing but as has shown the present research these data nevertheless also can use for revealing the general tendencies of caves glaciation change in the past. As we saw from data mention above general tendency for many caves of different morphology with permanent SIF is connected with degradation of their glaciation. And for this reason it is necessary to afraid that at stability of modern tendency of climate change permanent glaciation in many caves in nearest future can disappear. In this case it will be lost not only this important indicator of climatic changes of the present but also data about tendencies of change of external climate written down in ice thickness.

Conclusion

From above mention data we can also see that glaciation parameters in all kinds of caves with permanent SIF change almost synchronous. This especially good sees for periods before 1960^{th} and after them that correspond increasing of ice quantity in caves before 1960^{th} and decreasing after that. It means that all caves with permanent SIF in different areas have similar reactions on climate change not only now but also in nearest past. It allowed us to use modern situation for caves with permanent SIF for prognosis of caves glaciation in far past in the hole.

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Keywords: caves glaciation, dynamic, snow-ice formations.

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BACK

SNOWFALL AND RAINFALL PRECIPITATION VARIATION IN EUROPEAN RUSSIA: IMPACT ON RIVER RUNOFF UNDER CONTEMPORARY CLIMATE CHANGE

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Introduction

Contemporary global warming is a fundamental driver for the observed long-term changes in water cycle during past decades. Theoretical estimates according to the Clausius-Clapeyron relation and observations have indicated an increase of lowertropospheric moisture content at a rate of about 7% per 1K (Held and Soden 2006). Under climate change, frequency of snowfalls and rainfalls can change considerably. Changing patterns of winter precipitation and temperature have resulted in changes to the ratio of snowfalls/rainfalls to total precipitation. This shift primarily occurs during spring and autumn as precipitation shifts from snowfall to rainfall due to winter warming and shortening the snow cover duration. This also results in change of seasonal structure of river runoff including maximum melt water discharge. All these situations have significant impact on water resources, their availability and risks of catastrophic floods. Possible future changes of the precipitation structure can be estimated using its changes due to the contemporary interannual variations. The shifts in the precipitation structure are rather inhomogeneous in space. Thus, it could be interesting to assess its impact on variability of annual and spring runoff for extent watersheds. The aim of the study is to obtain quantitative estimations of solid and liquid precipitation fraction on annual river runoff variability as well as to reveal relation between the liquid/solid precipitation ratio and extreme spring river discharge in Volga basin during last decades.

Data and methods

Data on solid and liquid precipitation sums from two sources were preliminary tested. One of data base (P_1) was completed by Bogdanova et al. (2010) and now is available in open access in RIHMI data bases (http://meteo.ru/data). The specific feature of this precipitation data base is application of a bias correction model to precipitation time-series in order to avoid well

known inhomogeneities in precipitation observations at Russian meteorological stations, particularly, due to wind-induced biases. The second kind of data base (P_2) was obtained on the base of daily data on air temperature and precipitation analysis. The daily time series (RIHMI data bases, http://meteo.ru/data) have been analyzed in order to calculate monthly sums of solid and liquid precipitation, and the daily mean air temperature equal to +1ºC have been chosen as a threshold value. Then, half-year sums of both solid and liquid precipitation were calculated for April to September and October to March months of each year, representing "warm" and "cold" halves of a year. Annual sums of solid and liquid precipitation were calculated too. For solid precipitation, the sums for the end of a year was added to the next year in order to get total sum of water resources available in the river basins in each hydrological year. Comparison of these two data bases on annual solid and liquid precipitation was based on the assessment of value of runoff variance explained by each of data base. The North Dvina runoff (at Ust-Pinega) variation were chosen for this comparison test. The time series cover years from 1966 until 2006, that allows us to avoid two inhomogeneities in precipitation observations related to measuring equipment changes and wetting correction employed in 1966. Data on snow-water equivalent, SWE, (RIHMI data bases, http://meteo.ru/data) were also considered, as independent source of data on solid precipitation.

In order to assess the comparative shares of solid and liquid precipitation and their changes the obtained time series of solid and liquid precipitation from Volga (at Volgograd) river basin were analyzed using forward multiple stepwise regression. For Volga basin, temporal dynamics of the mentioned characteristics and their relations with the annual runoff, spring runoff and its share in the annual runoff were studied.

Results

Parameters of the multiple stepwise regression carried out for comparison of quantitative assessment of solid fraction of precipitation from two data bases on North Dvina runoff (at Ust-Pinega) variation (Table 1) show that time-series with wind-induced bias correction can explain only 30% of runoff variance. That is the most low value and detects weak correlation in comparison with solid precipitation without wind-induced bias correction (52%) and SWE (39%) as well.

Table 1. Parameters of regression of North Dvina annual runoff on annual solid precipitation from precipitation data bases P_1 (with wind- induced bias correction), P_2 (without wind-induced bias correction) and snow-water equivalent, SWE.

Data base	Regression parameters					
	B	Std.Err.	R, multiple	R^2%, multiple	*t(N=37)*	Significance level, *p*
P_1	0.24	0.07	0.54	30	3.40	0.00
P_2	0.29	0.05	0.72	52	5.69	0.00
SWE	0.25	0.06	0.63	39	4.34	0.00

Fig. 1 demonstrates the difference between course of solid precipitation from data base P_1 and runoff and solid precipitation without wind-induced bias correction (P_2) as well during the period since the end of 1980-s to earlier 1990-s when the maximum values of North Dvina runoff have been observed. Time-series of SWE and solid precipitation without wind-induced bias correction are absolutely corresponding to runoff maximum different to solid precipitation from data base P_1. The last allows us to conclude that the correction of wind-induced bias has been exceeded real the wind disturbing effect on precipitation measures in this period. Thus, data from base P_1 was excluded in the further study concerned with solid and liquid precipitation in Volga basin.

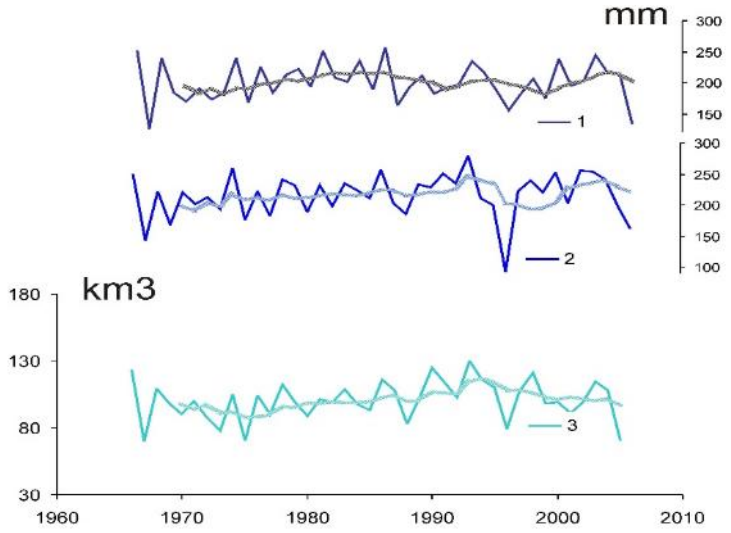

Fig. 1. Variation of annual solid precipitation (1, 2), mm, and North Dvina annual runoff, km^3, (3). 1 – annual solid precipitation from data base P_1, with wind-induced bias correction; 2 –

annual solid precipitation calculated on daily data on air temperature and precipitation (without wind-induced bias correction), P_2.

Comparative share of solid and liquid precipitation fraction on Volga runoff obtained as a result of regression analysis (Table 2) show that the annual runoff can be explained by variation of these two mentioned characteristics up to 65%. The leading role with 40% belongs to solid precipitation, share of liquid precipitation about 26% includes previous year impact with 10%. Impact of the air temperature of previous year (in August) turned out noticeable only for spring runoff (8%), the leading role (37%) belongs to solid precipitation.

In the case of winter runoff the same share (45%) of its variability is related with liquid and solid precipitation of previous year, 29% and 16% correspondingly. Variation of liquid precipitation explains up to 60% of summer-autumn Volga runoff.

Table 2. Parameters of multiple stepwise regression of Volga runoff (at Volgograd) on solid (P_{sol}) and liquid (P_{liq}) precipitation in 1951-2006. P_{sol} ($\tau = -1$) – solid precipitation of previous year; P_{liq} ($\tau = -1$) – liquid precipitation of previous year; $T_{aug}(\tau = -1)$ – surface air temperature over the Volga basing in August of previous year

	Regression parameters						
	B	Std.Err.	R, multiple	R^2%, multiple		$t(N=37)$	Significance level, p
Annual							
P_{sol}	0.47	0.08	0.63	40	40	5.59	0.00
P_{liq}	0.23	0.05	0.75	56	16	4.58	0.00
P_{liq} ($\tau = -1$)	0.17	0.05	0.81	65	10	3.19	0.00
Spring							
P_{sol}	0.39	0.08	0.61	37	37	5.01	0.00
$T_{aug}(\tau = -1)$	-4.99	2.32	0.67	45	8	-2.15	0.04
Summer-Autumn							
P_{liq}	0.16	0.02	0.74	55	55	8.24	0.00
P_{liq} ($\tau = -1$)	0.05	0.02	0.78	60	5	2.90	0.01
Winter							
P_{liq} ($\tau = -1$)	0.08	0.02	0.54	29	29	4.74	0.00
P_{sol} ($\tau = -1$)	0.09	0.02	0.67	45	16	3.93	0.00

Comparison of interannual variation of Volga runoff from observations (Fig. 2) with runoff calculated on the base of obtained multiple forward regression equation (Table 2) demonstrates rather precise it simulation. It touches upon 5-10-year fluctuations and trend 1952-2006 as well.

More comprehensive consideration of calculated annual runoff for two periods: 1951-1975 and 1976-2006, shows that crucial decrease of Volga runoff in the mid of 1970-s has been simulated less precise to the contrast of following runoff growth during three decades. These two periods differ according to the comparative impact solid and liquid precipitation on annual runoff variability. Multiple regression estimates obtained for two periods show that share of liquid precipitation in runoff variability increased up to 37% and exceeded the impact of solid precipitation, which has decreased to 13%.

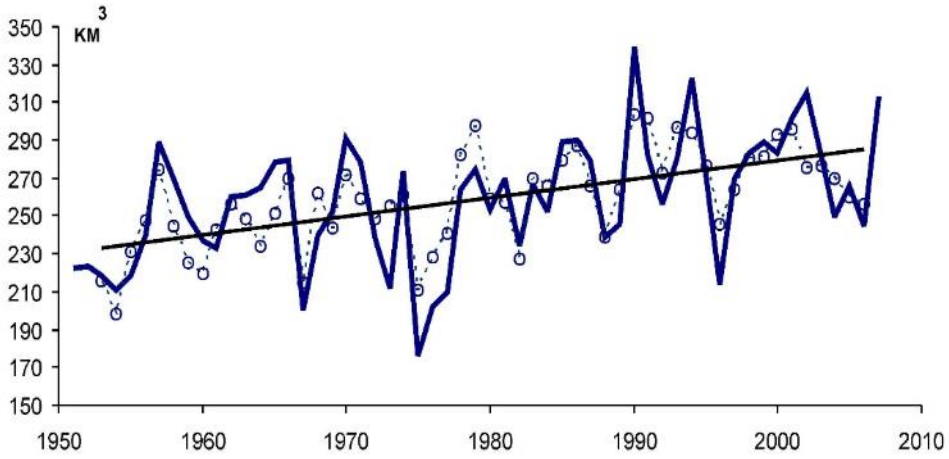

Fig. 3. Variation of annual Volga runoff (at Volgograd), observed, solid blue line, and calculated, dashed line with markers, on the base of regression parameters from Table 2. Straight black line indicates linear trend

In the temperate zone climate. the liquid/solid precipitation ratio of the annual sums is rather important from the view point of extreme flood occurrence. Hence, change of the ratio can result in variations of the maximum runoff volume in spring. Statistical characteristics of relationships between the liquid/solid precipitation ratio and runoff parameters in Volga basin for 1951-2001 time series are shown in Table 1. While annual runoff is not related to the ratio, the spring runoff (occurring in April), as well as the fraction of spring to annual runoff are correlated to the liquid/solid precipitation ratio in opposite phase. The correlation coefficient

between $P_{liq}/P_{sol}+P_{liq}$ ratio and spring runoff and are not high, still statistically significant, but it rather high for the fraction of spring in annual runoff.

Table 3. Correlation coefficients between liquid/solid annual precipitation ratio ($P_{liq}/P_{sol}+P_{liq}$) and runoff characteristics in Volga basin in 1951-2001 (R – annual runoff. R_{spring} – spring runoff). Numbers in bold are significant at $p < 0.05$

Runoff characteristics:	R	R_{spring}	R_{spring} / R
$P_{liq}/P_{sol}+P_{liq}$	0.02	-0.38	-0.50

In Fig. 3. time series of the $P_{liq}/P_{sol}+P_{liq}$ annual precipitation ratio and spring runoff in Volga are shown. One can see that negative correlation between the two parameters on high frequencies is evident. Evidently, this fact demonstrates possible reduce of extreme flood risk as a consequence of increase of liquid fraction in precipitation annual sum under contemporary winter warming.

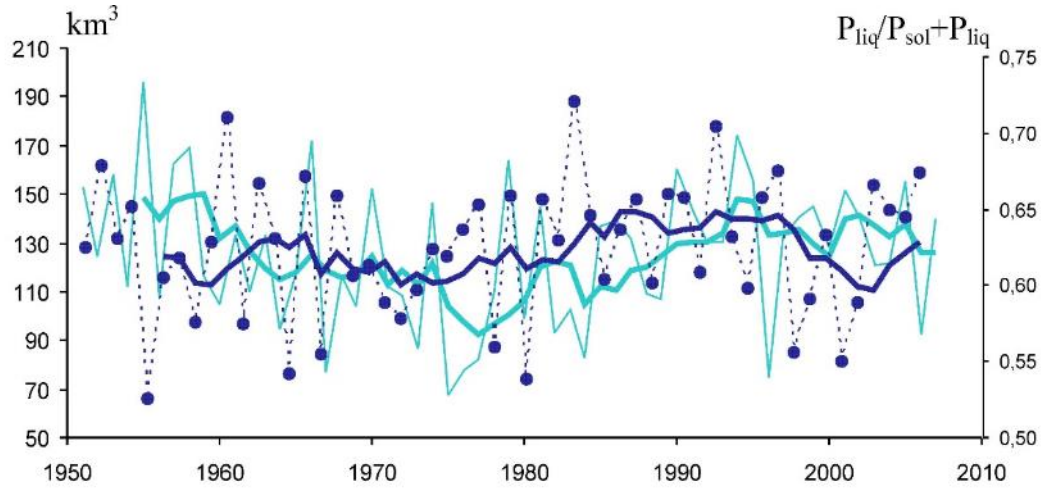

Fig. 3. Change of the liquid/solid precipitation annual ratio. dark blue. and spring river runoff. km^3. from Volga basin (at Volgograd). light blue. The dashed bold lines show 5-year running means.

At the same time, multi-year tendencies of the 5-year running means (decrease before the mid-1970s and increase thereafter) are correlated positively. This implies that dependence of the maximum runoff on the liquid/solid precipitation ratio is non-linear: it is positive on low frequencies and negative on periods up to 3-4 years.

Explanation of this fact is probably the following. In North Eurasia, the contemporary climate change (on the scale of several decades) is related to strengthening of cyclonic activity. spreading over the north-eastern part of Volga basin. This part of the basin, adjacent to Ural mountains, is contributing the largest input to contemporary increase of the snow accumulation

(Popova et al. 2015, Popova 2007), and hence, maximum melt water discharge. This can be seen in their low-frequency variations. At the same time, increase of the liquid precipitation fraction and decrease of snow accumulation due to warmer winters in the rest of the basin leads to some lowering of the melt water peaks (Popova et al. 2015, Popova 2007). This situation is connected to the geographical position of the Volga basin: in its north-eastern half, increase of snow accumulation takes place, while in the south-western half some snow is replaced by rain.

Conclusions

The liquid/solid precipitation ratio has increased in the regions with significant frequency of warm events in winter, particularly in the south and west of the East European Plain. Estimates of comparative share of liquid and solid precipitation in Volga runoff variability obtained using multiple stepwise regression show the leading role of solid precipitation for the whole period 1951-2006 and increase of impact of liquid precipitation since 1976. While change of liquid/solid precipitation ratio is in accordance with low-frequency spring runoff tendencies, revealed negative correlation between liquid/solid precipitation and spring runoff demonstrates the opposite course of their interannual anomalies and thus suggests decrease of extreme flood risks under contemporary climate change.

Acknowledgements

The study has been supported by Russian Foundation for Basic Research (grants 17-05-00555).

Keywords: Volga, North Dvina, precipitation; solid/liquid fraction, river runoff, water resources; climate change.

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BACK

TIEN SHAN HIGH MOUNTAIN SCIENCE CENTER AND ITS ACTIVITIES

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Tien Shan High Mountain Science Center is located on the northern slope of the Teskey Ala-Too Ridge, in the valley of the Chon-Kyzyl-Suu river. Tien Shan High Mountain Science Center is the successor of the former widely known Tien Shan Physical Geographic Station. The Tien Shan Physical Geographic station was established by the Institute of Geography of the USSR Academy of Sciences in 1947 on the initiative of academicians Grigoriev and Avsyuk. Well-known geographical community academician Gerasimov, Doctor of Geographical Sciences, Corresponding Member of the USSR Academy of Sciences Avsyuk, Doctor of Geographical Sciences, Professor Glazovskaya, Candidates of Science Iveronova, Zabirov, Kaletskaya, Matveeva, Lysichek, Zimina, Rantsman, Dorogonevskaya and many others worked at the station. In 1953 the Tien Shan Physicogeographical Station was transferred to the balance of the Kyrgyz branch of the Academy of Sciences of the Kyrgyz SSR.

The Tien Shan Physical Geographic Station participated in the programs of the IHY (International Hydrological Year) and IHD (International Hydrological Decade). The research was carried out jointly with the geographical faculties of the Kyrgyz, Moscow, Leningrad, Kharkov state universities and a number of other research institutes. Cataloging the glaciers of the Kyrgyz Republic has become one of the most important results of the station's activities.

The volume of the research carried out by The Tien Shan Physical Geographic Station is several times greater than the work of the Khibiny Geographic Station that has existed since 1948, the Pamir Biological Station of the Academy of Sciences of the Tajik SSR and the Renet Station of the Institute of Deserts of the Academy of Sciences of the Turkmen SSR.

The station fell into decay, scientific research practically ceased in the 1990s, after the collapse of the USSR. The station was revived in 2006 after the transfer of the station to the balance of the Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic and its renaming to Tien Shan High Mountain Science Center. Nowadays there are three laboratories at the Tien Shan High Mountain Science Center: glaciology, onshore processes, and biogeography. Monitoring of the reference glacier Kara-Batkak was resumed in 2007. On the basis of the Center, the research Lake Station was established to study the coastal processes of the Issyk-Kul lake. GPS stations, limnigraphs, RLS radar-remote sensing machine and an automatic meteorological station were installed in cooperation with the laboratory LEGOS (Laboratory of satellite geophysics and oceanography), the Observatory of the Mid-Pyrenees (Toulouse, France).

We proposed to establish the International High Mountain Scientific Center on the basis of Tien Shan High Mountain Science Center at the Regional Meeting of Heads of State Organizations for Science and Technology with the participation of representatives of the International Association of Academies of Sciences in 2008. This proposal was supported by the Kazakhstani Agency of Applied Ecology, the Institute of Water Problems of Tajikistan, the Mid-Pyrenees Observatory (Toulouse, France), the Institute of Ecology and Geography of the XUAR of China, the Institute of Desert Meteorology under the Chinese Meteorological Administration. The Kyrgyz-Chinese Scientific Research Center for Ecology and Environment of Central Asia was established together with the Institute of Ecology and Geography of the Academy of Sciences of the People's Republic of China. 4 automatic weather stations, 4 gauging stations with automatic water level registration and a station for monitoring forest ecology are installed in different high-altitude zones of the Chon-Kyzyl-Suu river basin with our partners from China, Japan, and France.

The main activity of the Center is focused on the monitoring and study of glaciers. The object of stationary observation is the Kara-Batkak glacier (the basin of the Chon-Kyzyl-Suu river), which has been under surveillance since 1956. In addition, the Center monitors glaciers and hydrometeorological observations at the concession area of the Kumtor mine, in the basin of the Naryn and Sary-Zhaz rivers. The purpose of the monitoring is to assess the state of glaciers and monitor their dynamics in connection with the technogenic impact of the mine. The complex monitoring of the Kara-Batkak glacier was restored thanks to the participation of the Center together with the University of Colorado in the project CHARIS (Contribution to High Asian Runoff from Ice and Snow) in 2013-2017.

Currently, the Center cooperates with the following scientific institutes:

1. University of Colorado, USA, CHARIS Project "Creation of joint efforts in order to assess the role of glaciers and seasonal snow cover in mountain hydrology High Asia."
2. Moscow State University and the Russian Academy of Sciences Glaciers mass balance and mathematical modeling of glaciers dynamics.
3. Institute of ecology and geography of CAS Creation of material and technical base for joint complex researches of mountain ecosystem of the Tien Shan in conditions of climate change.
4. Kyrgyz and Chinese Research Center “Mountain Ecosystems” Complex research of mountain ecosystem of the Tien Shan in conditions of climate changes.
5. Institute of Meteorology of deserts under China’s Meteorological Administration. Study of the variability of trees and determination of their age on the background of climate changes.
6. LEGOS laboratory, Meteo-France and Montpellier University. Satellite altimetry of Issyk-Kul lake surface. Hydrological modeling of Chon-Kyzyl Suu river and Issyk-Kul lake river.
7. National Academy of Sciences of USA, USAID PEER project. Paleoglaciological researches of ice valleys and isotopic and chemical study of ice and water resources for long-term forecasting of ice and climate changes in Central Asia.
8. Regional Water Environment System Laboratory, Water Resources Research Center, Disaster Prevention Research Institute, Kyoto University, Japan. Observation and research, snow accumulation, glaciers melting and impacts of climate change on the water resources in Central Asia.

The Center plans to continue monitoring and research in the near future. Particular importance is to focus on the glaciers monitoring, the necessity to update the catalog of glaciers of the Kyrgyz Republic and the ongoing study of the glaciation dynamics for developing reliable forecasts of water-ice and climate changes.

BACK

STUDY OF SNOW COVER IN MOSCOW FORMED FROM HEAVY SNOWFALLS, JANUARY–FEBRUARY 2018

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During the Northern Hemisphere winter of 2017/18, heavy snowfalls were observed in the European Territory of Russia, which led to the disruption of transport and additional work for community services, and in some regions of the United States. The snowfalls, between 3 and 5 Feb 2018, in Moscow were considered to be the heaviest snowfalls for the past 100 years of observation. An analysis was conducted of the resulting snow thickpack; the snow's density and the size and form of crystals deposited as solid precipitation composing the snowfall layers were characterised. On the basis of hydrometeorological observational data extracted from the Moscow station at Balchug, a snowpack, modelled from data from the period of the heavy snowfalls between Jan and Feb 2018 was created according to the method from (Golubev et al. 2008) and compared to a real (observed) snowpack. The method for compiling the thicknesses of the modelled snowpack's stratigraphy consisted of extracting information from the meteorological data corresponding to the snowpack's layers. The term 'snowfall' is understood as an event of solid atmospheric precipitation (snow) over a duration of a certain period of time (up to one or several days) with an intensity of not less than 0.1 mm per day and a temperature below 0°C, i.e. under condition of snow cover presence. The snowfall intensity was characterised as the sum of the precipitation, its snow water equivalent (SWE) during a snowfall. A comparison of the modelled snowpack stratigraphy and the observed stratigraphy gave an acceptable fit. On 6 Feb in Moscow, near the Lomonosov Moscow State University, a snowpack, 36 cm high, composed of four layers was observed; there were three approximately equal layers, with the lowest layer divided in half. The lower layers (0–9 cm) and the middle layer (10-21 cm) were composed of slightly faceted, small- and medium-grained (0.1–1 mm) crystals. The upper layer (21–36 cm thick) was composed of dendritic fragments, the branches of which were 1–1.5 mm long (Figure 1a). The densities of the snowpack's layers are given in Table 1.

Table 1. Snow layers and its density.

Layer (cm)	Density (g/cm$^{3)}$
0–5	0.300
5–10	0.216
10–16	0.266
16–22	0.233
22–36	0.133

The stratigraphy of the observed snow layers was compared to that of the modelled snowpack. The snow layer observed in contact with the ground surface had a density of 0.3 g/cm^3 and a thickness of ~5 cm, corresponding to the deposition of precipitation between 14 and 20 Jan, with an SWE, of the summed precipitation, of 14 mm (Figure 2). This was in agreement with the modelled 0.3 g/cm^3 x 5 cm = 1.5 g/cm^2 = 15 mm SWE. The upper half of the lower third of the snow thickness had a lower density of 0.216 g/cm^3 and a thickness of ~4 cm, which corresponded to the deposition of precipitation between 21 and 23 Jan, with a summed SWE of 8.8 mm. This was also in agreement with the model: 0.216 g/cm^3 x 4 cm = 0.864 g/cm^2 = 8.64 mm SWE. The middle third of the snowpack was ~10 cm thick; the density of the upper half was 0.233 g/cm^3 and the density of the lower half was 0.266 g/cm^3. It was formed from snowfalls between 29 Jan and 1 Feb and had an SWE of 27 mm. This agreed with the modelled (0.233 g/cm^3 x 5 cm = 1.165 g/cm^2 = 11.65 mm) + (0.266 g/cm^3 x 5 cm = 1.330 g/cm^2 = 13.3 mm): a 25 mm SWE in total. The upper third of the snowpack consisted of fresh snow with a density of 0.133 g/cm^3 and a thickness of ~17 cm, which was formed as the result of snowfalls between 3 and 6 Feb, from 45 mm of precipitated SWE, compared to 0.133 g/cm^3 x 17 cm = 2.26 g/cm^2 = 22.6 mm SWE. This slight difference can be explained by evaporation from the surface of the snow thickness and the drift of freshly deposited snow away from the observation point. From the observations of the precipitated ice crystals, it was noticed that during the deposition of the middle layer's snowfall, between 29 Jan and 1 Feb, ~1 mm (29 Jan and 01 Feb) crystals, in the form of columns and plates, and dendrites with diameters of 1–2 mm (30 Jan) were deposited. This was preceded by decreasing air temperature: −5°C to −8°C. During the extremal snowfalls, between 3 and 5 Feb, dendrites with diameters of up to 4 mm were deposited. This was preceded by increasing air temperature, up to 0°C. After one week of snow compaction, on 14 Feb, the layers deposited during the heavy snowfalls between 29 Jan to 1 Feb and 3 to 5 Feb were compacted into one layer and a small, new fresh snow layer was then deposited (Figure 1b).

Therefore, the heaviest snowfalls, between 3 and 5 Feb in Moscow and across all the European Territory of Russia resulted in the extremal growth of a stratified snow thickness.

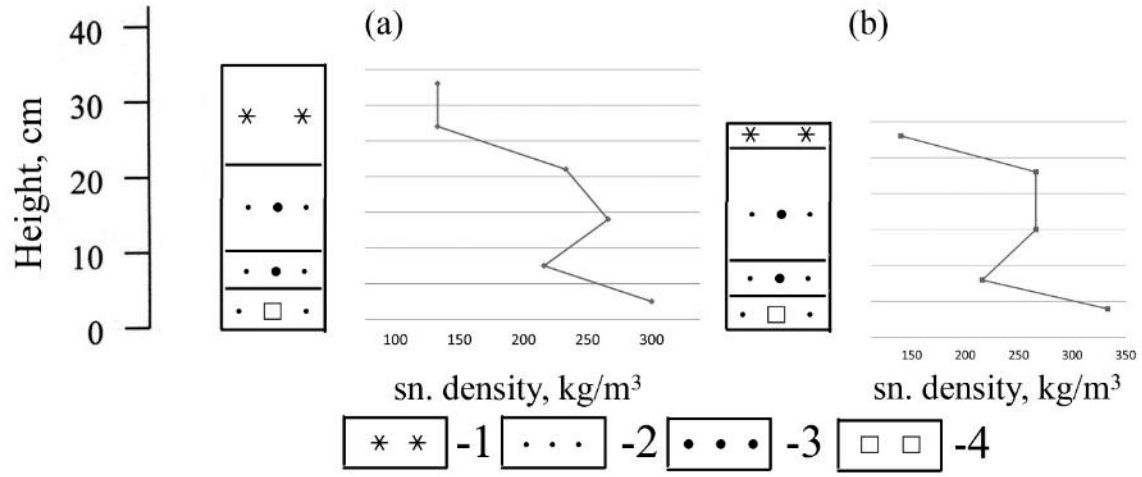

Fig. 1. Observed stratigraphy in a snow column near Lomonosov Moscow State University (a) 8 Feb 2018 and (b) 14 Feb 2018, with density plots (kg/m^3). 1= new snow, 2 = fine-grained snow (0–0.5 mm), 3 = medium-grained snow (0.5–1 mm) and 4 =faceted crystals.

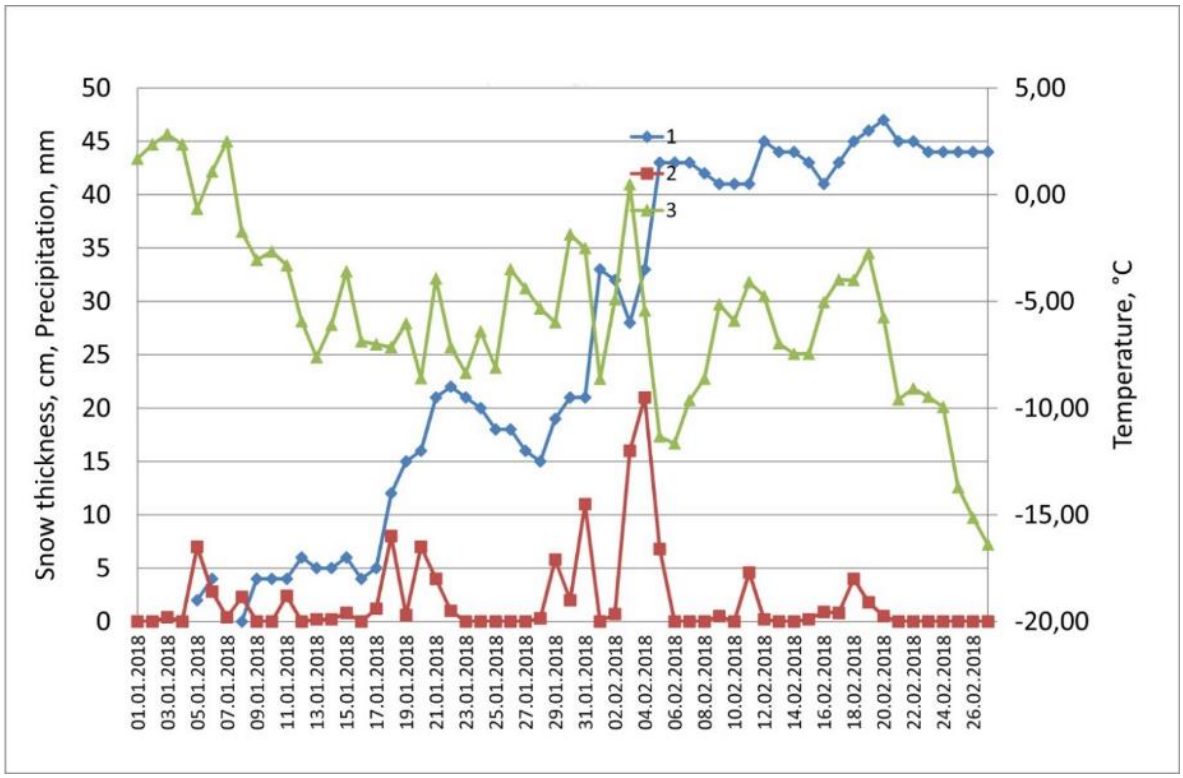

Fig. 2. (1) Variations in snow thickness, (2) precipitation and (3) air temperature. Source: Moscow Meteorological Station, Balchug, winter 2017/18 (http://rp5.ru/).

Keywords: Solid precipitation, snowfall, snow thickness, snow water equivalent.

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BACK

MASS BALANCE MONITORING AND CAPACITY BUILDING IN CENTRAL ASIA

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Glaciers are a key component of the high-mountain environment of Central Asia. They are essential for water availability in the region and glacier retreat can trigger natural hazards, such as GLOFs. However, in Central Asia continuous glacier mass balance observations, which are required for efficient water resource management and disaster risk reduction, are sparse. According to regional mass balance studies based on remote sensing data, glaciers in the Tien Shan are losing mass. As for glaciers located in the neighbouring Pamir, several geodetic mass balance studies suggest less negative mass balances or balanced conditions. However, changing processes cannot be understood fully based on solely on remote sensing studies. They often rely on bulk estimates, provide only decadal changes and are connected to unknown uncertainties. Therefore, a combination of approaches is necessary. A promising noval approach, where observations of transient snowlines and geodetic mass balances are used to constrain a model, provides annual mass balance series for remote glaciers. Nevertheless, in-situ measurements of glacier mass balance are a prerequisite for validation and calibration of any approach. On the one hand, extensive mass balance monitoring programmes are needed to overcome the data scarcity in Central Asia. On the other hand, capacity-building efforts in the research area of the cryosphere are necessary to ensure the sustainability of any monitoring. CICADA project aims on a capacity building amongst stakeholders in Central Asia and the continuous monitoring and open access of in situ data from glaciers in this data sparse region. Here, we give an overview

of the CICADA project and an insight into different mass balance studies of Central Asian Glaciers performed within CICADA and related projects.

Keywords: glacier mass balance, capacity building, Central Asia.

BACK

THE SURFACE VELOCITY OF THE ELBRUS GLACIERS ACCORDING TO REMOTE SENSING DATA

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Europe's largest ice-covered volcanic massif of Elbrus (5642 m) is a unique object for studying the reaction of mountain glaciers to modern climate changes. The feeding areas of the Elbrus glaciers are in conditions of almost free atmosphere, while their languages descend to heights of about 3000 m, covering the maximum diversity of conditions in the entire glacial zone of the Central Caucasus. One of the most important indicators characterizing the regime and dynamics of its glaciers are changes in the speed of ice movement. The estimation of this indicator becomes especially actual in conditions of negative mass balance, observed annually during the last 11 years (2006-2017). In this paper, the data of the radar satellites (Sentinel-1 A and B) and digital terrain models are used to solve this problem. Selected Sentinel interferometric pairs on the Elbrus glaciation area were obtained during the ablation period of 2017. Evaluation of the movement of the glacial surface between the images of each pair was performed using the displacement tracking function in the SNAP 5.0 toolkit. The spatial resolution of the radar data varies from 5 to 20 m. The obtained surface velocities of the Elbrus glaciers range from 0 to 0.6 m/day. The paper analyzes the spatial and temporal variability of this indicator on the basis of comparison with the data of existing ground and remote measurements and gives an assessment of the possibility of using the results obtained in calculations of the mass balance of glaciers in Elbrus.

This study is supported by the Russian Foundation for Basic Research, grant 18-05-00838.

Keywords: Elbrus glaciers, surface velocities, radar data, mass balance.

BACK

RECONSTRUCTION OF DONGUZ-ORUN GLACIER FLUCTUATIONS ACCORDING TO DENDROCHNOLOGICAL, LICHENOMETRIC AND REMOTE SENSING DATA

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Over the last few centuries almost in all mountain areas of the world there is a tendency to glaciers retreat. This trend is consistent with an increase in the global average annual temperatures that occurs in the last 100-150 years (IPCC, 2013), which makes it possible to talk about the high sensitivity of glaciers to climate change. The most sensitive glaciers to climate fluctuations are warm valley glaicers of simple form. However, glaciers with individual characteristics are of interest for the purposes of paleoclimatic reconstructions. . Glacier Donguz-Orun is of particular interest, because its tongue is debris-covered and it has avalanche and ice falls feeding, which is not typical for the classic valley glaciers of the Caucasus. Despite extensive studies of Caucasian glaciers by foreign and domestic researchers since the middle of the XIX century, information about this glacier is limited. In this study we analyze historical (descriptions, pictures), cartographic, dendrochronological and lichenometry data, as well as remote sensing data, to estimate the fluctuations of the Donguz-Orun glacier over the last centuries. It has been established that the Donguz-Orun glacier in the past had several clearly marked advances about 100, 200 and more 350 years ago, which are expressed in relief in the form of uneven-aged coastal moraines. Despite the fact that the Donguz-Orun glacier is characterized by pronounced features, the main periods of its advances are consistent with the known large fluctuations of mountain glaciers during the Little ice age in the early 20th, early 19th, and, probably, in the middle of the 17th century. However, unlike most other Caucasian glaciers, the Donguz-Orun glacier advanced in the 1970s-2000s. The scale of its degradation from the end of the 19th to the beginning of the 21st century is also uncharacteristic for the Caucasus: a linear reduction in size in more than a century is only about 100 m.

Keywords: dendrochronology, tree-rings, glacier fluctuations, lichenometry, Little Ice Age, remote sensing, repeated photographs.

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BACK

Cultural Regionalism and Regional Identity

- The Concept Of Geocultural Space As Basis Of Cross-Disciplinary Research Of Objects Of Heritage In Cultural Geography
  Alina Paranina, Roman Paranin

- Geographic Contributions To The Question Of Ethnic Regionalism And Regional Identity In Central Europe – With Special Regard To The Past And Present Of Ethnic Based Territorial Autonomies In The Carpatho-Pannonian Area
  Károly Kocsis

- Ethnic Settlement Shifts In Russia In 1989-2017: Main Trends And Cultural-Geographical Consequences
  Vladimir Streletskiy

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- The Migration Destination Choice as a Criterion of Self-Identification(The Case of Young People Leaving Noril'sk and Dudinka)
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POSTER

- Hierarchical Structure Of The Territorial And Cultural Identity Of Rural Inhabitants Of The Russian North And Siberia
  Alexandra Sokolova

BACK

THE CONCEPT OF GEOCULTURAL SPACE AS BASIS OF CROSS-DISCIPLINARY RESEARCH OF OBJECTS OF HERITAGE IN CULTURAL GEOGRAPHY

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Introduction

The purpose of the article is to reveal the potential of the cultural geography in solving the problem of rational use of prehistoric objects of cultural heritage. The development of research methods and methodology allows using ancient objects as sources of information about the stages of the evolution of nature and culture (Marsadolov et al., 2013; Paranina and Paranin 2014, 2016, 2017a, 2017b, 2017c; Paranina and Grigoryev 2017).

The navigation concept of the information modeling of the world (IMW) developed by the authors, considers the constructive influence of the planetary-cosmic supersystem on the natural diversity and the forms of human adaptation (biological and supra-biological). The proposed set of methods unites a wide range of humanitarian and natural sciences in a single problematic field of determining the rational functions of prehistoric objects of cultural heritage in the past and in the present. The results of the research contribute to deepening the notion of geocultural space and the possibilities of preserving its diversity.

Capabilities of the concept of "geocultural space"

The concept of "geocultural space" allows us to connect the development of material and non-material culture with the coordinates of geographical space-time. The widest definition of geocultural space is given by V.N. Streletsky: "Geocultural space acts as a framework, sphere, product and context of human activity. It can be considered in two different aspects: 1) the study of culture in geographical space ...; 2) the study of geographical space in culture ..." (Streletsky 2005, p. 330).

In the studies of the historical geography of Eurasia, V.I. Paranin showed that the structure and dynamics of the geocultural space are determined by the flows of matter, energy and information mastered and organized by humans: navigational algorithms of the processes

of self-organization of territorial systems, the structure of geocultural space in toponyms, ethnonyms, cartographic, mythological and other models of historical and prehistoric time (Paranin 1990, 1998). Analysis of the rational designation of the primitive graphics of Europe emphasizes the fusion of astronomical and mathematical knowledge in the art of the the Paleolithic age (Frolov 1992). Representations about the wide system of cultural communications of the prehistoric past are being developed in ethnography. The concept of "anthropology of the movement" connects the circumstances of a person's development with the conditions of a nomadic way of life as a planetary phenomenon (Golovnev 2009).

The interdisciplinarity of studies of cultural objects is also determined by the variety of resources and conditions which a person interacts with in the process of developing nature. It is important to understand that from the surrounding natural environment a person receives not only substance and energy, but also vital information about space-time. The adequacy of their actions depends on this information. Therefore, "development of nature" is widely understood by the authors - as a form of geographical adaptation and various-dimensional modeling of the surrounding world. In this context, prehistoric objects can be considered as a reflection (model) of geographic and geocultural space at the time of their creation.

Obviously, the structure of the ancient navigation tools reflects the landscape-geographical and planetary-astronomical realities of its time. The instrumental functions of objects in the information system of the life support of ancient communities (intergenerational and neighborly ties) explain a special place in the structure of the geocultural space-the sacral status and peculiarities of location (in the territorial system and the regional communication network) (Paranina 2014. 2016, 2017a; Paranina and Paranin 2014, 2016).

Thus, the reconstruction of the rational designation of ancient objects makes it possible to clarify the links: horizontal - spatial and vertical - ecology-semantic, based on the correlation of landscape and culture components.

Navigation and development of geographical space

The navigation model of the evolution of geocultural space is based on the priorities of orientation in space-time and motion. It can be represented in the sequence "astronomical-geodetic networks - navigation networks - territorial systems". Let us consider the main links of this model.

Creation of *astronomical and geodetic networks* of different scale is promoted by the widespread demand for information on geographical space-time. To maintain the simplest calendar, it is sufficient to fix one day of the year (according to the astronomically significant azimuth of the cosmic landmark). The formation of a local network (from several tools)

provides the need for more detailed information with the possibility of organizing regular long-term observations. The set of instruments on a vast territory represents information support, both local activities and regional mobility. Analysis of age-varying elements of astronomical and geodetic networks allows us to trace the development stages of instruments and technologies of orientation, the variety of ways of marking and marking space-time.

The concept of "navigation network" reveals the connection of astronomical tools with communications - natural and artificial structures of the developed space that provide movement. The structure of navigation networks reflects, first of all, the natural and social conditions of mobility: the modes of movement, the range and duration of the operation of the tracks, the spatial rhythm, the seasonal regime, the stability of the flows. Steady flows naturally form a territorial system.

The main parts of the navigation network inevitably assume the functions of supporting elements of the created spatial structure of the developed territories. Linear structures provide movement, area-based interactions, point spots are places of stops and information accumulation - these are the points most conveniently located at the crossroads, boundaries of natural environments, strategically important areas (estuaries or sources of rivers), near sources of fresh water and astronomical instruments. At such points, settlements were formed, and later cities - polyethnic settlements, city-states and capital centers of states.

The structure of territorial systems is related to their functions in the geocultural space and is revealed through such characteristics as a place in functional zoning of the landscape, economic specialization, role in the geographical division of labor, etc. As shown in the studies of V.I. Paranin: the centers located at intersections of transcontinental routes, controlling the main traffic flows in the region, are "doomed" to fulfill the metropolitan functions (Paranin 1990, 1998). The fixing of the outer boundaries of territorial systems could be realized at the stage of wide application of reverse sighting technology (using the gnomon of sun-clock-calendars). Complex analysis allows us to identify elements (centers and boundaries) of territorial systems that existed before.

Modeling of geographical space-time and development of culture

It is known that navigation in space-time takes a leading role in the system of biological adaptation. Since the birth of the biosphere, organisms have been guided by planetary-cosmic cycles, since landscapes are very dynamic, therefore, they are not reliable. The peculiar fact of the human is that in astronomical navigation human was the first to use tools.

The practice of measuring space-time naturally forms a system of notations-signs and theoretical concepts. The technology of direct sighting of the ascend/descend of the luminaries

in the near-horizon observatory forms a universal binary system of counting and understanding of the dualistic nature of the world. The reverse sighting along the shade of the gnomon is comparable with the aromorphosis in biological evolution: it gives the measured midpoint - noon, a stable landmark, measured daily at any point of geographic space; it allows us to determine the latitude and to create a regional navigation network; to fix in graphic signs not only the intersection of the horizon line, but the entire trajectory of the Sun in the sky. The amount of information received in the past with the help of shadow is comparable to an information explosion, and high quality (reliability, universality, verifiability) made the gnomon and calendar the basis of the hexadecimal number system and many measurement systems: lengths, weights, monetary units, etc. In general, the comparison of the semiotics of light and culture confirms the opinion of ancient philosophers about the astronomical nature of the sign.

Semiotic productivity of the gnomon (angle indicator and calendar) is reflected in architecture and art. The shadow of the foundation stone for the period of six months allows us to determine the main geographic directions and astronomical landmarks at a specific point in the geographical space (taking into account the latitude, altitude above the sea level, horizon shape). One day's shadow chart can be the basis of zoomorphic images: the tail fin of fish (the line of shadows is rays), wings (lines - feathers), horns (lines - annual increment). In the days of solstices and equinoxes, the geometric basis of solar signs (radial and triangular) and six-armed Shiva is created; more frequent drawing (for example, once a month) gives the image of the multi-armed Shiva or the shape of the open lotus. For a year, the shadow covers an area in the shape of a labrys (two-sided, two-legged ax of the gods of light and the gods of the shadow). A sketch of the shadow of the T- and L-shaped objects gives solar signs in the form of a swastika. When they are installed by the crossbar along the meridian, the direct form of the shadow is formed at noon.

Geometric signs of navigation in space-time are abstract in form but specific in content. Since the periodic repeatability of the connection "light signal - sign" and reinforcement (including food) form a stable connection (reflex), then the problem of the influence of navigation technologies on the processes of sapientation - the development of abstract thinking and the formation of *Homo sapiens* – is logical. In other words, we can assume that it was not the human who created the oldest signs, but the signs-knowledge formed the human (Paranina and Paranin 2017b).

Invariance of the flow of information processes (the mode of solar illumination, its perception and instrumental registration) and the development of communications facilitated

the unification of the design of navigation information in a multilevel system of tools, knowledge and signs.

Conclusion

Interdisciplinary studies of the prehistoric heritage in the cultural geography show that the consistency of the structure of territorial systems with the land-time guidelines is based on the objective functional connection of actions of the "measurement-designation" and is reflected in toponymy, semiotics and other information models of the world that perform adaptation tasks.

The information link "the natural process - the sign - the image - the myth" fills these concepts with a new meaning based on the performed function (sign - the graphic model of the process, the image - the artistic interpretation of the sign, the myth - the plot description of the natural process and the technology of its cognition). The algorithm of actions "astronomical orientation - an abstract geometric sign - practical application" explains the cosmic origins of intellect and culture: the primary navigational purpose of old and ancient objects of cultural heritage, the astronomical basis of sign systems and cosmism of thought, originally inherent in human and preserved in traditional folk culture.

The objective relationship "energy (light) - information (signs and knowledge)" raises the question of the negentropic role of culture in the geographic space of the Earth.

Keywords: geographic adaptation, geocultural space, information, modeling.

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BACK

GEOGRAPHIC CONTRIBUTIONS TO THE QUESTION OF ETHNIC REGIONALISM AND REGIONAL IDENTITY IN CENTRAL EUROPE – WITH SPECIAL REGARD TO THE PAST AND PRESENT OF ETHNIC BASED TERRITORIAL AUTONOMIES IN THE CARPATHO-PANNONIAN AREA

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Despite the ethnic cleansings, deportations, forced assimilation, homogenisation and partly due to the immigration of foreign-born population there is any country in Europe which could be called as ethnic homogeneous. This is particularly true in the case of the small „nation-states" of Central Europe (mainly of the Carpatho-Pannonian area). So, starting from the fact, that in ethnically divers regions the territorial autonomies are one of the most effective tools of minority protection and conflict solution, and are safeguards of ensuring the cultural survival and protection of collective rights of national minorities, this paper try to outline the geographic background of existing (and missing) territorial autonomies in Europe (1st part) and more detailed in Central Europe (mainly in the Carpatho–Pannonian area, 2nd part). Although the emphasis is largely placed on contemporary situation, important sections of this geographic work are devoted to the historical development of the ethnic based territorial autonomies as well.

BACK

ETHNIC SETTLEMENT SHIFTS IN RUSSIA IN 1989-2017: MAIN TRENDS AND CULTURAL-GEOGRAPHICAL CONSEQUENCES

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The subject of this presentation is a brief description and analysis of ethnic settlement shifts in Russia during the Post-Soviet period and their cultural-geographical consequences. The specific cultural-geographical feature of Russia is an enormous space corresponding to the so-called Russian ethnic mega-core, both in European and Asiatic parts of the country. Actually, the ethnic mega-core of the country includes the majority of Russian administrative units where the share of ethnic Russians in the total population is much higher than the average index for the whole Russian Federation (more than 80%). The Russian ethnic mega-core of the country is much larger than the ethnic peripheries of the Russian Federation, both in surface and in demographic potential. Outside the Russian ethnic mega-core there are three large cultural regions within the Russian Federation characterized by striking ethnic specificity: the Northern Caucasus (to be more precise, its highland part populated by so-called mountain peoples), the Volga-Ural multicultural area and the Turkic-Mongolian belt of Southern Siberia (Buryatia, Tuva, Khakassia, Altai). The most important changes in the ethnic structure of the Russian Federation at the end of the 20th – beginning of the 21st centuries are the following. The first tendency is a gradual and slow transformation of the ethnic structure, due to demographic changes and migration processes. The second tendency is a rapid growth of the share of “titular” (indigenous) ethnic groups of national republics of the Russian Federation in the total population of those republics. Some reasons for that are the significant demographic differences between ethnic Russians living in national republics of the Russian Federation and several “titular” peoples of those republics (especially Muslim groups with higher rates of natural increase). In some cases (for instance, in Sakha-Yakutia) the transformation of the ethnic structure of population in national republics was influenced mainly by the considerable out-migration of ethnic Russians from those republics to other regions of the country. The third tendency is a growing concentration of “titular” (indigenous) ethnic groups within “their” national units.

Keywords: ethnic groups, ethnic settlement patterns, ethnic and regional identiy, trends in ethnic structure of population, cultural geography, Russia.

BACK

IMAGE OF BELGIUM IN RUSSIA: OPINION OF STUDENTS-GEOGRAPHERS IN LOMONOSOV MOSCOW STATE UNIVERSITY

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Due to the advancement of informational technologies in modern society the importance of geographical perceptions for territorial development is increasing. Perceptional images are actively used in regional marketing and strategic development, they contribute to the growth of investment climate and tourist attraction. To some extent these images have become the same resource of the territory as natural resources and industrial objects. This research is dedicated to the analysis of the role of image as a perception of a territory by an external consumer, particularly, a narrow group of students-geographers. The study was carried out on the basis of questionnaires filled by students in 2012–2017. Students were asked to write associations that spring to mind when Belgium is mentioned. There were no restrictions: students could name geographical objects, famous people, historical events or national dishes. More than 500 questionnaires were analyzed, representing over 1,500 associations. As a result a cognitive map of the country was drawn up. Belgium is 13 times smaller than Russia by population and 500 times by area. Therefore, the first association with this country is its small size and central position in Europe in general and in the European Union in particular. Many students name Brussels as European capital, and it is also the most remembered city of the country. Ghent and Bruges are also mentioned very often, less people mention Antwerp and the southern part of the country is hardly covered. Many students recall various "culinary" associations, mainly because of adjective "Belgian" in many dishes (Belgian wafers, Brussels sprouts, Belgian chocolate etc.). The next group of images consists of cultural associations, for example, Flemish artists. One of the widely-spread misconceptions was registered — many people think that all Flemish artists relate to Belgian cultural legacy, as modern Flanders is located fully in Belgium. Men also often note sports events, mainly of those kinds of sports that are spread in Belgium (bicycle and football). Contrary, women often remember Belgian lace, and some of them recall the breeds of dogs.

Keywords: Belgium, image of Belgium, geographical perception.

BACK

INDIGENOUS ETHNIC CODE AND SIBERIA WILDERNESS: NEW IDENTITY OR DISAPPEARANCE?

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In the era of dominance of innovative solutions and community networking, the "Western society" considers the status of indigenous peoples predominantly as “backward” and “archaic”. Culture has emerged as the main tool for human interaction with nature. Anthropologists have repeatedly argued that the historically specific ethnic groups that have arranged part of the environment for themselves and defended it from the other groups of people living in a certain territory, maintain harmony in a period of life change across generations. It also appears that culture promotes the transfer from generation to generation of certain values and chosen beliefs. It appears that the essence of the fundamental ideas of ethnic code implies that every nation, understood as a community of people united by common descent, historical, cultural, social, and ethical values, shares a collective identity different from the others. This presentation covers the selected philosophical postulates, scientific arguments and speculative opinions, how in recent centuries the ethnic function of mankind has been critically violated. It is argued that the modern civilizational change of the guidelines for the development of human society, which is less and less connected with the intention of harmonious interaction between man and nature, is the principal reason for the complication of the global problems of mankind. The remote territories of Siberia, where the traditional practices of implementation of livelihoods of indigenous peoples are rooted, look like a harbor for the world’s most undisturbed ecosystems. However, the European “wilderness” ideal has not found great popularity, remaining little-known in Russian scientific and conservation circles. Nevertheless, the relatively intact socio-ecological systems present both unique challenges and promising opportunities.

BACK

EXPLORING LANDSCAPE CHANGE AND REGIONAL IDENTITY IN DIFFERENT EUROPEAN CONTEXTS

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The issue of regional identity is particularly presented in the view of the current socio-environmental changes in post-industrial/late-industrial landscapes through different land use patterns, where, as a consequence, the identities of urban societies seem to be threatened. The landscape perception and spatial identity is in reality more than a physical phenomenon, it also involves memories, symbolic meanings and relationships among the main actors of landscape. The landscape in this sense is seen as a social construction that is shaped within the processes of perception, communication and preference. Here specific landscapes (or their elements and features) within region / space appear as symbolic or representative of the whole region. Based on the results from a research project investigating the cultural landscape as a social construction and its perception in every-day life, the paper has a special focus on dynamics, actors, and cultural values around landscapes of Venice, Leipzig and Arkhangelsk. Particular attention is given to analysis of its meaning in ordinary life of citizens. Both the narrative and physical landscape patterns have been shaped by a local process of constant comparison with well-known symbols, including landmarks of regions. In particular, the paper illustrates how the landscape will be interpreted in the local dialogue of place, especially in the perceptions of its residents and tourists as reported in semi-structured interviews and participant observations. As memory and place of belonging, a cultural landscape is not only what people see, but also a way of seeing, e.g. how people interpret it with their mind, using basic knowledge, previous experiences and senses. In this way, paper explores some of the associated ideas of landscape as a social construction in reflections to people of different cultural, natural and social background. The results confirmed that regional identity is determined not only by symbolic places but also by special landscape types and that the changes in the landscape occurred in different time periods cause needs to adopt various meanings and practices among particular actors of landscapes.

Keywords Cultural landscape, landscape interpretation, social construction of landscape, perception, Germany, Russia, Italy.

BACK

ON THE WAY TOWARDS EXOPOLIS? CRITICAL GEOGRAPHIES OF CONSTRUCTED AND LIVED URBAN REGIONS

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Cultural & regional geography were focused on the representations of space & place until the critical approach established the call towards combining material & immaterial realms. The cultural turn within non-representational geography is seen through the lens of what Henry Lefebvre names a double illusion. In Lefebvrian terms, cultural geography in the XXth century has executed a shift from the material / perceived space towards the conceptual space of representations, but the forthcoming critical paradigm is concerned about the third realm, that is the "representational spaces: the space directly lived through its associate images and symbols, and hence the space of 'inhabitants' and 'users'", or 'thirdspace'. The contemporary urban space is stressed to be complex, heterogeneous, multifaceted, interrelated. This vision of the new space constitution revives the idea of a palimpsest, as the latest embraces that very endless multiplicity co-existing in one & the same (totally urbanized) region. Lived / real-and-imagined urban regions are regarded as palimpsests with everyday practices seen as processes of (re)construction of new layers. Constructing an imagery of Skolkovo Innovation Centre in Moscow (Russia) as a part of an excursion project is used as a case-study in this paper. Though positioning itself as being out of history & thus non-authentic, Skolkovo claims to be regarded as a city; even a kind of an ideal city. The contrast of that constructed reality & the lived cultural landscapes of the Innovation Centre is used to describe Skolkovo as one of *exopolises*. Based on Baudrillard's simulacra, exopolises are "exact copies of representations of everyday reality that somehow substitute for the real itself… The Exopolis itself is a simulacrum: an exact copy of a city that has never existed". Skolkovo is seen as not the only example of an exopolis, but rather as a tool to understand *the urban* through its change. The urban is regarded as "a theoretical category, not an empirical object", and an exopolis as a new form of the urban & *the region*.

BACK

PECULIARITIES OF FORMATION OF SOME PLACE NAMES OF PORTUGAL

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For the last few decades the problem of studying toponyms has attracted the attention of many researchers. There are a lot of geographical and linguistic research, but one of not enough developed questions of the origin of some Portuguese place names is being studied in the article. A toponym reflects social and cultural essence, language contacts within the territory. Some elements can also describe some geographical features and landscape characteristics which are connected with historical and cultural transformations. The toponymy of Portugal includes names which have their origin from different languages (for example, from Celtic, Latin, Arabic, Galician-Portuguese, Portuguese, etc.). Some modern place names of Portugal have Celtic roots: Braga – from *Bracari* (Celtic tribes); Vila Nova de Gaia - gallaeci (Celtic tribes); Cantahnede ("big stone"); are situated in the Central and Northern regions of Portugal. Most of the Portuguese place names derived from Latin: Abrantes (much gold); Aveiro - aviarium (bird's yard, a place where there are many birds); Lourosa - laurus (laurel); Portimão - Portus Magnus (big port); are situated in the Lisbon, Northern and Central regions. The influence of the Arabic language on the formation of the place names reflected physical and geographical characteristics of the territory – natural landscape, lakes, rivers, springs: Albufeira - al-Buħayra (sea, lagoon); Alverca do Ribatejo - Al-birkâ (lake); Almada - Almadana (mine); Loulé - Al'ulia (refers to the height, a hill); Moura - Murah (pasture); Odivelas - Ued Ballas (red river); Olhão (spring (hydrology)); are sitauted in the Lisbon region, in the regions of Alentejo and Algarve. Some place names of Portugal are of Galician-Portuguese origin: Leiria - laria (furrow, bed) - agricultural land; Câmara de Lobos - "wolf's lair"; Ponta Delgada (ponta delgada) - "thin cape"; Ribeira Grande (big river) - in honor of the river Ribeira Grande; Angra do Heroismo - "bay of heroism", where the castle was built. Many place names have Portuguese roots which reflect natural and geographical features of the territory (peculiarities of relief near water area), historical processes, economy (agriculture, trade), and the ethno-linguistic composition of the population. These cities are located in the Northern and Central regions, in the Azores and Madeira Island.

Keywords: Country Study of Portugal, toponomy, place names of Portugal, formation of place names, typology of place names.

BACK

THE EVOLUTION OF SOCIOCULTURAL AREAS IN URBAN HABITAT

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The evolution of sociocultural areas in urban habitat is process of forming the territorial systems through making places in the territorial structures. Author made the new concept, which says that there are six steps of forming sociocultural areas. The first of them is the place researching. Due to this process, some explorers discover the land, find the resources and describe their value. The second step is the socio-cultural place projecting. According to this process, social groups make territorial public contract. The third step is the construction of the territorial structures. Through this process, we can see forming the territorial structures as lines and nodes. There are many problems during this process like territorial conflicts, informational wars, economic difficulties. The fourth step is the area making. Through this period, social groups find their special common sense, sense of place, traditions, typical cultural actions and reactions, etc. The fifth step is the frontier zones making. According to this process, we can find three variants of it - changing (or loss) of the place function, territorial expansion, and territorial conflict. The sixth step is the territorial integration (trans-barrierity). There are three variants of it - horizontal integration, hierarchical integration, rebuilding integration.

Let us speak about the example of socio-cultural territory – The Lengory-MSU territory. This territory was included to Moscow in 1925-1935. Due to this process, there were engineer and geological works like researching for making territorial project. The general plan of Moscow of 1935 year included the project of Lengory' transformation. The road network, the Main Building (Glavnoe Zdanie) of MSU were built in 1949-1953. Area making of MSU Territory was a long process of forming stable networks, accessibilities, connections. It started after the opening of GZ for students in 1953 and ended in 1980-ies, when the MSU territory became the integral socio-cultural system. Frontier zone making started in 1993. In those days there was a territorial expansion to the New Territories of MSU (active transformation to university needs started in 2003). Integration started in 2005, when the underpass between old and new territories of MSU was built.

BACK

THE MIGRATION DESTINATION CHOICE AS A CRITERION OF SELF-IDENTIFICATION (THE CASE OF YOUNG PEOPLE LEAVING NORIL'SK AND DUDINKA)

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The choice of migration direction is based on individual experience and one's social status. The local geographic myths and institutional environment also matters. The method of using the geographical preferences and choices as a key to understanding the socio-cultural phenomena of the city of Norilsk seems to have brought positive outcomes. Since the tendency to express migration intentions is very strong among Arctic cities people we invite to use such declarations as a new method for studying of Arctic social process. The direction of future migration declared could be used as a marker of person's social position in the North. The research is based on a questionnaire run among pupils of eight high schools in the city of Norilsk, the city with the most extreme environment within the group of large Russian Arctic cities.

Keywords: Arctic, Far North, migrations, geographic myths, image of a city, social status.

BACK

POSTER

HIERARCHICAL STRUCTURE OF THE TERRITORIAL AND CULTURAL IDENTITY OF RURAL INHABITANTS OF THE RUSSIAN NORTH AND SIBERIA

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The regional identity in the North of Russia and Siberia was a result of the Russian colonization of the river valleys and intermountain depressions; this process was strongly influenced by the following natural and ethno-cultural factors: 1) the structure of hydrographic network, the landscape, natural zonation; 2) the stage of settlement of the territory; 3) economic activity, the material and spiritual culture of settlers; 4) ethnic and religious affiliation of the indigenous population, the material and spiritual culture; 5) inter-ethnic and international communication; 6) peculiarities of dialect, folk terminology, toponymy, ethnonyms, katoikonyms. The model of territorial self-identification of the inhabitants of the Russian North and Siberia (the basins of the rivers Severnaya Dvina, Indigirka, Kolyma, Argun) is built according to the materials of dictionaries of Russian dialects and field studies. The complex approach allowed to build a 7-step identification pyramid. The structure of the pyramid reflects the perception of geographical space by residents of The Russian North and Siberia. Toponyms, ethnonyms, folk geographical terms are used as markers of the identity:

1. The elementary level – own settlement / part of the settlement (katoikonims, microtopnyms).

2. The local level –own municipal formation (toponyms, katoikonims).

3. The micro-regional level –ownpart of the valley orbasin (katoikonims, toponyms).

4. The medium-regional level – the basin of own river (folk geographical terms, ethnonyms).

5. The macro-regional level – own natural zone (taiga, tundra), own landscape (folkgeographical terms).The territories of other ethnic groups are perceived as strangers.

6. The mega-regional level (the North, Siberia) is perceived as their own. The South, the center, the European part of Russia are considered as strangers (folk geographical terms, ethnonyms).

7. National level – own Russian land (ethnonyms).

Keywords: geographical identity, toponymy, folk terminology, Russian North, Siberia.

BACK

Dangerous Geomorphologic Processes: Regional and Global Trends, Human Impact, Current Methods of Study, Assessment and Forecast

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POSTER

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BACK

MORPHOTECTONICS AND EXOGENOUS PROCESSES OF THE KOLA PENINSULA

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The Kola Peninsula with a thin cover of Quaternary sediments that lie directly on the basement rocks, has long been a testing ground for the study and the statements about block structure of the lithosphere. Even the first explorers of the Eastern part of Fennoscandia, I. Söderholm, V. Ramsay, F. N. Chernyshev expressed opinions about the horst nature of this territory. A. Karpinsky (1919) substantiated the interconnected system of longitudinal (NW) and transverse (SW) faults along the Eastern periphery of the Fennoscandinian shield and, in particular, the uplift of the Kola Peninsula horst and lowering of the grabens framing it in the Kandalaksha Bay and the Throat of the White sea, as well as the normal fault scarp along the northeastern shore of the Barents sea. In addition, A. Karpinsky maped out the North-Western limit of the Kola block, pointing to the lateral direction from Murmansk to the South-West, towards the Gulf of Bothnia. Block structure of the territory has been repeatedly confirmed and interpreted using both methods of deep geophysical research and remote sensing data (Golod (ed.) 1980; Kratz (ed.) 1978); Bilibina (ed.) 1986). The largest blocks in the Archean-Proterozoic Basement and the Riphean system of grabens under the Kandalaksha Bay (part of the Kandalaksha-Onega Graben (paleorift) (Konstantinovsky 1977), interfacing with the aulakogenes of the Russian plate, were identified. The largest structures are developed lengthwise in relation to the Kola Peninsula.

Morphological manifestation of tectonic block structure with clear linear borders in the form of ledges or linear graben depression was the justification for the approval of a significant number of researchers, of the latest revitalized and active differential movements of the Kola Peninsula, as a whole, the Fennoscandian shield. The neotectonoc blocks of different hierarchical rank were distinguished and regionally generalized by N. I. Nikolayev (1962, 1988), V. I. Babak (ed.) (1980), A.F. Grachev (ed.) (1997), V.G. Trifonov (ed.) (1987, 1999) and other researchers. Nevertheless, the comparison of materials shows the existing

discrepancies in the block structure of the Kola Peninsula. In fact, their positions converge on the recognition of the location and nature of the main faults that define the boundaries of the Kola block and marked about 100 years ago.

Recently, there has been a certain deepening of knowledge on these zones and it is connected, first of all, with seismic studies conducted within the waters of the White and Barents seas. Within the Kandalaksha-Onega paleorift, only the increased capacity of the Riphean deposits and, accordingly, the depth of the Foundation immersion, amounting to about 8 km (Zhuravlev 2007; Kazanin et al. 2006), but also tectonic dislocations in the upper horizons of the cover, up to late - post-glacial sediments (Rybalko et al. 2013), are established. Dislocations in the loose cover are matched with an extensive system of graben-shaped depressions, developed, to varying degrees, on the entire area of the White Sea, including the Onega, Dvinsky bays, the Throat of the White sea, but especially expressive and dense in the Kandalaksha Bay (Shvarev et al. 2015, Shvarev and Nikonov 2017).

It is characteristic that the structures at the bottom of the sea are interfaced with the dislocations on the coastal land. A significant change in relation to the block structure is the statement of the presence of shear displacements in addition to the statement of the activity of block-discontinuous structures, manifested in vertical block displacements. It was marked in the recent tectonic synthesis for the study area (Baluev (ed.) 2010; Baluev et al. 2012) the shear displacements in the North-Eastern framing of the Kola Peninsula ("Karpinsky line"). Direct confirmation of its activity are numerous of paleoseismodeformations in the form of rockslides, collapses, cracks, disturbances of various types (folds, ruptures, liquefaction) in Holocene sediments, founded in different parts of this extended structure (Nikolaeva 2006, 2008; Zykov et al. 2011; Lukashov and Romanenko, 2010; Baluyev et al. 2012; Verzilin et al. 2013]. However, seismic dislocations grouped in other parts of the Kola Peninsula as the boundary (on the Kandalaksha Graben updated) (Avenarius 2008; Verzilin and Bobkov, 2009; Shevchenko et al. 2007), as well as internal (Avenarius 1989; Nikolaeva 2001, 2003; Shvarev 2003; Lukashov et al. 2004), marking block fragmentation of lower hierarchical levels.

Analysis of remote sensing data clearly shows the total coverage of faults of different ranks in all areas of the Kola Peninsula, but their manifestation in the topography and spatial parameters in different parts of the Kola Peninsula varies substantially. Some of the areas characterizes the inexpressive and "chaotic" lineament network, forming vast spaces with a small-block, slightly vertically differentiated surface (the area of the upper-middle reaches of the riv. Ponoy along the southwestern periphery of the Keivy upland, the NE sector of the Kola Peninsula to the South of Cape Svyatoy Nos to the northern tip of the Keivy and a number of

other areas). Other parts of the Kola Peninsula are the well-structured areas with sharply differentiated apex surfaces topography and deeply dissected by graben-shaped narrow valleys for tens of meters. The most expressive is the area between Kiev and the northeastern Barents Sea coast of the Kola Peninsula between 36-39° of eastern longitude.

Morphological manifestation is one of the main criteria of the newest and modern activity of discontinuous structures. We can separate elongated sections and group of ruptures by this indicator. The maximum concentration of the most "fresh" ruptures is associated with the wide area between the Keivy and the North-East coast (Fig.1).

It is possible to draw some conclusions about tectonic stresses and block dynamics that formed the modern morphotectonics of the Kola Peninsula basing on the planned pattern of faults, their interface with the topography. First of all, the boundary parts of the Kola Peninsula are characterized by moving apart sections: along the northeastern shore of the Kola Peninsula and in the Kandalaksha Bay. In the first case, the extensions form graben-shaped structures parallel to the coastline, developed in one, rarely two lines with a total width of 3-5 km, rarely up to 15 km, generally preserving the width along the Barents Sea coast. The North-Eastern shores of these structures are marked of peninsulas (Holy Nose, Teriberskaya, Rybachy) or islands (Kildin, Olenyi Islands, Seven Islands) or estuary parts of the valleys (riv. Ivanovka, Iokanga). In the second case, the separation structures form a wide, relatively symmetrical zone expanding to the South-East with maximum depths near the axial areas. The width of the zone ranges from the first km in the upper part of Kandalaksha Bay to 15-16 km in the middle part for about 70 km and to a width of 50 km or more at the exit from the Bay to the central basin of the White Sea. The moving apart tectonics of the Kandalaksha Bay is characterized by an extensive system of grabens at the bottom with a maximum depth of more than 300 m, developed in a coulisse manner presented by several echelons. System of grabens extending along the Kandalaksha Bay in the SE direction, are dissected by transverse and diagonal faults. These structures observed at the bottom in the form of transverse scarps and shifts of the centerlines of the grabens and coastal land. In addition, the moving apart structure in the upper part of Kandalaksha Bay, conjugated with an annular depression, which elements are marked by the depressions of lakes Kolvitskoje, Kanozero, Knyazhya Guba reservoir, and the Kolvitsa river valley.

The pattern of rupture structures is significantly different on the Kola Peninsula and on the mainland. The border of these parts can be drawn from the Kola Bay to Khibiny and Lovozero tundra and further SSW along the basin of Lake Imandra to the Kandalaksha Gulf., This boundary is clearly defined in the northern part by two subparallel faults with a shear

component (right shift), judging by the ratio of the topography features on the wings. The border is less expressive to the South.

The block structure is subject to the General South-Eastern trend to the East of this border: external (North-Eastern), Central (axial) and South-Western parts are allocated. The axial part is a sloping on the SW block, framed by the North-Eastern periphery of the parallel ridges of the Keivy hills of and its branches, and by the southern periphery – in parallel ridge-and-hollow topography, marked by the upper valleys of the rivers Varzuga, Strel'na, Purnach. The NE block is a flat upland, dissected into diamond-shaped blocks by diagonal faults. The SW block–sloping lowland with poor dismemberment. In addition, along the Eastern periphery there are structures of conjugation with the depression of the White Sea Throat: an arc block in the southern part with a bending discontinuity in the South-East direction and an arc segment in the North-East, bent towards the land. The morphostructure of the latter was formed under horizontal stresses (left shift), while the outer (Barents sea) part of the morphostructure was formed under tensile conditions, and the inner (Keivy) – under compression conditions, judging by the s-shaped curved pattern of discontinuous disturbances in the northeastern block. Apparently, the ridge-and-hollow topography of the southern flank of the axial block also reflects compression conditions. The nature of the coastline on the southeastern closure of the Kola Peninsula: smooth, without graben-shaped transverse or longitudinal bays, indirectly confirms these conditions of morphotectonics. Fiord-shaped bays appear only to the North starting from the mouth of the riv. Ponoy.

Continental block structure to the West of the Kola Peninsula border is sharply different from the Eastern part. Here, the position of North-East blocks is as if to "butt" to the blocks of the Peninsula. The corresponding depression is expressed on the surface. The most characteristic example is the Lake Inari. There is changing the nature of the coastal zone also, which is characterized by diagonal articulation of long and broad quasi-longitude (NNW) and NE fiords, facing to the fault scarp between grabens of the Varanger fiord and estuary of riv. Malaya Volokovaya. The predominant structure of the offshore part is the North-Eastern wide step between the Varanger and the Rybachy Peninsula, along with the lengthwise grabens.

Thus, the morphotectonic features of the Kola Peninsula differ significantly from the mainland, from which it is separated by a system of predominantly strike-slip faults with NNW orientation. The block structures of the NNE and SSW flanks of the Kola Peninsula were formed under conditions of stretching with linear and annular lowerings, combined with longitudinal (along the Northern periphery) and transverse (in the southern part) shifts.

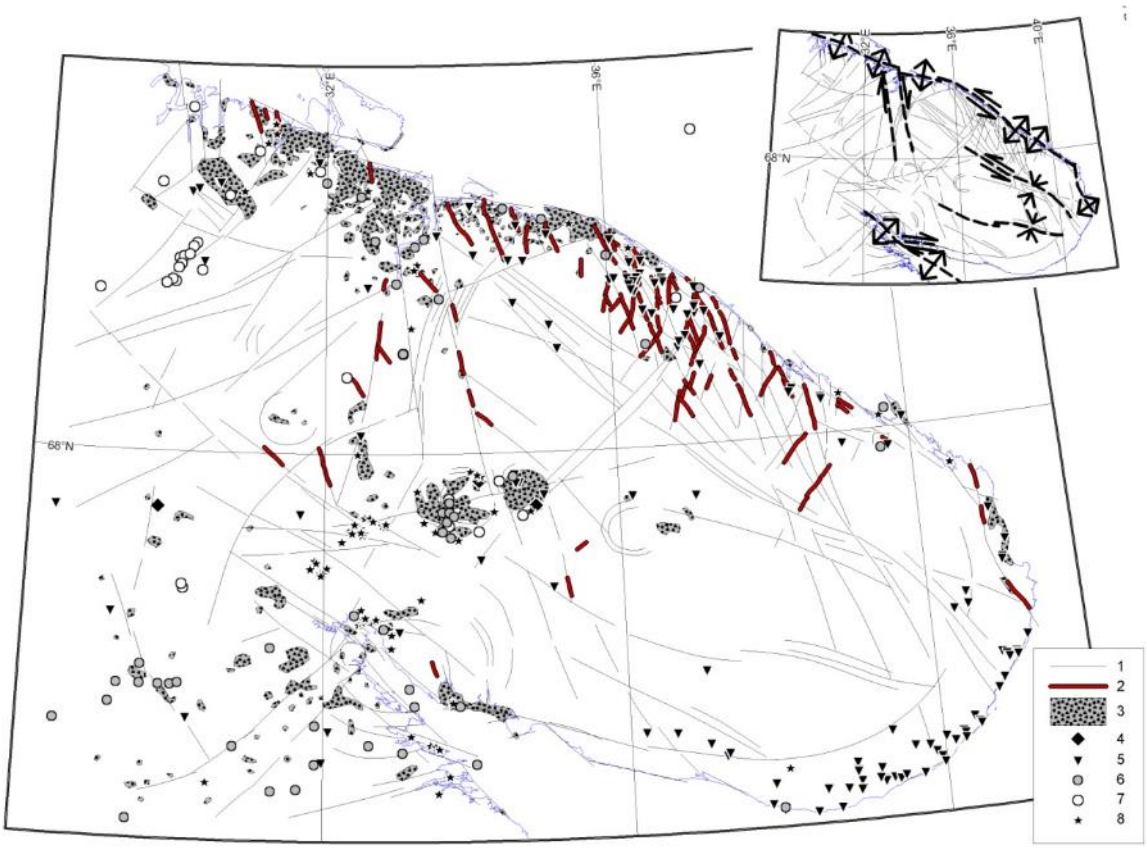

Fig.1 Combination of the block structure and exogenous geological processes manifestations of the Kola Peninsula. On the inset - the main interblock zones with elements of tectonic stresses expressed in morphology (zones of shear, tension and compression). Legend: 1 – borders of the blocks; 2 – sections of "fresh" cracks; 3 – zones of rock falls; 4 – landslides; 5 - waterfalls; earthquake epicenters: 6 – according to the catalogue of OSR-12; 7 – according to the USGS catalog; 8 – by the paleoseismological data (according to different authors – see text)

Keywords: morphotectonics, Kola Peninsula, active tectonics, exogenous processes, paleoseismicity

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LATE PLEISTOCENE GLACIATION IN THE TELETSKOYE LAKE REGION, RUSSIAN ALTAI: LUMINESCENCE CHRONOLOGY OF GLACIAL-RELATED DEPOSITS

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The geomorphological structure of the basin of the Teletskoye Lake and its environs has been studied for more than a century. Most previous studies (Yakovlev 1916, Bublichenko 1939, Kaletskaia 1948, Strelkov and Vdovin 1969, Bondarenko 1971, Bogachkin 1981, Maloletko 1987, etc.), were focused on the problem of the origin of the basin. Formation of the lake was discussed by Bublichenko (1939), who estimated the lake lifetime at 36,000 years. We obtained new data on the absolute geochronology of glacio-fluvial and glacio-lacustrine deposits in a number of sections (Fig.1), which allow us to clarify the dynamics and chronology of the Late Pleistocene valley glaciation in the Teletskoye Lake region and the time of the lake formation. Optical-luminescent dating (OSL) was performed in the GADAM Centre, Institute of Physics, Silesian University, Poland.

Core at the bottom of the Biya Valley 2.7 km downstream from the Artybash village (Fig. 1) revealed clayey lacustrine sediments with a thickness of more than 50 m under modern alluvium (Bublichenko 1939). Judging by the abundance of organic remains, these are deposits of the epoch, possibly related to the Kazan interglacial. Probably, these deposits continue to the east, to the latitudinal (northern) part of the Teletskoye Lake. At modern sources of River Biya at Artybash these deposits are buried under the moraine ridge that dammed River Yogach, a small tributary of Biya. The lower part of Yogach valley is filled with horizontally layered sandy-pebble material that provided two OSL dates: 82.6 + 7.0 ka (GdTL-1715) in the base of the section, and 50.2 ± 3.3 ka (GdTL-1716) in the top (Fig. 2). Thus, the glacier blocked the Yogach River not later than 80 ka ago, and the resumption of flow and river cutting down had occurred about 50 ka ago or somewhat later.

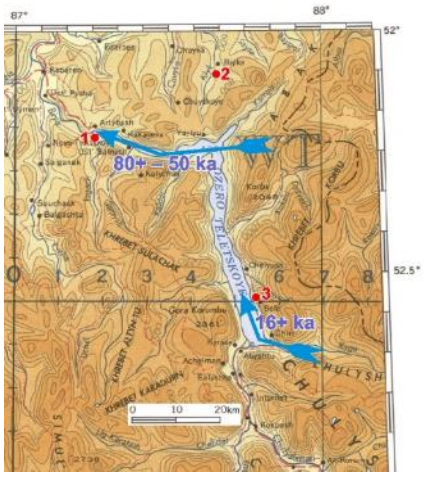

Fig. 1. Overview map of the study area. Sections described in the text: 1 – Iogach, 2 – Biyka, 3 – Bele. Blue arrows and numbers designate maximal advance of valley glaciers and their age.

Fig.2. Deposits of the glacier-dammed lake in the Yogach valley. Red numbers are OSL ages (after Baryshnikov et al. 2016).

The retreat of the glacier about 50 ka ago is documented also by the data obtained from the glacio-fluvial deposits to the north of the Teletskoye Lake, near the Bijka village (Fig. 1). Here, two units composed of coarse clastic deposits with a total thickness of about 10 m are exposed in the quarry (Fig. 3). The upper Unit 1 5 m thick is composed of fairly well-rounded pebble-boulder material with rough horizontal stratification. According to the size of the material two subunits can be recognized. The upper subunit 1a with a thickness of 3 m is represented by a larger material - boulder-pebble (up to 0.5-0.7 m) in a gravel-small-pebble matrix. The lower sublayer 1b, 2 m thick, consists mainly of pebbles with inclusions of rare boulders, with gravel-sand matrix. At the base of the exposure lies Unit 2, composed of cross-bedding of sandy-gravel and pebble layers that dip at an angle of 30-35º to the west.

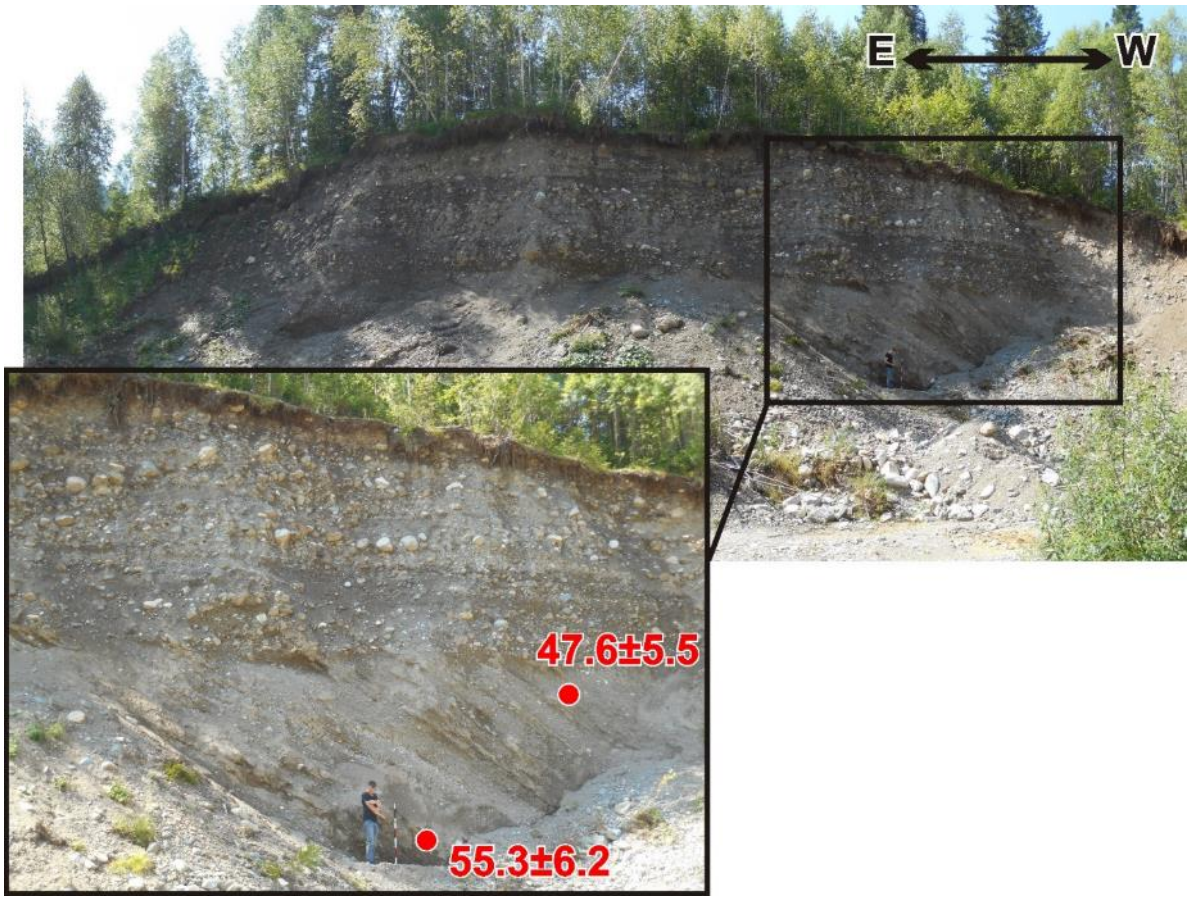

Fig. 3. Glacio-fluvial deposits at the Biyka village north from the Teletskoye Lake (Red numbers are OSL ages (this study).

The deposits exposed in the pit were interpreted as glacio-fluvial, accumulated during two phases of glacier melting. The upper pack is practically free of sand material and therefore not dated. Two dates were obtained from sand material in Unit 2: 47.6 ± 5.5 ka (GdTL-2950) from the depth of 6.3 m, and 55.3 ± 6.2 ka (GdTL-2949) from the depth of 9.2 m. Obviously, the accumulation of this cross-bedded stratum occurred geologically instantly. Both dates intersect with their intervals of uncertainty, so to estimate the time of accumulation of the lower unit, one can take the average of the two OSL age – about 51 ka ago.

The meridional part of the lake does not bear any traces of fresh glacial erosion and does not resemble a trough valley. Four levels of terraces, apparently of fluvial genesis, with the elevations above the lake of 45, 65, 70 and 85 m are clearly expressed. Lower terraces are erosional, they are embedded into a 70-meter pebble mass. In the Izhon site (left side of the lake), a stratum consisting of well-rounded pebble fragments of light-gray two-mica granites, diorites, greenish-gray porphyrites, metamorphosed rocks, lies on greenish-gray metamorphic schists and schistose sandstones. The bedrock basement rises by 13 m above the lake. There are no large boulders here. Petrographic composition of pebbles is very similar to the alluvium of

the Biya River. The mass is leaned against the bedrock side of the lake and can be traced along it for hundreds of meters.

In the sources of the lake on its right (eastern) shore is developed the so-called Belene terrace (named after the small farm of Bele located there). The terrace has a height of about 120 m above the lake. Up to an altitude of about 25 m above the lake, it is composed of thin-layered sandy-silt lacustrine sediments. Above they pass into fluvial pebbles, and then into boulder mudflow deposits. From a height of some 70 m, moraine begins composed of a large angular blocks. The glacial origin of the terrace is also proved by the uneven surface topography abounding of closed depressions, apparently glaciocarstic.

More than 30 years ago, one of the authors of this work discovered a fragment of a terrace composed of thinly layered sediments, apparently of lake origin (Fig. 4). The terrace was located at an altitude of 420 m from the lake, on a steep eastern slope near the Belene terrace. Probably, it was a lake, dammed by a valley glacier – located between the glacier body and the steep slope of the lake trough. In 2015 we visited this site again, sampled the exposure and obtained the following OSL dates: 14.0 ± 0.9 ka (GdTL-2947), 15.7 ± 1.1 ka (GdTL-2946) and 19.5 ± 1.3 ka (GdTL-2948). The average from the three dates of *ca.* 16.5 ka may be regarded as the time of the maximum spread of the valley glacier in the upper reaches of the Teletskoye Lake.

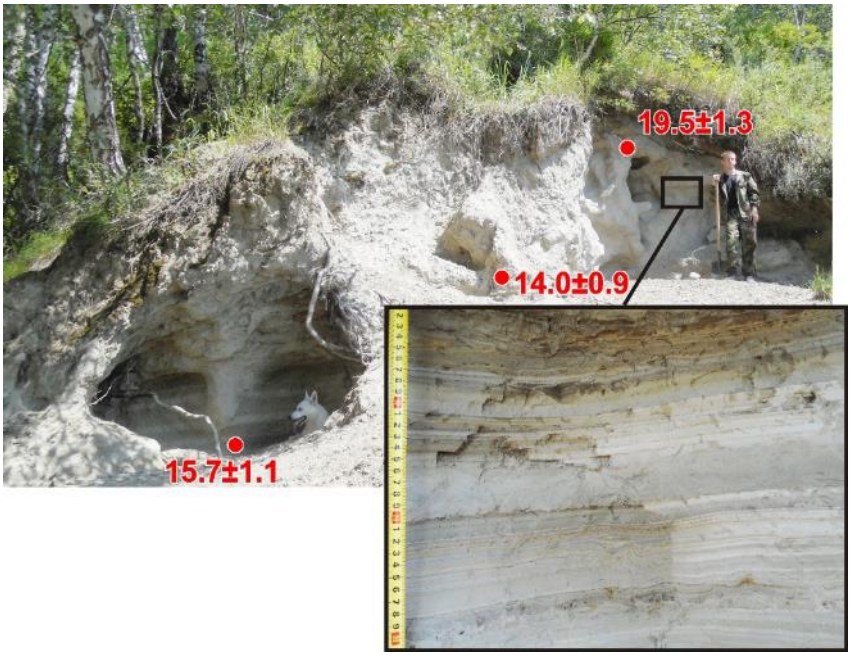

Fig. 4. Glacio-lacustrine terrace at the elevation od 420 m above the Teletskoye Lake (Red numbers are OSL ages (this study)).

Discussion and conclusion

The results obtained allow us to propose a new interpretation of the late Pleistocene glacial history of the Teletskoye Lake region (Fig. 1). The most part of the meridional section of the lake was not occupied by glaciers in the late Pleistocene. Morainic and glacier-related fluvial and lacustrine complexes in the area of Biika and Artybash were formed by a glacier descending, most likely, from the eastern slope of Teletskoye Lake, which was first proposed by Kaletskaya (1948). Based on the OSL dating, this glacier operated in the Zyryan epoch about 80-50 thousand years ago (late MIS 5 – MIS 4 – early MIS 3). After the degradation of this glacier (about 50 thousand years ago), the morainic dam in the area of Artybash still existed for some time. As shown in (Baryshnikov et al. 2016), it was breached between 35-40 thousand years ago, and from this time one can count down the modern history of the Teletskoye Lake, which confirms the long-standing assessment of Bublichenko (1939).

In the Sartan epoch (MIS 2), the glacier occupied only the upper reaches of the Teletskoye Lake (Fig. 1). Some researchers (Butvilovsky 1993) assumed that the glacier descended along the valley of River Chulyshman. However, there are no traces of glacial activity in the lower reaches of Chulyshman. Clear glacial landforms and deposits are found only in the Karasuk valley upstream from the mouth of Bashkaus (left tributary of Chulyshman), 50 km from the mouth of Chulyshman. We propose that the Sartan glacier reached from the Kyga valley (the southeastern tributary of the lake – see Fig.1) and pressed against the western side of the Teletskoye Lake, which allowed to preserve the lacustrine-alluvial basement of the Belene terrace.

The research is supported by the RAS Presidium Program No.19 "Fundamental problems of geological-geophysical studies of lithospheric processes".

Keywords: glacial history, valley glaciers, Last Glacial Maximum, glacio-fluvial deposits, moraine, dammed lakes, OSL dating.

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BACK

GEOMORPHOLOGICAL HAZARDS IN ALTAI: PAST AND PRESENT

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Article discusses geomorphological hazards recorded in Altai notably ice- dammed lakes formation and their catastrophic drainage followed by a huge mudflow. Currently strong surface temperature anomalies induce catastrophic flooding phenomena affecting residential neighborhoods. The article provides a review on the pathway of the floods and indicators of repeated outburst events. Earthquakes are another geomorphological process with various extent of resulting damage and occurrence.

With regard to the rugged terrain, world mountain ranges used to be the epicentre of the Earth's surface tremendous transformations occurring due to the existence of glacier ice, breaks of glacial dams, huge mudflows spreading downstream, flooding, tectonics, seismic and earthquake activity of the Earth's crust, debris fall and other extreme natural events. It is well illustrared in the Altai Mountains area.

I.P. Gerasimov in 1987 developed a scientific theory that mountain formation refers to the geological processes, associated with three main cycles in the history of a geomorphological stage of the earth's development. The central idea of this theory is that the earliest phase of the surface topography development is the macrocycle of basal planation surface formation or a global peneplain of the Mesozoic Era. However, over a long period of time the basal planation surface was exposed to diverse tectonic deformations and complex denudation processes resulting in the differentiation of the present-day relief (1978).

Before the Paleogene Period vast areas including the Altai Mountains and its foothills were characterized by a uniform base-leveled terrain or hillocky denudation plain with intense development of chemical weathering and denudation processes.

The second macrocycle is associated with the genesis of the stepped ascending denuded terrain and extensive sheet-like accumulative plains having regional and local distribution patterns. Although it originated in the Paleogene Period, the second macrocycle continued for a prolonged period of time. Meanwhile, apparently, the dynamics of global plate tectonics

gradually increased and continued into the Neogene Period reaching its maximum by the beginning of the Quaternary Period.

The next Pliocene phase in Altai is marked by the differentiation of tectonic activity in two opposite directions. Slow subsidence of Earth's crust occurs in the foothill plain. While a lifting movement of the Earth's crust occurs at the site of the future mountainous region. Thus, a new stage in the process of hazardous geomorphological phenomena occurrence has begun.

Today there is much obtained actual data that allow us to reconstruct the events from more than 100-150 thousand years ago, thus using state-of-the-art methods of paleochronology and geological incision exploration of the Altai Mountains arterial river terraces – the Biya and the Katun', the study revealed that the Upper Neo-Pleistocene glaciers, pre-existing in the central part of the Altai Mountains, moved from the river valleys to the open foothills. The glacier moving through the meridional section of the Teletskoye Lake took up debris scattered on the terrace edges and its advance provided considerable increase of sediment production. Then in the Lake's most latitudinal segment the glacier split up into two parts. One part passed over the watershed (the Yaylyu site) to the upper reaches of the Chaygol, Klyk, and Baigol rivers, while the other advanced to the latitudinal section of the lake with the huge quantities of sediments transported downstream due to the lateral moraine debris flow. It was a distinctive rock glacier landform and its lower cone lies in the Upper Biya valley.

Valley glacier dammed some tributary valleys including Yogach river valley. In this case tributaries downstream Yogach have been dammed, as a result of sandy-gravel accumulations deposited along the side moraine. To determine the numerical ages of deposits we examined lacustrine deposit samples applying the optically stimulated luminescence (OSL) technique. OSL dates obtained from bottom parts of the exposure were dated at 82.6 ± 7.0 ka (GdTL-1715), at the upper parts of the exposure dated at 50.2 ± 3.3 ka (GdTL-1716). Thus, about 100 thousand years ago the valley glacier dammed tributary valleys including Yogach and geochronology of the Upper Biya valley is estimated at 20 thousand years as evidenced by our monitoring observations done in the foothills section of Altai (Baryshnikov et al., 2015).

Global warming trend and glacier retreat in the Upper Neo-Pleistocene resulted in the rapid rise of Lake Teletskoye level, as the only waterway – the Biya valley, through which the runoff occurred, was blocked by the end moraine. Lake Teletskoye overflow with glacial melt-waters and destruction of morainic dam constraining glacial melt-waters induced a huge mudflow – giant Biya Debris Flow that spread downstream with much eroded material being redeposited in the Biya valley. This event was attributed to 18-20 thousand years ago (Baryshnikov 1992).

Geomorphological mapping indicate that the Katun River valley has many sections – stretches with widths of up to 3-4 km alternate with narrow sections, some localized stretches, whose profile is often limited to 300 m ravine. At the valley deepening section a staircase of terraces is being formed as a rule. Such a beaded shape of the river valley was a key factor at the time of outbursts from glacial lakes, so far as narrow sections served as natural “hydraulic locking” system, capable to blow off high velocity of the runoff after frontal shock-wave run. The deposition of finer sediment from the sediment plume generated during debris flow occurred further downstream leading to formation of a series of fluvial terraces with rare inter-layers of boulders. The aggregate of data suggests that the above events occurred about 25-28 thousand years ago (Baryshnikov et al., 2015).

The collected facts and their interpretation give the basis to outline the following concept – formation of the ice-dammed reservoirs in the Chuya and Kurai Basins, as well as in the Teletskoye Lake, had occurred apparently in the same time period, very likely about 100-150 thousand years ago, while the release of large amount of water along the river Katun occurred around 30 thousand years ago, that is 10 thousand years earlier than Lake Teletskoye drop. A glacial period preceded the above events.

Currently extreme events in river basins of the Altai Mountains are followed by ice dam formation and catastrophic flooding phenomena. In December 2005, Chemal village, a famous health resort located in the Republic of Altai, was affected by an extreme event, namely damage to residential buildings caused by the flooding due to ice-dam formation and subsequent overflow of still open Chemal river. It was associated, first and foremost, with rapid warming and break up of partially formed ice on the river (Marinin and Baryshnikov 2009).

Such strong surface temperature anomalies might have been initiated primarily by foehn winds – dry, warm, down-slope winds that occur in the downwind side of a mountain range. Cold air is forced downwards expanding over comparatively narrow intermountain hollows resulting in its adiabatic warming. Descending vertically, the air is heated by the dry adiabatic lapse rate which equals about 1°C per 100 metres. Thus moving from a height of 2500 m the air becomes warmer in just a matter of minutes. A foehn like situation typically lasts from less than a day to several days – up to 5 days, and is responsible for rapid temperature rise and relative humidity increase. V.V. Sevastyanov (1998) proposed to recognize the foehn warming effect observations from "Chemal" weather station as close to the maximum for the entire territory of the Altai Mountains. If so, partial thawing in fall-winter period accounts for newly formed ground ice segregation followed by a huge flow of snow and ice large mass at the rate of 5-6 km/h.

There is little doubt that there have been repeated cataclysmic floods in the valleys of Altai arterial rivers, though their geological and geomorphological background is not evident today. It could only be supported by extrapolation of the events that occurred in the 20th and 21st centuries. For example, in 1969 flooded level reached six meters in low-water period of the Katun river. The Biya river level has had exactly the same dynamics. Hence, tributaries have been dammed resulting in fluvial terraces flooding and direct damage to residential neighborhoods. In 2006 the Bolshoe Ugrenevo village was affected by spring flood on the Biya river. Widespread flood damage to housing stock occurred throughout Altai krai in 2014. In all, above 1, 500 dwellings were severly damaged, bridges destroyed, lives lost.

Earthquakes are another geomorphological process that can cause severe problems to both humans and the environment. The first data on earthquakes in Altai were produced in 1761. This earthquake was registered in Semipalatinsk (Semey) and Ust-Kamenogorsk with magnitude 6–7 at the epicenter area, and as noted by I.V. Mushketov (1891), in the Kolyvano-Voskresenskiy mines and in Barnaul, a distinct tremor and roar was heard at the time of the earthquake. Relatively reliable information about the past was preserved in the north-western and northern areas of the Altai District, such as Rudny Altai, Barnaul-Novosibirsk Priobye, and others.

Apart from earthquake evidence, seismic activity with an intensity of 4 – 6 points was recorded in 1774, 1824, 1825, 1887, 1901, 1902 and 1911 in Priirtyshye and in the Kolyvan region, and the earthquakes of 1829, 1882, 1914 and 1931 years – in Kamenskoe Priobye. The seismic events of 1785 and 1893 are mentioned in the historical records of Barnaul as "considerably strong earthquakes". A series of earthquakes in Altai have been described in detail by I.V. Mushketov and A.P. Orlov (1893). G.I. Tanfilyev (1902) reported on earthquakes in the Southern Altai, which occurred twice in October 1846 in the area of Zyryanovskoye mine.

The 2003 Altai earthquake happened on September 27 at 11.33 GMT, 17.33 local time, in Altai Republic with a moment magnitude of 7.3–7.5. It was the largest earthquake to have struck the Altai mountains in more than seventy years.

Large 2003 earthquake was closely followed by numerous aftershocks that were of a large magnitude and rate. The first large aftershock (with the magnitude 7.4) struck at 18:52 GMT on the same day, and a second major aftershock (with the magnitude 7.0) followed on October 1 at 01:03 GMT.

The earthquake was accompanied by the formation of seismic dislocations on the earth's surface. Field-based seismic-geological surveys undertaken in the epicentric area have made it

possible to establish principal sections of earthquake ruptures and deformations, extensional fissures and striking faults (Imaev et al., 2007). The main shock and the later aftershocks were dextral strike-slip events which contributed to deformation of the fault zone. Continuous section of ruptures (more than 20-25 km) suggests an overall mechanism of striking fault. Reports vary as to the extent of the resulting damage. However it appears not to have directly led to a loss of life due to the very low population density in Altai Republic.

We conclude that geomorphological hazards in Altai are recorded and thoroughly investigated throughout its history. Be aware of the environment and potential risks is the triggering factor nowadays.

Keywords: peneplain, glaciers, glacial dams, mudflow, flooding, earthquake, temperature anomalies.

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BACK

VOLCANISM, LAHARS AND COASTAL PROCESSES AS NATURAL LIMITATION OF MATUA ISLAND (CENTRAL KURILS) TERRITORY DEVELOPMENT

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Matua is typical small volcanic island situated in the central part of Kuril isles arc. It has a size of approximately 6x12 km. 90% of island occupied by telescoped stratovolcanoes: extinct – Matua, and active - Sarychev Peak. The latter is situated inside Matua caldera. South-eastern part of island is terraced plain, consisted of marine terraces (up to 45 m a.s.l.) and flattened peripheral parts of Matua volcano lava flows.

Development of territory require preliminary assesment of natural hazards. It was revealed that island is susceptible to volcanic eruptions, lahars, coastal processes and tsunami.

Eruptions of Sarychev Peak volcano cause pyroclastic flows, waves and less lava flows. Somma of Matua volcano protect suitable for development eastern plains from these hazards. However, growth of active cone soon will results in Matua caldera overfilling and subsequent advancement of pyroclastic flows inside the plain. Only sectors of plain topographically protected by extinct lava domes will be in safety.

Lahars, triggered by eruptions, apear to be additional danger. In summer 2009 they advanced only 1 km out of foothills. In case of catastrophic eruption in spring, when snow cover has maximum thickness, lahars can be much greater. As a result of such evidences in the past, most part of south-eastern plain is covered by lahar fans of different age.

Eruptions also activate coastal processes. Pyroclastic fans advanced into the sea are subject to intensive abrasion (up to 30-60 m/year). Alongshore sediment flow cause wave of accumulation spread toward south-east. Building of hydrotechnical infrastructure transverse to the shore in Ainu bay will inevitably cause intensive accumulation westward and abrasion eastward of construction site. Low marine terraces are also susceptible to tsunami. In Ainu bay footprints of tsunami 15.11.2006 observed on a heights up to 20 m a.s.l.

Keywords: volcanic island, natural hazard, coastal processes, lahar, volcano, tsunami.

BACK

IMPACT OF ANTHROPOGENIC ACTIVITIES ON CHANNEL GEOMETRY OF THE SAPTAMUKHI RIVER SYSTEM, INDIAN SUNDERBANS

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The Ganges-Brahmaputra-Meghna delta is one of the largest tide-dominated deltas in the world. The Sunderbans, the southern part of the Ganges-Brahmaputra-Meghna delta, has received much attention for its continuous event of embankment breaching each year. However, little scientific measures have been taken to combat the disaster, which is likely to increase day by day due to climate change. It has been found that the behavior of tidal rivers, which is modified by the anthropogenic activities, is responsible for the repetitive event of embankment breaching and consequently, loss of biodiversity, particularly after monsoon and the bore tide. Therefore, improved understanding of the behavior of the rivers helps in planning sustainable development in the Sunderbans. Studies on at a station hydraulic geometry help in understanding the behavior of the rivers. This paper presents results of at a station hydraulic geometry (‘b,' ‘f,' and ‘m’ exponents and their relationship) of the Saptamukhi River system of the Indian Sunderbans for pre-monsoon (April-May), monsoon (July-August), post-monsoon (December-January) seasons, and bore tide of 2016-2017.

Two tidal rivers, namely the Kalnagini Khal and the Hatalia Doania Khal connect the Saptamukhi River in the east and the Hugli River in the west; as well as three north-south oriented tidal rivers, namely the Banstala Khal, Nebutala Extension of Kalnagini Khal, and Gandakata Khal joining the Saptamukhi River are considered in the present study. The Saptamukhi River System respond to anthropogenic activities differently at different stretches of the river. The calculated ‘b,’ ‘f’ and ‘m’ values (that range from 0.18 to 0.57; 0.14 to 0.55, and 0.16 to 0.70 respectively) indicate erosion proneness at the embankment construction sites, while sedimentation at undisturbed areas. Construction of embankments along the banks of these rivers and increased sedimentation in river beds resulted not only the dearth of fresh water supply from the Hugli River but also caused significant changes in the channel geometry of these rivers. Overall, the present study has found that this river system is very much vulnerable to changes due to relative sea-level rise as well as anthropogenic activities.

Keywords: At a station hydraulic geometry, embankment, human interference, tidal river, Indian Sunderbans.

BACK

CYCLE OF EXTREMAL EXOGENIC PROCESSES IN LANDSCAPES OF THE CENTRAL CAUCASUS (ON THE EXAMPLE OF CHEREK BALKARSKY BASIN)

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According to our idea extreme exogenic processes (hereinafter – EEP) associated with accumulation and transportation of debris – landslides, rockslides and debris flows – forms a cycle. Cycle scheme: after the huge debris flows descend in the mountainous landscape the debris begins to accumulate as a result of landslide-rockslide, fluvial processes and the avalanche overthrow. After reaching a critical mass, even under low effect of any factors (precipitation, temperature, seismicity, frost weathering and snow accumulation) the next debris flows descend is occur. For the first time all these factors are considered in the complex.

The influence of strong earthquakes on EEP is evident. But we also consider weak seismic events, starting with three points on the 12-point scale MSK-64.

We estimate the contribution of frosty weathering to the formation of a base for the EEP on the transitions of air temperature through zero mainly in the winter-spring period. The destructive effect of this process on rocks is particularly pronounced on steep snowless slopes.

The high temperature of the air contributes to the intensive melting of the snow cover and glaciers and activates, first of all, the glacial debris flows and riverbed processes.

Heavy rainfalls in the warm season activate all EEP. Heavy snowfalls in the winter-spring season and large snow accumulation contributes to the avalanches, which facilitates the preparation of ground for EEP and assumes the activity of riverbed processes.

The integrated analysis of air temperature, precipitation, seismicity, frosty weathering and avalanches was carried out for the Cherek Balkar River basin. According to preliminary data EEP cycle comes to 3–5 years within study area.

Keywords: cycle, extreme exogenous processes, integrated analysis, preparation, mountain landscape, rocks.

BACK

CATASTROPHIC PROCESSES IN RIVER VALLEYS OF VOLCANIC REGIONS

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In areas of modern volcanic activity, the catalyst for catastrophic processes in river valleys, in addition to exogenous factors, can be endogenous ones - primarily eruptions. The most frequent in the valleys of such regions are volcanic mudflows - lahars, caused by the melting of glaciers during eruptions. However, with detailed consideration, the spectrum of catastrophic processes is much broader, and the reasons for the formation of mudflows are very diverse. Often, these processes are cascaded: an endogenous catastrophic event - an eruption - provokes another endogenous or exogenous catastrophic event, or a series of interrelated and/or sequentially developing catastrophes. In addition to the above-mentioned melting of glaciers during eruption, mudflow can be the result of: 1) flooding of the main valley with lava flow, with damming of its tributaries and ponds formation in their valleys: the formed pond lakes are subsequently "poured" into neighboring valleys or basins, or the dam is destroyed as a result of erosion; 2) blocking the valley with a dam or even filling it over an extended area after the explosion with a lot of fragments of the apical part of the volcanic cone; 3) descent of pyroclastic flow along the valley and its filling with volcanic material and the blocking of tributaries with formation of pond lakes in them; 4) formation of a pyroclastic cover with a capacity of some meters, with its subsequent redistribution with concentration in the valleys; 5) partitioning of valleys in hydrothermal zones by landslides formed with weak seismic shocks that can accompany eruptions.

Subsequent cutting of the rivers within the valleys filled with various volcanic material and breakthrough of the formed pond lakes lead to the formation of mudflows. The muddy stream can also form as a result of a "splash" of the lake during the eruption of a volcano located in it or in the immediate vicinity. Catastrophic consequences can also have the results of reformation of the river network due to formation of cracks and other deformations of the earth's surface during eruptions.

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Keywords: eruption, mudflow, filling a valley with volcanic material, pond lake.

BACK

AVALANCHE AND DEBRIS FLOW ACTIVITY IN THE WESTERN AND CENTRAL CAUCASUS AND THEIR IMPACT ON LANDSCAPES

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Snow avalanche and debris flow activity and their impact on landscapes of some river basins of Central and Western Caucasus (Teberda basin) which are famous for winter and summer tourism have been revealed on the basis of real-time observations, interpretation of remote sensing data and indication methods. Some common and individual features of this catastrophic nature processer's activity were detected in study regions as well as in different altitudinal belts. Large snow avalanches after interval of 40-60 years were marked out in high mountains of all basins as well as debris flow and avalanche releases in the same basin during one year. Intensification of small debris flows (with volume of 1-10 thousand cubic meters) or appearance of new one in the middle mountains especially in the Teberda basin due to the meteorological conditions and anthropogenic activity is another feature of debris flow regime. Some of these debris flows destroyed the federal rood Karachaevsk-Dombay. The zones of debris flow formation are situated in the forest belt and were not marked out before on the debris flow maps. The risk of future debris flows is very high as the big amount of slope deposits became unstable due to the anthropogenic changes. The opposite trend of decreasing debris flow activity in high mountains of Teberda river basin except some flows was also revealed. Map of debris flow basins taking into account current results of investigation was compiled on the basis of previous maps. Main changes of landscapes as a result of debris flow and snow avalanche releases were revealed. The areas affected by debris flows and avalanches are characterized by metachronic landscape structure and different time of landscape successions. The landscape structure of the valleys usually gets more complicated due to the cumulative effect of debris flows and avalanches.

Keywords: debris flow activity, avalanche, landscape structure, indication, Caucasus.

BACK

GEOSPATIAL TECHNOLOGY IN LANDSLIDE MAPPING: A CASE STUDY OF UTTRAKHAND HIMALAYA, INDIA

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The term “landslide” basically means a slow to rapid downward movement of instable rock and debris masses under the action of gravity. Landslide is a major hydrogeological hazard that affects large parts of Himalayan area of Uttarakhand state in India. The study of landslides has drawn worldwide attention mainly due to increasing awareness of socio-economic impacts of landslides. Remote sensing images provide many useful land use information to combine in a GIS environment with other spatial factors influencing the occurrence of landslide. The recent developments in Geo-spatial technologies have opened the doors for detailed and accurate assessment of landslide prone area in the Uttrakhand Himalayan region. The populations living in these townships and villages suffer badly from the onslaught of landslide. Therefore, landslide susceptibility mapping is one of the important issues for urban and rural planning in India. The present deals with the use of temporal remote sensing data and geographical information systems for landslide mapping. Six categories of controlling factors for landslides i.e. slope gradient, aspect, lithology, land use land cover (LULC), drainage density, lineament density is defined in this study. Normalized Difference Vegetation Index (NDVI) has been generated to identify the vegetated and non-vegetated areas. The parameters of slope, aspect, lithology, land cover, rainfall, distance from fault, distance from river, and distance from road were used as variables in the Multiple Linear Regression analysis. ILWIS 3.31 Academic, Arc GIS 9.3, Global Mapper 13.0 and Excel software’s have been used for zonation, and statistical analyses respectively.

The study clearly reveals that a total number of about 695 landslides spots covering an area of about 2.30 sq. km. were mapped from Landsat-OLI-TRS image of 2015 whereas a total number of 157 landslides covering an area of about 1.60 sq. km. were mapped from Landsat-ETM+ image of the year 2005. This study directly linked with geographical innovation and technological challenges as considerable number of people being affected physically as well as

socially from occurrence of landslides hazard and also valuable for hazard zonation, mitigation purpose and regional planning in the Himalayan area.

Keywords: Landslide, remote sensing, GIS, Landsat, NDVI, Himalaya.

BACK

POSTER

RATES OF POSTGLACIAL INCISION OF THE UPPER VOLGA RIVER ESTIMATED BY LUMINESCENCE DATING OF THE TERRACE STAIRCASE

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Introduction

The influence of hydro-glacioisostatic deformations on the development of drainage systems has been studied mainly in the former glacial regions. The role of glacio-isostatic movements in the development of river valleys outside the ice sheets was first pointed out by Bylinsky (1990, 1996). Later, relevant studies were carried out in the lower Rhine and in the Rhine-Meuse delta, where the phenomena of incision and aggradation, as well as lateral shifts of the channels as a result of the Earth surface tilting in the LGM time were made (Wallinga et al. 2004; Busschers et al. 2007). Volga, the largest river of Europe, starts at the southeast edge of the former Scandinavian ice sheet (Fig. 1). The present study aims to identify possible glacioisostatic effects on the development of the upper Volga River development in the last glacial epoch.

Results

To estimate the values of glacioisostatic deformations, we used digital models of the modern topography and topographic surface for the time slice of 21,000 yrs BP, according to the ICE-5g (VM2) model (Peltier 2004). Subtraction of the first one from the second one allowed to produce a map of the topography deformations in the northwest of the Russian Plain in the LGM period relative to the ocean level of that time (Fig. 1). At some distance from the glacier a gentle compensating bulge can be traced. Its axis represents a broad, flat surface extending subparallel to the edge of the ice sheet at a distance of 300-400 km from it, approximately along the line Lutsk-Chernigov-Bryansk-Moscow-Kineshma. Near the edge of

the glacier is a flexure - slope towards the glacier, which is part of the glacioisostatic sink - subsidence of the lithosphere under the ice load.

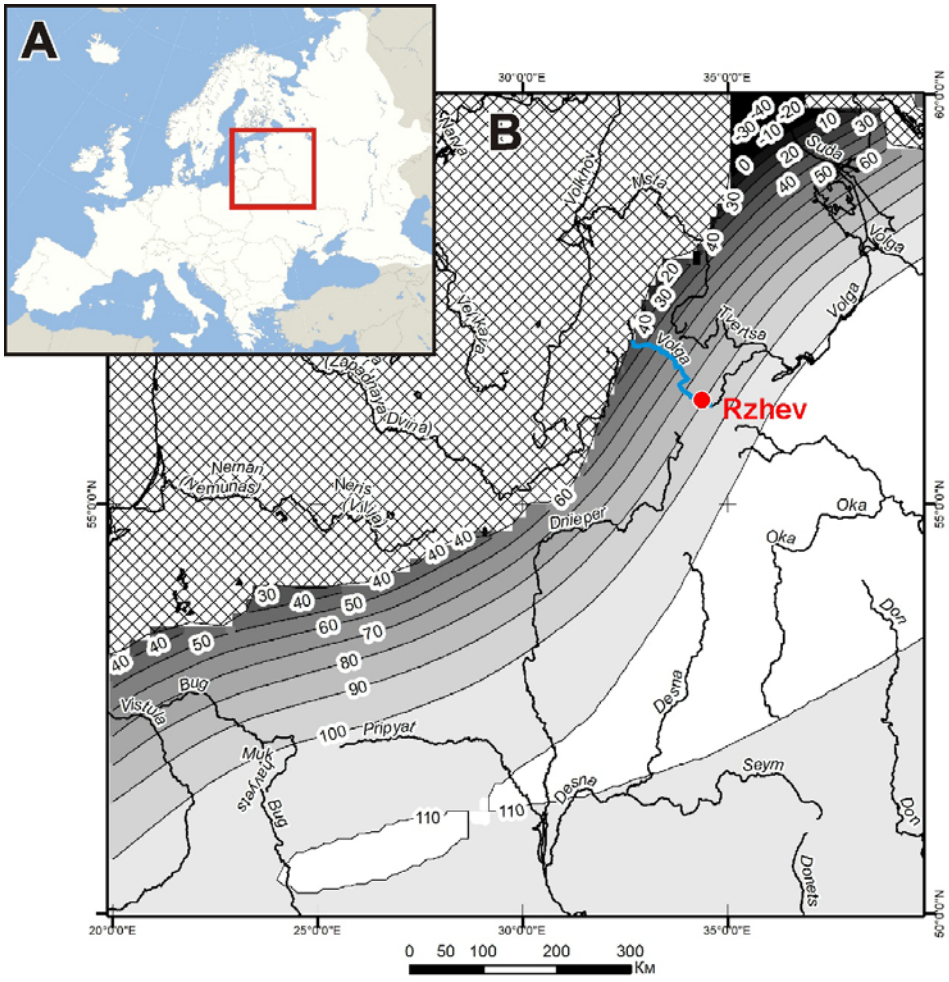

Fig.1. Location of the study site (A) and the map of glacioisostatic deformations in the LGM (B). The deformation map was obtained by subtracting the modern topography from the topography at 21ka BP, calculated by the ICE 5G (VM2) model (Peltier 2004).

For the purposes of this study, it is not the absolute values of altitudes that are important, but changes in the slopes of the earth's surface. The overlay of hydrographic net over the map of topographic deformation makes it possible to estimate changes in river slopes. Upper Volga from its outflow from the Verkhnevolzhskie lakes (the water surface of 204.5 m asl) downstream to the town of Rzhev (river elevation 150 m asl) flows opposite to the gradient of the LGM topographic deformation (Fig. 1). With the current fall of the river of about 55 m, the topographic skew of the LGM time was 60-65 m in the opposite direction (Fig. 2). This suggests that in this stretch of the valley the drainage must have ceased and a proglacial lake must have been formed. This is supported by the widespread development of lake sediments at the end of the Late Pleistocene in the Upper Volga region, which allowed to reconstruct the outlines of the large proglacial lake for the LGM and Late Glacial time (Rusakov 2012).

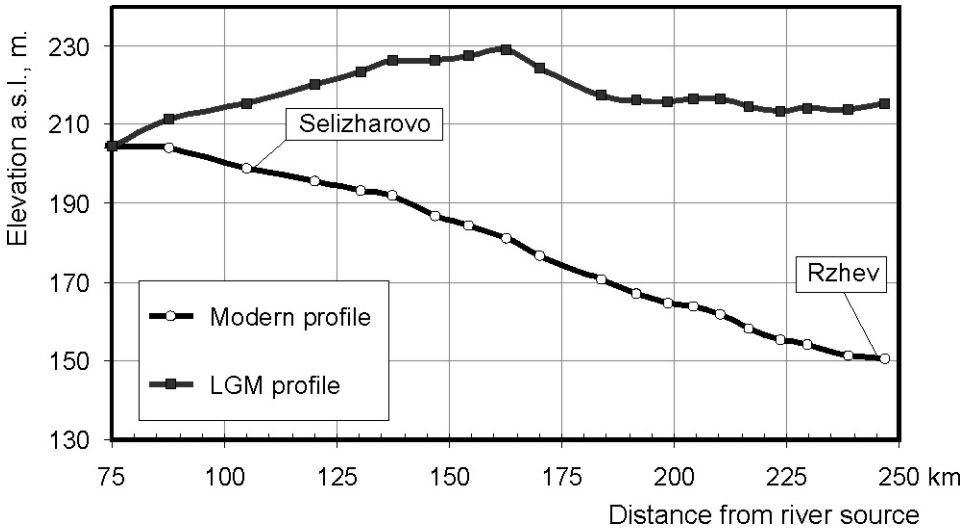

Fig.2. Reconstructed figure of the upper Volga longitudinal profile during the Last Glacial Maximum, according to estimated values of glacio-isostatic defornations (see Fig. 1).

After the ice sheet melting and relaxation from the glacial load, the surface of the lithosphere began to rise, the river flow resumed. The gradual increase in the slope of the valley was to cause the river to cut in. In favor of this says the presence on this stretch of valley of terrace staircases. However, direct dating of the age of these terraces has not yet been done. Some researchers believe that the beginning of the incision of the upper Volga does not refer to the Late Glacial age, but to an older time, dating the upper terrace to the Middle and Late Pleistocene boundary (Obedientova 1977). In order to obtain direct data on the time and rate of the upper Volga incision, we investigated the set of river terraces near the town of Rzhev (Fig. 3). According to the data of the topographic survey and mechanical drilling, the geological profile was produced, and a series of optical-luminescent (OSL) dates was obtained from sand samples (Fig. 4). Dating was performed in the GADAM Center, Institute of Physics, Silesian University, Poland.

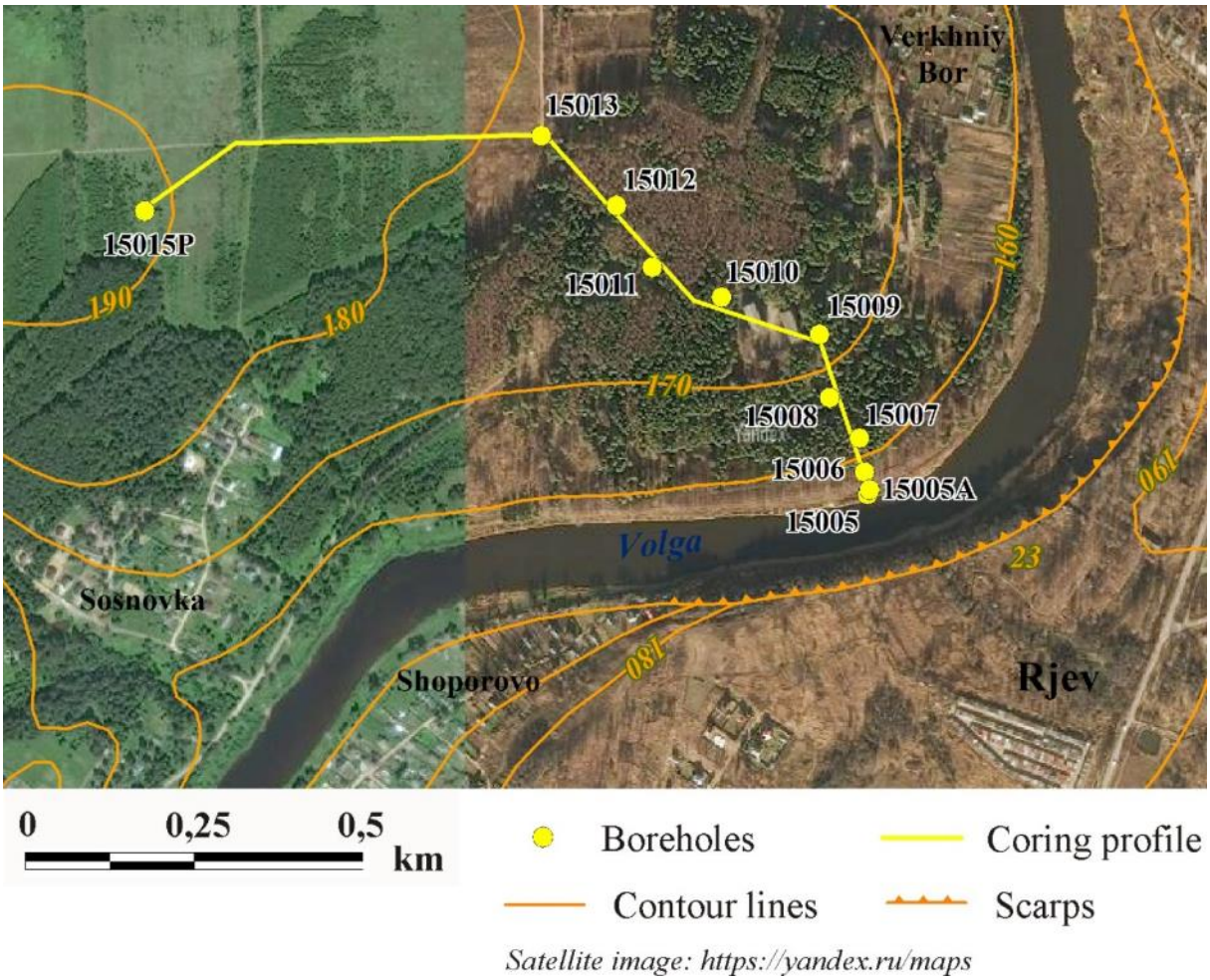

Fig.3. Overview scheme of the study site in the Volga valley at Rzhev.

Results

The obtained results confirmed the formation of the terrace stairs in the Late Glacial time. Some dating inversions (for example, the date from the floodplain turned out to be somewhat older than the date from the first terrace) are associated with methodological difficulties, in particular, the possibility of incomplete zeroing of the luminescent signal in channel alluvium. It can also be the case that the narrow segment of the floodplain, drilled by well 15005, is an erosion step, undercut in the alluvium of the first terrace and covered with young overbank fines. In favor of this supposition is the high position of underlying Middle Pleistocene moraine. In this case, the date reflects the age of the terrace, and not the floodplain.

It was not possible to accurately date the highest, 16-meter terrace. The pebbly-gravelly alluvium of the terrace almost does not contain the necessary sand fraction for dating. Dated was only the upper relatively thin layer, which is entirely composed of sand. It provided too young dates 11.9 ± 0.7 and 11.3 ± 0.8 ka, which is most likely indicative of the aeolian genesis of this sand cover. Another layer of sand material was encountered in core 15012 in the

backside of the terrace. The date received here was 45.6 ± 3.1 ka, probably too old. Presumably, this sand was washed away from the adjacent slope of the valley, where Middle Pleistocene fluvioglacial deposits are exposed. We believe that the 16-meter terrace was also formed after LGM. In the future, attempts will be made to find more representative sections of this terrace and to obtain more reliable dates for them.

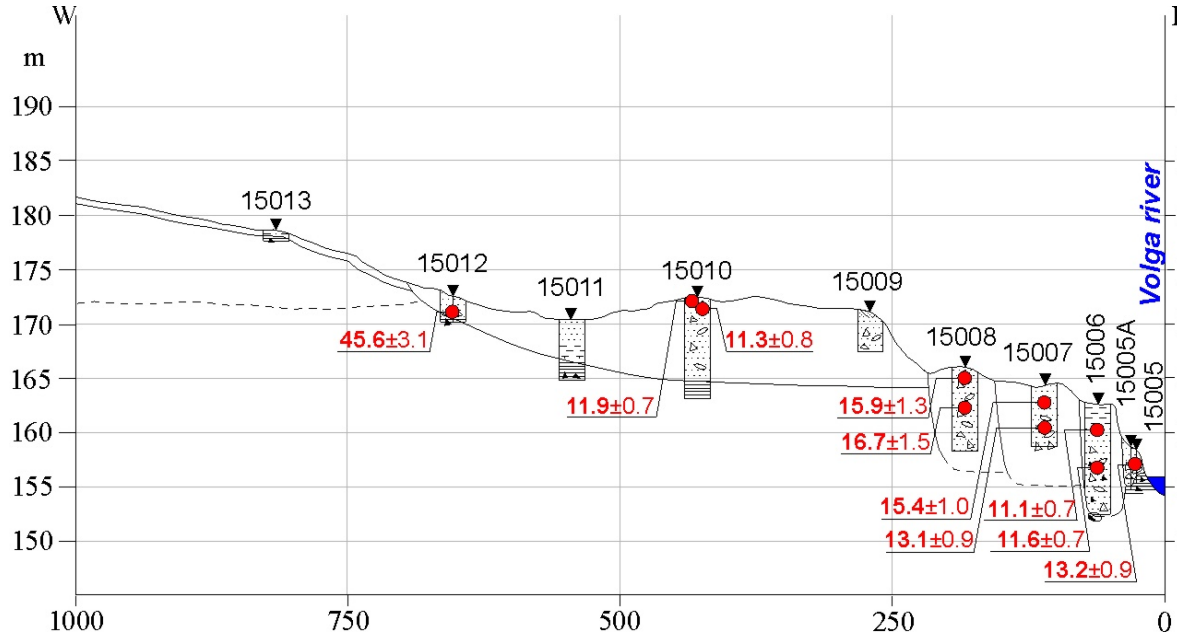

Fig.4. Geological profile through the terrace staircase on the right bank of the Volga River near the town of Rzhev. Red numbers are OSL dates.

In general, the incision began somewhat earlier than 16 thousand years ago (dates from core 15008) and ended somewhat later than 11 thousand years ago (dates from core 15006). During the time between 16 and 11 thousand years ago. The river incised by about 5 meters (the difference in the roof of sand in cores 15008 and 15006), i.e. the incision rate was about 1 m per 1000 years. If we extrapolate this rate to the initial phase of incision, the 16-meter terrace should have been formed no earlier than 22-23 thousand years ago. However, most likely, it was formed some later, as the incision has most likely slowed down with time, and in the early phase the incision rate should have been higher than the above estimate. The bottom of the alluvium of the lowest terrace (core 15006) is located at the same level or only a few meters above the present bottom of the channel. This suggests that the incision had already stopped in the early Holocene, somewhat later than 11,000 thousand years ago.

Thus, it was established that the formation of the upper Volga terraces staircase near the town of Rzhev (and, probably, in other parts of the valley) occurred after the maximum phase

of the last glaciation. Most likely, the cause of the incision was the glacio-isostatic uplift in the proglacial area. Already in the Early Holocene the cutting stopped.

Acknowledgement: This study was supported by the Russian Science Foundation (RSF), project 17-17-01289 "Reorganization of drainage systems and migration of the main watershed of the Russian Plain in the last glacial epoch".

Keywords: glacio-isostatic crustal subsidence and rebound, river incision, terrace staircase, OSL dating.

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BACK

MORPHOLITHOLOGICAL ANALYSIS OF MOSCOW CENTER

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Morpholithological analysis makes it possible to reveal the characteristics of relief both modern and inherited, and to typify morpholithosystems by a combination of different developmental trends and activity of relief-forming processes, as well as by their resistance to exogenous relief factors and various anthropogenic influences (Likhacheva 2004).

Morpholithological analysis is crucial in study of urban areas, where the maximum concentration of anthropogenic morpholitogenesis is observed. At the same time, natural morpholithosystems experience "metamorphic transformations" (Velev 1985) of structure and organization, which affects their engineering properties, and, finally, stability. Metamorphic transformations in urban areas lead to a change in the spatial arrangement of geomorphological boundaries, which entails a change in the structure of surface runoff, a disturbance of water exchange in the morpholithosystem, and activation of exogenous processes.

The purpose of this study is to analyze the influence of paleo- and buried relief on the present-day relief: to determine the degree of inheritance, patterns of exogenous processes development, their intensity change, determination of the regime of hydrogeological processes, estimation of seismicity.

Moscow territory is situated on the East European Plain in central Russia, which can be considered the first hierarchical level of the geomorphological organization of the urbanized territory - morphostructural or morphogenetic. The next hierarchical level is determined by the urban territory belonging to geomorphological regions or morpholithosystems: watershed - relatively stable (the Smolensk-Moscow Upland, Meshcherskaya lowland, Moskvoretsko-Oka plain) and the valley of the Moskva River - dynamically active geomorphologic morpholithosystem. We have defined this hierarchical level as the level of morphodynamic organization of the system. The third hierarchical level can be called elementary morpholithosystems - morpholithosystems, which are relatively homogeneous by geological-lithological and morphological characteristics and structure of which includes modern relief and elements of paleorelief, in particular paleovalley.

In the Quaternary the territory of Moscow experienced several cycles of erosion and accumulation, associated with covering glaciation and neotectonic movements. Several stages of incision occurred during the Lower and Middle Pleistocene and led to the formation of deeply embedded preglacial paleovalley (Kozhevnikov et al. 1979; Kozhevnikov and Kozhevnikova 1986). In that way several stages of the erosional relief development (pre-Quaternary, Quaternary and anthropogenic) have been identified. Buried relief surfaces were formed in different natural and climatic conditions, but they have the same genesis. However, since the natural and climatic conditions were different, the morphodynamic characteristics of the valleys are different from each other. According to the combination of paleo, modern and technogenic components, several types of morpholithosystem structure can be distinguished in accordance with the geomorphological structure of the present-day surface and the genesis and the lithology of the Quaternary sediments (Anikina et al 2017).

The territory of the Moscow center is characterized by the maximum anthropogenic pressure on the natural environment, which is increasing due to the continuing intense economic and transport development of the underground space to a depth of tens of meters. In the first approximation, the depth of the metro station can be used to estimate the depth of the anthropogenic development of the underground space, in most of the city center it is more than 30 m (up to 75-80 m). In this regard, it is especially important to study the buried relief, since many dangerous geological processes, such as karst, suffosion, quicksand etc are related to the paleovalley. Paleovalleys are also characterized by an increased seismic vulnerability (Likhacheva 1998).

But the transformation of the terrain in urban areas is not only and not just a change of heights, morphometric and morphological characteristics, but first of all leads to the creation of new landscape-geomorphological conditions, a new anthropogenic geomorphological system with peculiar features of functioning, and, what is extremely important, the structure of water exchange (Belousov 2000). The relevance of the study of Moscow's paleorelief is determined by its significant influence on engineering-geological and hydrogeological conditions and modern engineering-geomorphological processes.

Keywords: urban geomorphology, morpholithological analysis, morpholithosystem, paleovalley, buried relief, Moscow

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BACK

ORPHOLITHODYNAMICS AND ENVIRONMENTAL THREATS FROM LONG-TERM COMPREHENSIVE NATURAL AND TECHNOGENIC IMPACT: AQUATORIES AND COASTS OF SOUTH-EAST SECTORS OF THE AZOV AND BALTIC SEAS

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Coasts and waters of inland seas, mastered by ancient civilizations, are a vital source of water, biological, recreational, and other resources.

The purpose is to estimate the territorial losses from erosion, threats of chemical and radiation pollution of the coasts and water areas associated with the dynamics of the coastal area, the construction of ports and the consequences of the Second World War (1941-1945), for the management of marine resources.

The objects of research are the actively used southeastern sectors of the Baltic and Azov seas of the Atlantic Ocean basin (Bogdanov 2017; Bogdanov and Paranina 2017; Bogdanov et al. 2017).

The consequences of long-term (XVII-XXI century) human activity in the Baltic have been considered: 1) territorial losses and the destruction of man-made objects; 2) natural radioactivity of potential source of mineral raw materials – titanium-zirconium concentrates in beach sands and their content of ^{137}Cs (the "Chernobyl trace"); 3) echoes of the Second World War – ammunition on the shore and dumping on the seabed of captured chemical warfare agents from the arsenal of Nazi Germany. The study has determined the following. Coast in Courland, after Peter the Great built the port of Libava (the end of XVII century) had been stable. Modernization of the outport (at the beginning of the XX century) caused obstruction of sands along the coast and its grassroots catastrophic erosion to the North of the port. By the 1990s, at 4-6 km closest to port, shore has receded up to 200 meters. Houses, landfills, fragments of sewer were destroyed. There was a threat of collapse of toxic objects of municipal wastewater treatment facilities into the sea (town Schedes). Environmental disaster was prevented by timely constructed shore protection facilities (1988-1991). The concentration of the ^{137}Cs isotope could reach Bq/kg: in sands – 110, in organic soils and peatlands – up to 500. Echoes of War

resulted in storms bringing ashore ammunition, which caused injuries and deaths of adolescents, who found such "waste" (the elimination of the Nazis in "Liepaja pot", 1945). In different parts of the Baltic Sea there are about 60 submarine dumpings of captured warfare agents. The threat of environmental disaster may appear in case of their large-scale mechanical damage (trawling, drilling, pipelines, etc.). The uncertainty of information about the number of dumpings maintains the danger of their appearance on the seashore and the release by waves to the shore.

Risks of this kind are typical for the Azov Sea Temryucsky Gulf, on the shores of which the village, wineries, resorts, sports, tourism and others are located. In the inner part of asymmetrically concave arc to the southeast coastline there is a famous port-fortress "Temryuk" – the main source of contaminants (pollutants). The weakened dynamics of a coastal area near the port of Temryuk promotes stagnation of pollution. Technogenic catastrophes here, especially during the periods of storm, are dangerous because they carry out pollution, both to the Sea of Azov, and into the Black Sea through the Kerch Strait.

Thus, the long-term combined natural and technogenic impact on the water area and the coast largely determines the trends of their development, dynamics and environmental threats in the coastal zone of the sea.

Keywords: impact, natural, man-made, threats, dynamics, ecology, water area, coast, sea, Baltic, Azov.

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BACK

SHIFTING OF MORPHOGENESIS BELTS IN THE MOUNTAINS OF NORTHERN ASIA AS THE CONSEQUENCE OF GLOBAL WARMING

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Cardinal climate changes over the past 10,000 years have led to a global restructuring of natural processes and transformation of the environment, including in the relief and in its shaping processes. This was most clearly reflected in the mountains, where a significant shift in the belts of morphogenesis occurred. Analyzing their behavior in the mountains of Northern Eurasia, we have to state that it is not as unambiguous as it would be expected in conditions of global warming. Belts associated with the activity of snow and ice lost their positions and shifted upward by 0.5-2 km, but the behavior of the erosion belts and eolian morphogenesis shows the opposite trend. Erosion shows expansion not only upward, but also down the slopes of mountains, and aeolian processes have reduced their presence in the lower tier of the mountains, or in the present have lost all significance.

It is important that the relief, created in the Pleistocene cold periods, did not fully pass into the relict state and partly continues to develop in the former regime. This circumstance causes an additional division of the belts of morphogenesis into newly formed and inherently developing ones. The pattern of distribution of the belts of morphogenesis is complicated by the fact that the mountain structures of Northern Eurasia are located in a wide latitude range (from 40 to 75 ° N), as well as in sectors with different continental climate.

The established patterns of displacement of the morphogenesis belts make it possible to predict their behavior and the transformation of the mountain relief with the continuing warming of the climate.

Keywords: climate changes, belts of morphogenesis, relief, relict state, Northern Eurasia.

BACK

GEOMORPHOLOGICAL FEATURES OF THE LANDSLIDE DANGER OF THE MOUNTAINOUS PART OF THE CHECHEN REPUBLIC

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The landslide danger in the mountainous part of the Chechen Republic is one of the often manifested and hampering economic activities. Modern geomorphological conditions of landslide danger of the mountainous part of the Chechen Republic contribute to the intensive manifestation of landslide processes both in bedrock and in surface sediments. The main geomorphological features contributing to the active manifestation and wide development of landslides are the presence of thick strata of clayey rocks, a strong dissection, an abundance of steep slopes with increased and uneven gravitational stresses in the constituent rocks, and their wetting regime. The latter factor depends not only on hydrogeological conditions, but also on the intensity of atmospheric precipitation. The greatest connection between the manifestation of landslides and the arrival of precipitation is traced by two peaks of their activity: autumn-winter and spring. In both cases, the total precipitation falls from 63 to 82% of the annual precipitation. Humidification of rocks increases their mass and accordingly the action of gravitational forces on them, which is accompanied by a weakening of the strength of structural bonds in them, a change in the consistency of soils to plastic and even fluid. This all leads to a decrease in the strength (friction and adhesion) of rocks on the slope.

Relatively young, actively forming relief in the confrontation of intense modern uplifts and progressive erosion provides its high energy (elevation difference reaches 400-600 m).

Deep landslides in the mountainous part of the Chechen Republic are formed with an average slope of about 8-12 °. In the upper part, where landslides originate, the slopes are somewhat steeper, up to 20-25 °. For slip landslides, the steepness range from 10 to 20 ° is most characteristic (at a slope height of 100-250 m). The largest landslides-flows (up to 3 km in length) are confined to the ancient landslide troughs, which have slopes of 6-10 ° (sometimes up to 25 °).

These circumstances constantly prepare the instability of the slopes of the massifs, are periodically realized in landslide displacements that intensively process the primary relief.

Keywords: exposure slope, moisturizing, erosion of the relief, the energy of the relief, the instability of the slopes.

BACK

A MULTIPLICITY GENESIS OF THE LAKE BASINS OF MESHCHERSKAYA LOWLAND

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In Meshcherskaya lowland, numerous lake basins have different genesis. Water-filled depressions dominated in the West and Center of the lowland. In the East appear karst lakes. In addition, in this region was found several dozen astroblem-like (rimmed) depressions, surrounded by rims. Their sizes range from 100-150 m to more than a 1 km in diameter, the depth varies from several to dozens meters, the height of the rims reaches several meters. Four different mechanisms formed basins of these lakes.

1. Fragments of ancient pingos (hydrolaccoliths). In North America and Europe, was proved that such forms existed in cold climate of the last glaciations end. In our country, this phenomenon has been studied for the first time (Bronguleyev et al., 2014, Makkaveyev et. al., 2016). One of them, lake Krasnoye, has a diameter of 300 m and a maximal depth of 9 m. Deposits of the rim (sand and sandy-loam) have lumpy, practically non bedded structure. These deposits might be formed at the foot of the large ancient pingo existed here in the periglacial conditions, from the slopes of which unconsolidated sediments crept and were washed down.

2. Impact origin proved to the Smerdyach'e lake basin (Engalychev, 2009; Badjukov et. al., 2003, Makkaveyev et. al., 2016). With relatively small sizes of round lake (250 m), its basin reaches a depth near 30 m. The fall of the meteorite occurred after the epoch of last glacial maximum. Formed in the crater, lake developed as a karst lake: the impact of a meteorite was exposed easily soluble carbonate rocks.

3. Interglacial kame. Svetloe lake basin predate glaciation resulted in karst sinkhole. Its rim is composed of glaciolacustrine sediments. The marginal ice cover that overlapping the basin was broken over the lake. Ice walls of the glacier served as the banks of the interglacial lake and the loose material carried by melting water from the glacier accumulated near them. The lake deposits remain as a bank rise above the surrounded plain.

4. Basins of some rimmed depressions often not round and have elongated shape. They were formed due to extraction of valleys by glaciers (lake Danilishhe).

Keywords: lake basins**,** Meshcherskaya lowland.

BACK

SPATIAL DATA ANALYSIS AND MAPPING OF DANGEROUS GEOMORPHOLOGICAL AND GEOCRYOLOGICAL PROCESSES IN RUSSIA USING GEOGRAPHICAL INFORMATION SYSTEMS

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Information technology for the processing of digital spatial data had become an indispensable tool in the study of natural hazards and risks long ago.

Paper illustrates GIS application for simulation, analysis, and digital mapping, including samples of published maps of extreme ecological and geomorphological situations in Russia, namely Ecological and Geomorphological Situations in the Regions of the Russian Federation, scale 1:9,000,000; Zoning the Russia Territory according to the Hazard Level of Ecological and Geomorphological Situations, scale 1:9,000,000; digital large scale Geomorphological Map of Moscow city.

Other examples of the ArcGIS (Esri, USA) application relate to damage assessment of the geocryological processes development in the permafrost zone, in particular, in the Russian Arctic. Authors analyzed the unique set of data on cumulative effect of the geocryologic processes in the 72-kilometer railway line (from Chara to Cheena in the Kolar district of the Transbaikal region) in the absence of repair operations, protective, and compensatory measures during a long period of time (13 years). Degraded sections of the railway have been investigated for the damage assessment.

The progress in the investigations is associated with new technological possibilities of geographical research, network environment for storage and processing of spatial data, new data sources (satellite images, detailed digital elevation models, unmanned aerial data), and further development of cartographic visualization methods.

This study was performed in the Institute of Geography & the Water Problems Institute under RAS within the Program for Basic Research of the Presidium of the Russian Academy of Sciences «Spatial Restructurization of Russia Considering Geopolitical, Socioeconomic, and Geoecological Challenges», no. 53. Research project #16-05-00200 supported by the RFBR.

Keywords: geomorphological processes, geocryological processes, permafrost, mapping, geographical information systems.

BACK

Evolution of the World Economy under the Globalization and Regionalization processes

BACK

GLOBAL REGIONALIZATION AND ITS IMPACT ON THE ECONOMIC SECURITY POLICY IN THE FORMER SOVIET UNION

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Introduction and problem statement

The collapse of the USSR significantly changed the alignment of forces and the geostrategic position of the territories. The mechanisms for ensuring economic security, existing in the bipolar world, have become ineffective. In the same period, there was an intensification of the globalization processes. The creating of new economic ties and international relations took place in the conditions of blurring national borders, increasing influence of individual states, large corporations and organizations. For the institutionally fragile states of the post-Soviet region, this has become a special threat for economic security. At the same time, they gained access to new resources and technologies, accelerated economic development through technological cooperation and economies of scale when entering international markets.

Currently, globalization and regionalization processes are inseparable, which has become known as global regionalization (Barigin 2005). Global regionalization is expressed in the consolidation of regional forces to control markets, leading to a significant change in global production and economic processes.

Global regionalization leads to a change in the economic, political, social, cultural, psychological aspects of life, new challenges and threats to national, in particular environmental or economic security. Global regionalization leads not only to the transition to a post-industrial society through modernization and technological development of the country. It has compounded the further stratification of the population of countries into the richest minority and the poorest majority. Wages in mature and emergent countries vary widely, while emergent countries are assigned only low-skilled jobs in the world division of labor. The world asymmetry also exists other economic, political and social relations. And this poses a significant threat both for Russia and for other FSU countries.

The purpose of this work is to analyze the influence of global regionalization on the economic security policy in the former Soviet Union countries.

Methodology and research methods

The complexity of the problem under consideration was determined by the interdisciplinary approach, but the main scientific concepts were economic security and sustainable development theories, as well as institutional theory.

A statistical analysis of the data provided mainly by the Central Intelligence Agency, was made, as well as SWOT analysis to identify the strengths, weaknesses, opportunities and threats of global regionalization for the FSU region.

Using the comparative analysis method, the challenges and threats existing in the various FSU countries, as well as their institutional models, were compared.

As part of the case-study method, separate projects in the field of economic security, in particular, integration agreements and infrastructure construction, were considered.

Research results

1. Challenges and threats to economic security

It should be borne in mind that for the years that have passed since the collapse of the USSR, the FSU countries has become more fragmented (Guseletov). In Moldova, Latvia and Lithuania, outflow of population is quite high: in Moldova (net migration rate -9.4 migrants per 1,000 population in 2017) due to poor quality of life, in Latvia (-6.1) and Lithuania (-6.1) – due to the wide opportunities for employment and training. In Armenia, Kyrgyzstan and Tajikistan, poverty is a major concern; in these countries, one third of the population lives below the poverty line. At the same time, the unemployment rate in Kyrgyzstan (7.5% in 2016) is average in the FSU region, and in Armenia, this rate is officially the highest (18.8). In Ukraine, the unemployment rate is also quite high, but the inflation rate is also high in this country (13.9% in 2016).

In Estonia and Russia, the public debt is about 10% of GDP in 2016, and in Armenia, Kyrgyzstan and Ukraine it exceeds half of GDP. At the same time, Armenia and Kyrgyzstan have the largest budget deficit in the post-Soviet region, which in a complex shows the threat of loss of economic sovereignty (The World Factbook).

The FSU region is of considerable interest for China, Japan, Turkey and Iran in the east, for the US and the European Union in the west. The reason for this is the availability of energy resources, mainly oil and gas, non-ferrous metals, as well as the possibility of using existing transport routes.

For example, Japan, which completely imports energy, is trying to expand its influence in the Central Asian region, especially since the end of the 1990s. Japan gratuitously transfers significant sums as financial assistance, and in 2003 began cooperation in the «Japan plus Central Asia» format.

Iran is interested in increasing the transport network through its territory, and particularly draws attention to Azerbaijan among the FSU countries. The supply of Azerbaijan and Kazakh oil is already being carried out with the help of pipelines in the north of Iran, which, of course, does not suitable for United States. This explains the US claims to Iran nuclear program. Russian support is conditioned by the desire of the two countries, Russia and Iran, to limit the influence of pan-Turkism.

The influence of the International Monetary Fund and the World Bank was noticeable in the Kyrgyz economy. The accession of Kyrgyzstan to the WTO was largely due to the United States.

In general, a number of specialists, in particular Zbigniew Kazimierz Brzezinski, believe that the US, weakening the CIS and encouraging international integration, is trying to prevent the FSU countries of being controlled by any country and thereby provide direct access to its resources (Guseletov). This is achieved through assistance in neoliberal reforms, financial support of the opposition in the event that the course held in the country does not meet the interests of the United States, etc. (Baydurin 2017).

Common recommendations on the implementation of the policy of ensuring economic security in the FSU countries can be given on the basis of an addition to the SWOT analysis of global regionalization for the FSU region by studying the interaction of external and internal factors (the format of this research is presented in the paper (Attokurova and Makeeva 2016)) (see table 1).

Table 1. Interaction of external and internal factors of global regionalization for the former Soviet Union region

External Factors; Internal factors	Possibilities	Treats
Strengths	Strengths that enhance the return on opportunities: • territorial location – access to international markets, use of economies of scale; use of territory for transit. • availability of natural resources and relative cheapness of some factors of production – technological cooperation and transnational collaboration.	Strengths that minimize threats: • availability of natural resources – prevention of drop in budget incomes at all levels, wage cutting, rising unemployment rate and inflation. • protectionism policy on national actors – preservation of national production. • relative cheapness of some factors of production – weakening of territorial resource and raw materials specialization.
Weaknesses	Opportunities to strengthen the weaknesses: • access to technologies and resources; broadcasting of innovative experience – elimination of technological backwardness, increasing the competitiveness of products. • technological cooperation and transnational collaboration – infrastructure development; elimination of administrative barriers to entry to the international market.	Weaknesses, the elimination of which is necessary to prevent threats: • technological backwardness; low competitiveness of products; imperfection and lack of infrastructure – to prevent the consolidation of territorial resource and raw materials specialization; improving the financial standing of enterprises, avoidance of their bankruptcy и and, accordingly, the elimination of drop in budget incomes at all levels, wage cutting, rising unemployment rate and inflation. • imperfection of state institutions, including the field of tax and customs policy – prevention of national production takeover; assessing the effectiveness of the institutional system for national actors. • institutional disunity; fragmentation and multidirectionality of integration

		processes – to enhance the territorial attachment of actors.

Source: compiled by the author.

The main principles of ensuring economic security should be flexibility and readiness to respond immediately to changes, understanding the enchainment and interdependence of all processes and phenomena occurring at all macro- and meso- and micro-levels.

2. Politics typology in the field of economic security and integration processes

Due to the difference in challenges and threats, the current policy in the field of economic security varies considerably across countries. On the basis of the classification of the political systems of the FSU region by Evgeny Vladimirovich Pavlov (Pavlov 2008), there are two main types of policy in the field of security:

1. Closed, involving the minimization of the impact of actors and processes from outside (globalization) and presence of a rigid hierarchy inside. This policy is implemented in the countries of Central Asia, more in Turkmenistan (autarchy form) and less in Tajikistan and Uzbekistan (traditional).

2. Open, denying the relevance of isolation. An example of an open-type policy is one that is implemented in Russian Federation – the desire to integrate into the world economy, while retaining its sovereignty (Dougin 2008).

It should be noted that in some countries (for example, in Kazakhstan) that have chosen an open-type policy, a modernization model is being implemented, where the basis is formed by economic and political reforms of the internal environment, in other countries (for example, in Kyrgyzstan) adaptive model is chosen: a multidirectional foreign policy for adaptation to external environment.

At the same time, depending on the chosen vector, the external environment for integration into the world economy is considered as:

- international organizations, such as NATO, the Council of Europe and the European Union. This type of policy implies minimizing contacts with the FSU countries and is chosen by Estonia, Latvia and Lithuania.
- international organizations (NATO, the European Union and WTO) and with FSU countries.

With open policy, bilateral agreements and production sharing agreements are increasingly important (Burakovsky 2004), but there is also a multilevel and multidirectional integration: the Commonwealth of Independent States (CIS), the Collective Security Treaty

Organization (CSTO), the Union State of Russia and Belarus (USRB), the Eurasian Economic Union (EAEU), the GUAM Organization for Democracy and Economic Development (GUAM), etc.

The greatest effectiveness in ensuring economic security was achieved within the framework of the Eurasian Economic Community and in its projects of the Eurasian Economic Union and the Common Economic Space; the Collective Security Treaty Organization and the Union State of Russia and Belarus. The CIS has become, rather, a political, not an economic union (Baydurin 2017). Similarly, in a number of bilateral relations, there is a parity of economic and political interests (for example, Russia and Belarus, Russia and Kazakhstan), in a number of ones, there is political dominance (Russia and countries such as Armenia, Kyrgyzstan, Tajikistan) (Chayevich 2006).

Within the Eurasian Economic Union, a single customs tariff was established and non-tariff trade barriers were reduced, which led to a significant increase in turnover between its members. It seems that it is the Eurasian Economic Union should become the basis for integration in the sphere of ensuring economic security due to the significant potential of its integration trio (Belarus, Kazakhstan, Russia). Moreover, not only the FSU countries, but also Iran, Moldavia, Mongolia, Tunisia, Turkey, Syria are also being considered among candidates for accession.

With open policy, in addition to bilateral agreements and integration mechanisms, the instrument of ensuring security and realizing national interests is the infrastructure construction.

It is known that new transport routes change the alignment of forces. The Baku–Supsa oil pipeline, launched in 1999, made Azerbaijan less dependent on Russia for the supply of oil to Europe. The Tedzhen–Serakhs–Mashhad railway strengthened the economic cooperation between Turkmenistan and Uzbekistan with Iran, the Karakoram Highway in China, Kyrgyzstan and Kazakhstan (Baydurin 2017).

In 2011, US Secretary of State Hillary Clinton introduced the concept of the New Silk Road on changing transport corridors in the region: the launch of the TAPI gas pipeline (Turkmenistan–Afghanistan–Pakistan–India); supply of electricity from Central Asia to Afghanistan and South Asia, etc. Thus, it was intended to reorient the transport routes from the north to the south in order to exclude Russia (Laruelle 2015).

Projects implemented on the initiative of China, also built on the allegory «Silk Road» («Economic Belt and Road Initiative» and «Sea Silk Road of the XXI century») include the construction of transport and trade corridors along the territories of China, Kazakhstan, Russia, Belarus, Poland and Germany. This project can also reduce the transit and political role of

Russia, but it also has a number of benefits for it: development of the regions where the infrastructure of the New Silk Road will be built, activation of cooperation with Asian countries, and stabilization of the political and economic situation in Afghanistan and Pakistan (Stroganov 2016).

Conclusions

In view of the foregoing, the following conclusions may be drawn:

1). Integration into regional economic blocks and their creation due to access to resources, technologies and new markets provide the former Soviet Union countries with additional opportunities for accelerated innovation development and also increase economic efficiency – the basis of economic security. At the same time, falling into the sphere of influence of other countries (groups) creates new challenges and threats, which forces to change the external and internal policies. Global regionalization as a mechanism for improving economic security is considered by most FSU countries, but in some countries – mainly in Central Asia – the emphasis is almost exclusively on threats associated with the loss of economic sovereignty.

2). In the framework of concluding agreements and integration processes, institutionalization of economic security instruments takes place, but as interaction takes place in different directions and at different levels, it is not a matter of unifying or standardizing instruments. It should be noted, that the possibility of ensuring the security of national institutions is reduced. The risks in the field of economic security often become unrecoverable, so an important component of national and transnational policies is the minimization not of the risks, but their consequences in the shortest possible time.

Keywords: Globalization, regionalization, challenges, threats, politics typology, integration, SWOT analysis.

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BACK

MUTUAL DEPENDENCE BETWEEN GLOBALIZATION AND REGIONALIZATION PROCESSES: THE CASES OF AUTOMOTIVE, ELECTRONICS AND APPAREL INDUSTRIES

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In recent decades, the restructuring of the world economy under the globalization and regionalization processes has attracted much attention of both economists and economic geographers. In most cases, the discussion takes place within the context of several competing theories. Some of them reject the very existence of globalization, other proclaim the era of hyper globalization. We analyze the effects of globalization and regionalization on three important sectors of the world economy: automotive, electronics and apparel industries. Using these industries as examples, we propose a methodology which could be used for measuring globalization and regionalization trends in the manufacturing sector. We argue that globalization and regionalization processes are not countertrends because they don't run in opposition but mutually reinforce each other. In order to demonstrate this mutual dependence, several indicators are analyzed within each of the three industries: the shares of intra- and interregional merchandise trade and the degree of regional concentration of production. As our study has shown, the growing concentration of production at the regional level increases interregional trade.

Keywords: globalization, regionalization, interregional trade, intraregional trade, automotive industry, regional concentration of production, electronics industry, apparel industry.

BACK

MAIN TRAJECTORIES OF THE FOOTBALL INDUSTRY IN THE CURRENT ERA OF GLOBALIZATION

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At the turn of the century, the world football business turned into an independent industry with a huge turnover. Football business develops in line with the processes, which are typical for other industries in the era of globalization. We can compare the leading football clubs with the transnational corporations because the international scope of their activities became more important during last years. We have developed a methodology that allows to assess the involvement of the football industry of the leading countries in the globalization process.

The study will be based on the statistics of the 5 strongest European Football League: England, Germany, Italy, France, Spain. We choose these countries for study, because they have the strongest football and the strongest football business in the world.

To assess the international component of the country's football industry, we developed and calculated the coefficient of internationalization of the football business. It consists of 4 components: the share of foreign players, the share of foreign sponsors, the share of foreign owners and the proportion of clubs with the IPO.

As our studies of the cross-border links of the leading championships have shown, there are some geographical patterns in the football transfers. For example, the players from the countries of South America prefer to play in Spain and Italy, most of African players go to France, Germany and, especially, England are international championships.

Calculations of the share of foreign players in the dynamics led to the conclusion that the international component in the football industry is constantly growing. Also, we draw a map of the intercontinental links of the leading European championships to reflect the geography of international player transfers more clearly.

The above mentioned methods made it possible to conclude that the football industry in England is the most involved in the process of globalization, while in Spain, Germany and France the international component of the football industry is less significant.

Keywords: football industry, globalization, internationalization, cross-border links.

BACK

From Water to Dust – Researching Environmental Problems in Central Asia

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FROM WATER TO DUST – THE RIPARIAN FORESTS AND THEIR CAPABILITY FOR SAND FIXATION ALONG THE LOWER REACHES OF THE TARIM RIVER, NW CHINA

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Still in the 1960s the Tarim River was flowing between the hyper-arid Taklaman and the Kuru Tag Desert to its terminal lake, the lake of Taitema. Its origin is a confluence of four rivers at the City of Aksu. From there, Tarim River flows eastward along the northern rim of the Taklamakan Desert until it changes its direction to the south, and after roughly 2,000 km the waters are seeping away in the terminal lake. The Tarim River is one of the longest inland rivers of the world.

The riparian area along the river, a ‘green corridor’, is the Chinese hotspot for cotton production. Since the 1950s, socioeconomic changes (growth in population, agricultural production and water abstraction) within the region have led to high pressure on the ecological riverine and riparian systems. Especially the lower reaches of the river are affected by these changes. From 1970 to 2000, the lower reaches dried out, and no water reached the terminal lake anymore.

This has affected the ‘green corridor’ and the endemic Tugai forests were damaged and have started to diminish. The Tarim riverbed and Taitemea Lake have turned into dusty areas, no longer separating the two large deserts. But this corridor was and is crucial for the National Highway leading north from the Chinese Inner Provinces to the Xinjiang Uygur Autonomous Region. The forests serve as shelter belt for windblown sand, which is one Ecosystem Service provided by natural and sound Tugai forests, next to biodiversity, provision of firewood and timber, educational and recreational services and others. Since the year 2000, water has been diverted episodically for ecological purposes to sustain these services and keep the riparian forest in place. Nevertheless, the riparian ecosystems are still heavily degraded, the potential for recovery is poor.

Between 2011 and 2016, parts of these topics were addressed by the German research project *SuMaRiO – Sustainable Management of River Oases along the Tarim River, China*.

Especially the subproject *Ecosystem Functions and Ecosystem Services* investigated the prevention of dust transport and the dust and sand transport itself. The ability of riparian forests to provide these services depends on their state of health and is therefore strongly related to the limiting factor water. Although the main tree of the riparian forests, the xerophytic *Populus euphratica,* can survive periods of droughts, a low groundwater level over a long period of time leads to degradation of forest stands. Degradation reduces the ability to deliver respective ESS,for example the ability to fix sand and dust from the sandy deserts in the forests. Nowadays, the sand is easily transported through the ‘green corridor’ and accumulates on the National Highway. There is a strong connection between the ESS ‘sand fixation’ and the costs for artificial reed linings along the highway.

The dependency between river water, forest vitality and the ability of sand-fixation is presented.

BACK

RECOVERY OF THE NORTH ARAL SEA: A WATER MANAGEMENT SUCCESS STORY

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The Aral Sea a large terminal lake located among the deserts of Central Asia has suffered severe desiccation, primarily at the hands of man, since 1960. Irrigation has been the main culprit. The lake's area has shrunk more than 90% over the past six decades and it has separated into four parts of various salinities that at times are connected. Severe economic and environmental damage has accompanied the drying and salinization and some popular accounts have implied efforts to save the Aral are a lost cause.

However, a major effort by the World Bank in cooperation with the Government of Kazakhstan has partially restored both environmentally and economically what was the northern part of the Aral in 1960. Known as the "Small Aral" or "North Aral" this waterbody with an area of 6118 km^2 connected with the "Large Aral" (61,381 km^2) to the south via a shallow strait. By the late 1980s, owing to a substantial level decline, the Strait had become a channel. Local authorities in 1992 constructed an earthen dike with a fixed capacity outflow control pipe to restrict the discharge to the Large Aral thereby raising the North Aral level and lowering its salinity. This substantially improved the ecologic condition of the North Aral, but was plagued by recurring breaches that required repair and a catastrophic event in 1999 that destroyed the dike.

A priority of the World Bank and Kazakhstan Government was to build an engineeringly sound dike and dam in the channel to raise the level two meters and stabilize the area around 3200 km^2. Realized in 2003-2005 at a cost of 86 million USD the project has so far been a remarkable success not only significantly improving ecologic conditions but restoring the

fishery, which has been the major factor in improving the economy and living conditions in the area adjacent to the North Aral.

BACK

EVALUATION OF THE DEVELOPMENT OF PLANE EROSION BY METHODS OF ANALYSIS OF REMOTE SENSING DATA AND MODELING

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Processes of plane erosion are developed on large areas and lead to depletion and transportation of topsoil, humus layer's loss, finely rill outwash and other linear erosion forms development, and, as a consequence, contribute to soil fertility diminishing, land degradation, risk of gully erosion developing and land-retirement.

Processes of plane washout were studied based on Akmola oblast land, major grain-growing region of Kazakhstan. High-precision methods of Shuttle Radar Topography Mission (SRTM) digital terrain model analysis, methods of remote sensing data and unmanned aerial vehicle images processing with the use of specialized units ArcGIS 10.1., ENVI 5.1., Drone2Map, etc. were used for the assessment of plain washout development's quantitative parameters. At determining of annual average soil erosion's projected calculated value (tons per hectare) with the use of model, the monitoring data set on climate, terrain, soil's composition and structure, influenced on the plain erosion development, were studied and mapped.

It was determined that the oblast's territory falls under the regions with the largest area of washed-off soils within the arable land. Plane erosion is most active on areas of finely hilled massifs' slopes and cultivated slopes of rolling and hillside watershed plains. The most activity of plain washout was detected at the south-west of Tselinograd and south-east of Arshaly regions. Also spatial-temporal development of erosion processes at the Esil and Nura Rivers' valleys was studied, for the assessment of which the underlying surface nature, true altitude, watershed slope, rivers' hydrological regime were studied. The research's results have showed the efficiency and performance of the erosion processes quantitative assessment with the use of remote sensing methods. Furthermore, it is worth noting, that sufficient supply of mentioned methods with monitoring data on climate, soils, existence of actual and accurate digital terrain

model, as well as the use of ground monitoring data on soils, let obtain more accurate assessment results.
Keywords: Akmola Oblast, Plain Erosion, Remote Sensing Data, Modeling.

BACK

PROBLEMS OF DEVELOPMENT OF SAND DESERTS ON THE MANGYSTAU PENINSULA

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The formation of blown sands is one of the consequences of the degradation of sand desert areas. Being dynamic in nature, they cause significant damage to the economy, the population, the environment. The formation of blown sands is for the most part connected with the uncontrolled increase in the use of natural resources of sand desert areas. The restoration of degraded natural systems of sand deserts is going very slow. For sustainable development of the resources of sand deserts, it is necessary to take preventive measures, to determine the conditions for the formation and development of blown sands.

On the example of the Bostankum and Tuiesu sand massifs on the Mangystau peninsula, where, since the 60ies of the last century, the processes of blown sands encroachment into populated areas and infrastructure have begun, as well as factors of the formation and development of blown sands have been studied. For the conservation and sustainable management of sand massifs, the modern state of natural and territorial complexes was studied, office and laboratory, as well as monitoring, research was conducted in order to study the quantitative characteristics of deflation processes.

On the basis of the research conducted, the results on the directions and volumes of sand flow have been obtained, the possibility of mechanical re-arrangement of the relief of blown sands to protect settlements and transport engineering facilities has been considered. The development of environmental projects, which were implemented with the participation of authors in 2004-2008, was the result of the scientific research. The projects developed a detailed action plan for fixing blown sands by applying complex methods, including stabilization of the sand surface through mechanical protection made of vegetation, geotextile and building materials, as well as by wide application of vegetative reclamation from species of local flora, the use of growth stimulators. Currently, with the support of the local population, this area is

enlisted as a forest fund of the Mangystau region. The experience of sand fixation can be successfully applied within similar in conditions sand deserts of Kazakhstan.

Keywords: Mangystau Region, Blown Sands, Wind Erosion, Combating Desertification.

BACK

CLIMATE CHANGE IMPACTS ON BIOCLIMATIC CONDITIONS AND TERRESTRIAL ECOSYSTEMS IN CENTRAL ASIA

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Understanding and planning for adaptation and mitigation of climate and environmental change is crucial to implementation of sustainable development efforts and effective environmental and biological conservation in Central Asia. Climate change is and has been on-going, and is already evident and widely observed across the region. Meteorological data series for central Asia have shown a steady increase of annual and winter temperatures since the beginning of the 20th century. We summarize the current and future projected status of a set of bioclimatic indicators and the expected impacts of climate change on bioclimatic conditions in Central Asia. Projected climate change impacts were modeled for the four Representative Concentration Pathways (RCP) spanning the range of potential emission scenarios for the year 2050, based upon an ensemble of 13 Earth System Models produced by the Coupled Model Intercomparison Project - Phase 5 (CMIP5) of the World Climate Research Programme (WCRP). Under all scenarios, our spatial analysis indicates quick and drastic change in bioclimatic conditions in the near to medium term, and predicts significant and increasing biophysical and biological perturbation for biodiversity, ecosystems and ecosystem services, and agricultural and pastoral production systems. Potential impacts include both northward shifts in mean latitude and upward shifts in mean elevation of bioclimatic zones, expansion of the warmer ecoregions into higher elevations, decreases in area of the highest elevation biomes and ecoregions, and the disappearance of habits with highly specific sets of bioclimatic conditions impacting on biodiversity and other conservation efforts. We conclude that there is now an overriding necessity to recognize the now central role of a rapidly changing climate and environment across Central Asia, and highlight the need to plan for adaptation within almost all aspects of sustainable development and conservation planning, efforts and policy.

Keywords: Climate Change, Hydrology, Geospatial Modeling, Environmental Stratification, Terrestrial Ecosystems, Agro-Ecosytems, Biodiversity Conservation.

BACK

WATER AND LAND USE IN THE FERGANA VALLEY UNDER CLIMATE CHANGE

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In the framework of the research the changes in irrigation water deficit in the Fergana Valley, Central Asia under different scenarios of climate change and water management are evaluated. The Fergana Valley is located within the Syr Darya river basin and shared between Uzbekistan, Kyrgyzstan and Tajikistan. The main driver of economic activity in the Valley is cotton farming, which consumes large volumes of water. Currently growing population influences irrigation water demand by increasing the irrigated areas by 10 - 15 % underway. However, climate change may alter projected water demand increase in the Valley. We estimated the climate-related changes in the irrigational water demand in the Fergana Valley for the 2020s, 2050s, and 2080s using future weather patterns generated with five global circulation models (GCMs) run under the A1FI, A2 and B1SRES scenarios and on the basis of GIS technologies calculated water distribution under different water management scenarios. Considerably higher temperatures and a moderate change in precipitation may lead to enhanced potential evapotranspiration (PET), which nearly doubles irrigation water demand by the 2080s. In turn, the area under persistent water deficits increasing from current 12% to 18.3% by the 2020s, 27% by the 2050s, and to 38.2% by the 2080s.

In order to mitigate negative projections the scientifically verified scheme of irrigation taking into account the quality of soils and ground water table, correction of water consumption rates for different crops, and the change of crop composition in favor of the winter horticulture plantations and cereals are needed. Within a long-term period, the radical modernization of the irrigation system will be agenda to cope with climate change in the Fergana Valley and provide region with sustainable system of water and land use.

Keywords: Climate change, irrigation, agriculture, Central Asia, Fergana Valley, water demand, cotton production.

BACK

POSTER

SOURCES AND MECHANISMS OF ACIDIFICATION OF ATMOSPHERIC PRECIPITATION IN BAIKAL REGION (EAST SIBERIA, RUSSIA)

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Elevated acidity (pH<5.0) has been registered in atmospheric precipitation and snow cover in different areas of the Baikal region for many years. Acidity of atmospheric precipitation increases in the areas away from regional industrial sources.

Acidic precipitation has been more often registered (50-60% cases with pH<5.0) at the monitoring station Listvyanka (Southern Baikal) operating within the EANET Program since2001. Elevated acidity of precipitation recorded in the south of Lake Baikal is attributed to the formation of acidic components during transport of impurities from main regional sources located in industrial cities of Irkutsk and Angarsk 70-100 km off the lake. Large coal heating plants of these cities emit over 100,000 tons of SO_2 and approximately 60,000-80,000 tons of NO_x into the atmosphere annually. The ratio of major components emitted into the atmosphere, direct measurements of oxides of sulfur and nitrogen and chemical substances in aerosols, as well as balance estimates (emission/deposition) showed that precipitation acidification in Southern Baikal is caused mainly by the formation of nitric acid. Detailed analysis of chemical composition of snow sampled from the coast and the surface of Lake Baikal performed in 2011-2017 has confirmed this conclusion.

Snow collected in the background areas of the Baikal region has low pH values (4.8-5.0) characteristic of the majority of alpine areas that are not affected by regional sources. So far the reasons and scales of elevated acidification of atmospheric precipitation have remained unclear. It is likely associated with both natural processes (deficit of neutralizing alkaline components in pure atmosphere) and long-range transport of sulfur and nitrogen oxides with air masses from large industrial sources.

This study was supported by research project No 0345–2016–0008 and RFBR, research project No. 17-29-05044.

BACK

NET ECOSYSTEM EXCHANGE IN UZBEKISTAN SEMIDESERTS

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Net ecosystem exchange (NEE) is the flux of carbon dioxide (CO_2) between an ecosystem and the atmosphere. NEE is negative when the ecosystem is acting as a CO_2 sink and positive when it is a CO_2 source. Micrometeorological methods allow to measure different air and soil characteristics at the same time and are one of the basic approaches for NEE evaluation. The purpose of our research was to estimate the NEE dependence on environmental conditions in an arid ecosystem.

Field measurements were done in wormwood semideserts in Qarnob, western Uzbekistan, from 1998 to 2001. The Micrometeorological Bowen Ratio Energy Balance System (Model 023/CO_2 Bowen ratio system, Campbell Scientific Inc. (CSI), Logan, UT, USA) was used for measuring and calculating daily air and soil temperature and moisture, solar radiation, heat flux, wind speed, precipitation, evapotranspiration, and CO_2 flux at levels 1 m and 2 m. The correlation, regression, and factor methods were used for data analyzing.

The Uzbekistan semideserts are a source of CO_2 for the atmosphere and its average flux is equal to 3,06 ± 1,12 g C m^{-2} day^{-1}. Correlations between NEE and weather conditions have been accepted: direct for air temperature and indirect for precipitations. On the base of these correlations, a regression model has been calculated. This model can predict the CO_2 flux within medium values diapason. In semideserts no more than 16% of NEE dispersion depends on climatic conditions. It has been proven that temperature is the most important factor influencing the CO_2 formation in arid climate; precipitations may change NEE from emission to short absorption probably due to an intensification of photosynthesis.

Keywords: net ecosystem exchange, carbon dioxide, Bowen ratio, Uzbekistan semideserts.

BACK

Geographers and Economists for Better Future for Eastern Russia and Japan from the Sociodemographic Perspective

- Demographic Situation And Its Perspectivesin The Russian Far East: A Case Of Chukotka

  Kazuhiro Kumo, Tamara Litvinenko

- Stability and Instability of Population Dynamics AND HUMAN Settlements in Eastern Russia: Intra-Regional and Local Differences

  Tamara Litvinenko

- Labor Markets Of Regions And Municipalities Of Eastern Russia In 2010-2015

  Evgenii Antonov

- Migration Processes In The Russian North In The Post-Soviet Period

  Evgeniy Denisov

- Indigenous People Of The North In Yakutia:Evolution Of The Settlement In The Xx Century

  Viktoriya Filippova, Antonina Savvinova

POSTER

- Social Infrastructure Of The Settlements As A Base Of Sustainable Future Of Small-Numbered Peoples Of The North (Case Of South Yakutia)

  Antonina Savvinova, Viktoriya Filippova, Gail Fondahl

BACK

DEMOGRAPHIC SITUATION AND ITS PERSPECTIVES IN THE RUSSIAN FAR EAST: A CASE OF CHUKOTKA

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The purposes of the present study are, first of all, a general review of the population migration patterns in the Far East region of Russia following the demise of the Soviet Union; and secondly, a study of the situation that emerged in the developing regions as a result of the state policy of the Soviet period, using the example of the demographic trends in the Chukotka Autonomous Okrug as one of the most distal Russian territories with respect to the center of Russia. The detailed analysis of migration trends in the Chukotka Autonomous Okrug – the region with the most dramatic reduction in population in the post-Soviet period – dramatically exemplifies the results of the state policy for regional development.

This paper is built in the following manner. The second section reviews the policy of regional development during the Soviet period; whereupon the main tendencies of inter-regional migration flows in Russia are determined from the 1990s to the 2000s — and their main differences are set apart in comparison with the Soviet period in section 3. Section 4 describes the migration flows in the Chukotka Autonomous Okrug as a whole, while the fifth section traces the processes of weakening and full closing of each separate populated locality. Although the sharp decline in population in the Chukotka Autonomous Okrug was often mentioned in various materials, few specific research has been conducted with the main aim of studying this problem.

As is well known, most of the USSR population lived in the European part of the country. At the same time, managing new territories was conducted in a planned manner toward Siberian regions, despite being situated far from large European markets. Presumably, these were attempts to determine an effective return in the policy ignoring economic principles. The resulting “return“ of such state policy of regional management is shown by the present study.

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Keywords: Chukotka; Abandoned Settlements; Resource Utilization; Outmigration; Soviet Development Priority.

BACK

STABILITY AND INSTABILITY OF POPULATION DYNAMICS AND HUMAN SETTLEMENTS IN EASTERN RUSSIA: INTRA-REGIONAL AND LOCAL DIFFERENCES

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Regional peculiarities, intra-regional and local differences in population dynamics and its link to natural resources use and ethnic breakdown of the population can be observed in eastern regions of Russia. Against the background of the general instability of the demographic situation in Eastern Russia and its regions in the 1990s and its stabilization after 2002, it is possible to observe significant differences at municipal and settlements levels. Relatively greater stability (less population decline due to lower migration outflow and no liquidated and demolished settlements) can be observed in local areas with predominantly indigenous population engaged in traditional natural resource management. The local areas with predominantly Russian people engaged in the mining industry showed the greatest instability, especially in the 1990s. The extremely unstable was the situation in mining single-industry townships, many of them have been liquidated in the period up to 2000.

The stability in the development of rural settlements of the indigenous peoples can be explained by natural factors (the presence of renewable biological resources of tundra and taiga) and ethnocultural factors (ethnic composition of the population and tendency for traditional natural resource management) within the region. On the other hand, the instability of the non-indigenous people urban settlements can probably be explained not only by natural and ethnocultural factors but also by external factors (especially national-level political and economic factors as well as global economic factors such as demand for natural resources on the world markets).

Keywords: Eastern Russia, stability, instability, population dynamics, human settlement, indigenous peoples.

BACK

LABOR MARKETS OF REGIONS AND MUNICIPALITIES OF EASTERN RUSSIA IN 2010-2015

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The study is dedicated to examine features of post-socialist transformation of local labour markets by the example of municipalities in Asian part of Russia. This process has begun in early 1990s and was intensified by several economic crises and recessions (in 1990s, in late 2000s, in the last years). This transformation has been causing an increasing socio-economic polarization in Russia at regional and local levels. An increase in territorial inequality initiated by the transformation of local labor markets creates center-peripheral imbalances (by personal income, living standards, job diversity), primarily at the regional level (between large cities, regional centers and the rest of the territory). The transformation of municipal labour markets creates stable and growing reversible migration flows (commuting labour migration, seasonal work). Thus, the transformation of municipal labour markets underlie socio-economic polarization at regional and local levels, but it has been poorly explored.

Available statistics indicates different reasons of changes in capacity and structure of local labor markets. These reasons differ by town size, industrial specialization of towns, its geographical location. Such changes as employment shrinkage in large and medium-sized enterprises, simplification of labour market structure (growth of service and "budget" sector shares), increasing role of small and medium-sized enterprises have been found in the most of municipalities.

At the same time regional centers and large cities have passed the transformation phase and have adapted to modern market economy. Thus, in these cities local labor markets are becoming extremely attractive for labour force from regional periphery.

Keywords: labour market, local labour market, eastern Russia, Asian part of Russia, commuting labour migration.

BACK

MIGRATION PROCESSES IN THE RUSSIAN NORTH IN THE POST-SOVIET PERIOD

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The negative evolution of the migration situation is typical for northern regions of Russia in the post-Soviet period. It's caused by the deterioration of living conditions during the transformational socio-economic crisis of the early 1990s. At the same time, the vast territory of the Russian North shows a considerable internal heterogeneity.

During the post-Soviet period, the territorial gradients of the migration situation changed significantly. Interregional gradients, typical for the early 1990's, were manifested in the least migratory attractiveness of cities in the Far East and in the High North and in the influx of migrants in the cities of the Southern part. During the post-Soviet period interregional gradients became weak. On the contrary, intraregional disproportions intensified: a centro-peripheral gradient of the migration situation is typical for most of the northern regions. The dependence of the migration balance of cities on their population has significantly increased.

Interregional migration is the most important component of the outflow of population from northern cities. There are regional centers and their suburbs, along with the subcentres of regions and sustainable industrial centers among the centers of attraction of intraregional migrants in the North. A concentration of population in large and medium-sized cities is ongoing.

The migration attractiveness of regional centers has significantly increased during the post-Soviet period. In many regions of the North the regional center is the only city with a positive migration growth. Northern capitals concentrate the population of small towns and rural areas of their regions and lose their population within the interregional exchange with the regions of the developed part of the country. Regional centers attract young people and have a better ability to keep people in early retirement ages.

Keywords: Russian North, migration of population, regional centers, spatial gradients.

BACK

INDIGENOUS PEOPLE OF THE NORTH IN YAKUTIA: EVOLUTION OF THE SETTLEMENT IN THE XX CENTURY

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The authors completed some of this research in association with research projects funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) on “Indigenous Territorial Rights in the Russian Federation” and by the Norwegian Research Council (NRC) on “Challenges in Arctic Governance”.

During the 20th century the implementation of various administrative-territorial divisions and the industrial development of the republic have had a significant impact on the settlement of these indigenous peoples. Five nations of numerically-small indigenous peoples of the North live in the Republic of Sakha (Yakutia). The study of literature and archival materials indicates that the territorial organization of the everyday life of these indigenous peoples depends both on administrative measures and political decisions, and – to an even greater extent – on continuity of the settlement patterns in different historical periods. The study of the evolution of the settlement of the indigenous peoples of Yakutia in the twentieth century revealed some trends and features of the spatial location of settlements: there is a decrease in the number of settlements and an increase in the population in these settlements. It is established that the main areas of settlement of the peoples have remained, but there is a decrease in the areas of settlements of indigenous peoples of the North, which were transferred to a settled way of life. This work has resulted is a compilation of a much more accurate picture of modern indigenous settlement in Yakutia, which can be used in making policy recommendations for the further sustainable development of places of traditional residence and traditional economic activities of numerically small indigenous peoples of Yakutia’s North. The results of the study will be useful for development of proposals and advice concerning the settlement of conflicts that arise over land use as well as regarding programmes aimed at the socio-economic

development of indigenous small-numbered peoples of the North and for the protection of their traditional areas of residence, and their traditional ways of life.

Keywords: settlement, Indigenous peoples, Yakutia, Russia.

BACK

POSTER

SOCIAL INFRASTRUCTURE OF THE SETTLEMENTS AS A BASE OF SUSTAINABLE FUTURE OF SMALL-NUMBERED PEOPLES OF THE NORTH (CASE OF SOUTH YAKUTIA)

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Sustainable social and economic development of regions is closely related to the improvement of people's standards of living, particularly that provided by the level of social infrastructure development. One of the biggest problems of the modern village in the Russian North is the deterioration of the social infrastructure. During the years of post-soviet reforms, rural areas have witnessed significant changes in their social infrastructure. Decay of agricultural industry, degradation of its economic performance and decrease of the government's role in addressing social problems of the countryside underpinned this deterioration. Features of rural settlement in the northern regions of Russia require distinct approaches to the formation of social infrastructure. Northern settlements are social, economic, organizational and cultural centers. Ensuring a relativey high level of quality of life for the population of these settlements is the only way for stabilizing the economic potential of these places. The quality of life significantly depends on social infrastructure conditions. Within some territories, this social infrastructure provides a life-supporting environment and, in the end, encourages the demographic and social reproduction of population. This paper analyzes the features of the social infrastructure of the Northern regions of Russia using the example of the Evenks – an indigenous peoples of Yakutia. An analysis of quantitative characteristics of social infrastructure components in Evenk settlements in Southern Yakutia, demonstrate unfavorable conditions of social infrastructure to support this people's traditional environmental

management.

The authors completed some of this research in association with research projects funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) on “Indigenous Territorial Rights in the Russian Federation” and by the Norwegian Research Council (NRC) on “Challenges in Arctic Governance”.

BACK

Geographical Challenges in Extreme Environment of Recent and Past Epochs

POSTER

- *On The Need For Studying The Spatial Organization Of Matter Flows Of Various Ranks On The Earth's Surface*

  N. Sokolova

BACK

ANTHROPOGENIC EXTREME ALLUVIATION OF THE FLOODPLAIN IN THE LAST CENTURIES

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Soil-archaeological investigations were initiated by N.Krenke on the Moskva River floodplain (Krenke et al. 2001). Overall, seven major soils aged from the Allerod period and Early Holocene to the modern period, were identified (Alexandrovskiy 2004). Analogous series of buried soils encompassing the entire Holocene were studied in river floodplain of other rivers in Russian plane (Sycheva et al. 2003) and in North America (Holliday 1992; Mandel 1992; 2008; Baker et al. 2000).

Sandy alluvium of the last millennium with an underdeveloped soil 1a(16-17th centuries) forms a modern high floodplain and covers the ancient floodplain surface (soil 2), marked with ceramics of Iron Ages and early Middle Ages.

The Late Holocene soil 2 is usually defined as an Albeluvisol, Luvisol or Chernozem. It is covered by thick layered sediments (Fig. 1-2). Its burial in the Moskva River and many other river valleys of the Russian Plain began about 800 cal BP (Folomeev et al. 1988; Sycheva 1999; 2006; 2009; Panin et al. 2001; Panin and Matlakhova 2015). Extremely high flooding and thick layers of alluvium date back to the maximum human impact in 18-19th centuries AD. Deforestation and plowing of slopes at that time led to erosion and the accumulation of the eroded material in the bottom of valleys. As a result forest vegetation on the well-developed Luvisols, which existed in the floodplain 2500-800 cal BP, was replaced by modern, mostly meadow vegetation on the young underdeveloped Fluvisols.

In the upper reaches of Don, a well-developed soil formed in the floodplain during almost the entire Holocene and was buried only in the last 200-300 years (Gonyany et al. 2007). This is corresponds to the time of the beginning of arable slope erosion in the Upper Don region

(Fig. 3). In the area of the Epiphany expansion of the Don floodplain, the burial of the forest soil with cultural layers of 12-14th and 16-17th centuries began only in the 18th century (Gorskaya et al. 2016).

Thus, in the river valleys of the center of the Russian Plain (Moskva, Oka, Don, and their tributaries), the following signs of anthropogenic origin of extreme floods are found:

A thick alluvium layer of the last millennium lying on well-developed soils indicates a previous long stage of the absence of sedimentation and stability of the floodplain surface.

Sharply intensified erosion processes on the slopes of river valleys and ravines (arable erosion) that correspond to the time of active agricultural development of the territory.

Accordingly, the landscapes of the territory change. According to soil and palynological studies, forests in significant areas were replaced by arable fields and anthropogenic steppe meadows. Subsequently, the soils underwent a process of progradation (humus accumulation, the disappearance of signs of podzolization, the appearance of molehills).

The anthropogenic origin of the extreme floods of the last millennium is confirmed by the following facts:

In the floodplain, Albeluvisols and Luvisols of the previous stage of landscape evolution are replaced by underdeveloped alluvial layered soils formed under conditions of extreme floods.

In the forest zone (the Moskva River basin), where extensive agricultural development began earlier (11-13th centuries AD), erosion-sedimentation processes also began early. To the south, in the forest-steppe (the upper reaches of the Don), due to late agricultural development, these processes began later, in the 18th century AD (Gorskaya et al. 2016).

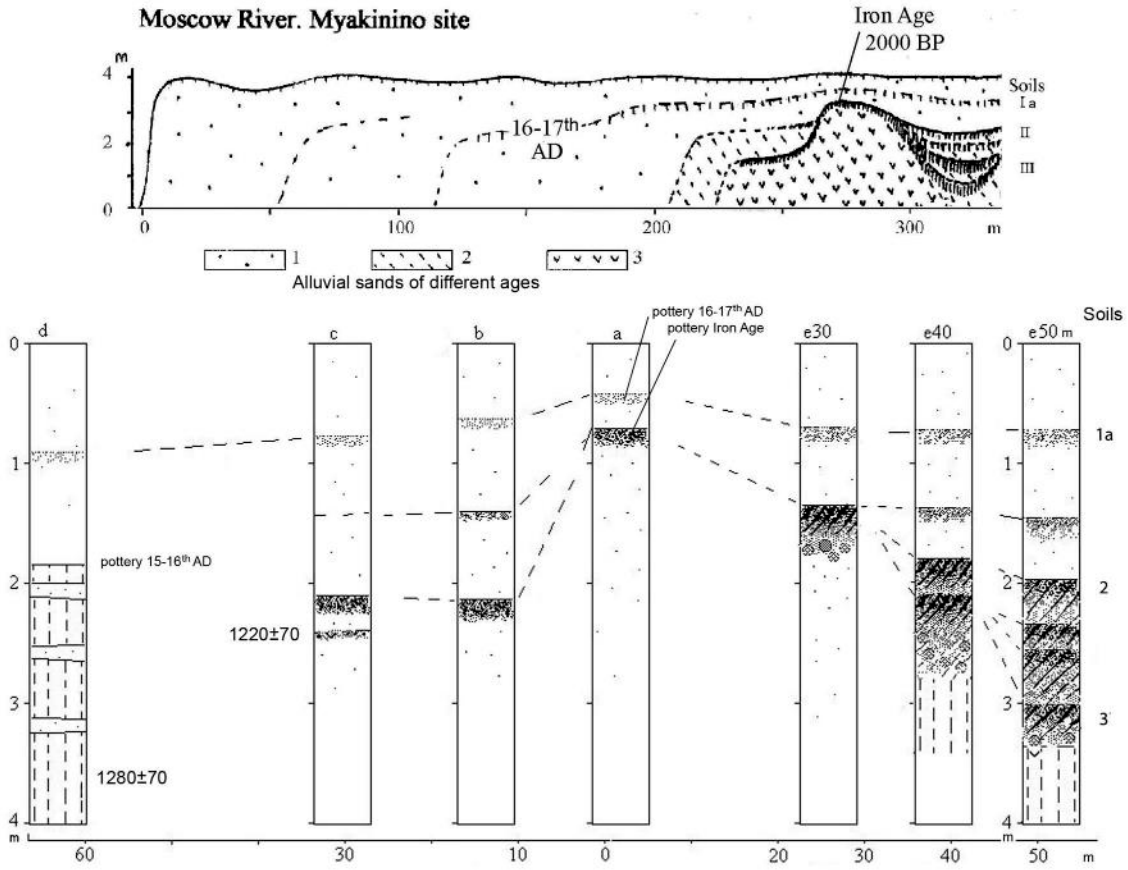

Fig.1. Sandy alluvium of the last millennium with an underdeveloped soil 1a(16-17th centuries) forms a modern high floodplain and covers the ancient floodplain surface (soil 2), marked with ceramics of Iron Ages and early Middle Ages.

Fig.2. Thick strata of the young "plowed" alluvium in the Istra floodplain. The most active processes of alluvium accumulation are dated back to the 18th century. The edge of the 17th-century soil lies at the base of the section (270 cm) (Ershov et al. 2014).

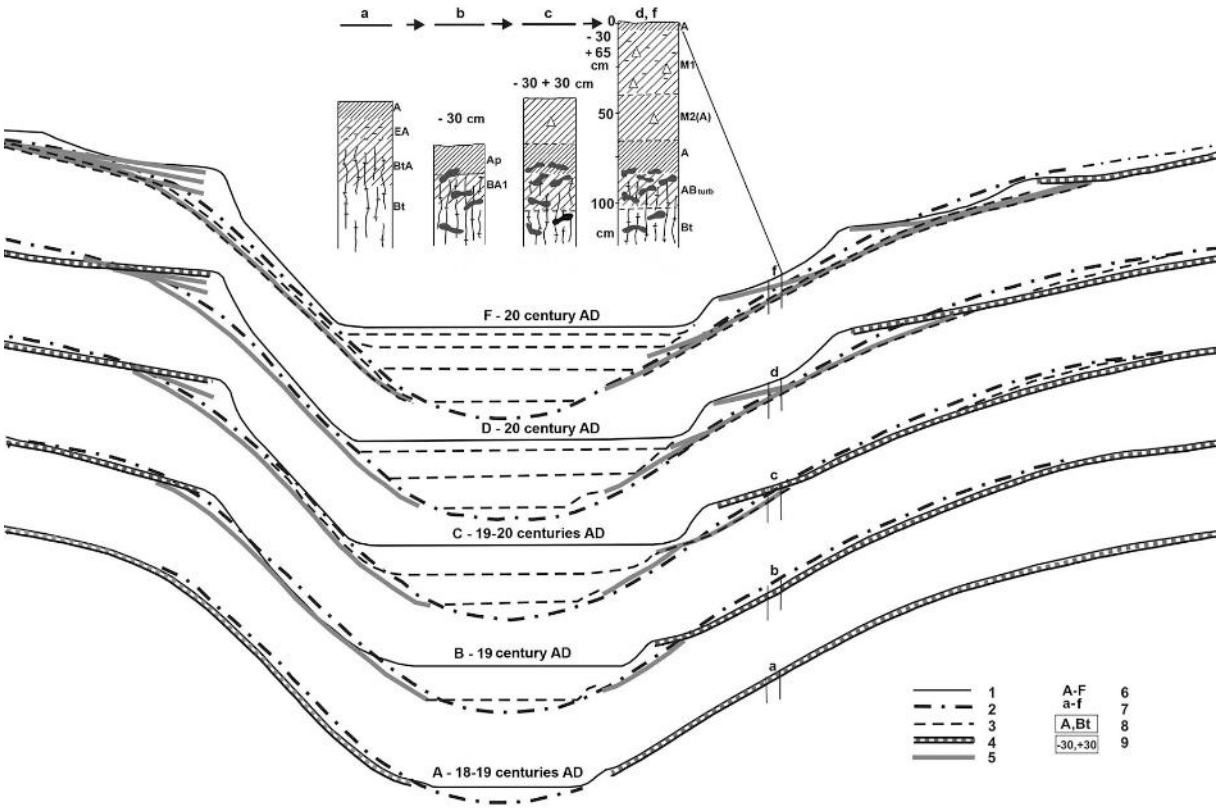

Fig.3. The development of erosion and sedimentation processes and the formation of stepped slopes of the ravine under the influence of plowing in the last 250 years (Kulikovo battlefield, ravine Sebinka). 1 – Modern surface of the ravine; 2 – the original surface of the ravine; 3 – stadial surfaces; 4 – arable horizon of the current stage; 5 – arable horizons of previous stages; 6 – stages of filling with colluvia; 7 – stages of soil development on the slopes of the ravine; 8 – soil horizons; 9 – thickness of the washed-out and/or deposited layers.

Keywords: Extreme alluviation, floodplain, anthropogenic soils.

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BACK

LANDSCAPES IN EXTREME CONDITIONS OF RECENT AND ANCIENT EPOCHS - NEW CHALLENGE FOR PHYSICAL GEOGRAPHY OF XXI CENTURY

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The existing extreme landscapes include very cold environments in Arctic, Antarctic and high mountainous areas, very dry deserts, caves, strongly changed by human activity and artificial ones. The study of the landscape processes in extreme environments can help us understanding the diversity of ecosystems in the world and the trends in their development throughout the history of the planet, and to predict possible change of landscapes. It is proposed to distinguish the landscapes of orthoextreme environmental conditions and landscapes of paraextreme conditions. Criteria of orthoextreme landscapes – weakly developed soil profiles and/or stressful state of biota and very low emission of C-containing gases from soil. By orthoextreme landscapes we understand a variety of crusts or protolandscapes (endolithic, hypolithic, certain types of rock varnish, etc.), landscapes with soils without or weakly developed humus and litter horizons which are regarded Arenosols, Nudilithic Leptosols, Regosols and some Solonchaks. Paraextreme landscapes are defined as a transition stage from orthoextreme landscapes to the common ones developing at a "structural-functional optimum". They are adequately described and studied by classical physical geography. According to the factors of extreme environment we propose to distinguish clima-extreme landscapes (especially at high latitudes and deserts, and high mountains), topo-extreme landscapes limited in development due to local relief conditions (caves, cliffs, etc.), litho-extreme landscapes limited by toxicity or low nutrients content in rocks, as well as their very poor physical properties, such as high rocky fragments content and the virtual absence of fine earth, and sedimentoextreme or briefly sedi-extreme landscapes with profiles constrained by sedimentation of aeolian, fluvial, volcanic and other material.

Keywords: extreme environment, Arctic, Antarctic, deserts, toxic substrate, sedimentation.

BACK

HIERARCHICAL ORGANISATION OF RAISED BOG SURFACE

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The analysis of the hierarchical organization of the raised bog surface (Tverskay oblast) was carried out on the basis of transect tacheometric data (1 m) and the SPOT6 image (1.62 m). The spectrum was determined using the Fourier transform. Approximation of the spectral density (SP) from period (P) is carried out according to the formula logSP =a-b*log(1/P). Fractal dimension (FD) is FD=(d-b)/2 (d is 7 for surface and 5 for transect).

Spectral analysis of the SPOT6 image showed the existence of periods in which an increase in the spectral density in the spectral residuals with its fractal dimension of 2.22, which reflects a not significant increase in the amplitudes of the reflection values with the growth of the period. Thirteen main periods with an increased spectral density are identified which are the most probable in reflecting the surface of the bog (4 m, 6 m, 9 m, 11 m, 13-14 m, 17 m, 22 m, 27 m, 30 m, 34 m, 48 m, 69 m and 160 m).

Analysis of the spectrum for the relief of the bog surface showed in its residues the presence of sixteen periods with a relatively high spectral density (3 m, 4 m, 5 m, 6 m, 7 m, 8 m, 9 m, 11 m, 13-14 m, 17 m, 19 m, 23 m, 27 m, 37 m, 54 - 75 m and a trend from 100 m) with a fractal dimension of 2, which reflects the presence of relief forms for all periods of the spectrum.

A comparison of the hierarchical organization of the surface of the bog obtained by reflecting its surface and directly measuring the relief profile shows the presence of nine common hierarchical levels (4 m, 6 m, 9 m, 11 m, 13-14 m, 17 m, 27 m, 69 m and 160 m). This shows a high correlation between the structure of reflection and the surface relief of the raised bog.

The work was supported by RFBR grant 17-05-00560.

BACK

EATURES OF VEGETATION RESTORATION IN CALDERA KSUDACH AT THE SOUTH OF THE KAMCHATKA PENINSULA

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Formation of vegetation within caldera Ksudach (Kamchatka) after 109 years from the catastrophic eruption of Shtubel cone in March 1907 is extremely uneven. The slowest recovery is in the territories where the layer of fallen tephra is maximal, the active movement of the pyroclastic cover continues under the influence of relief-forming processes - erosion, deflation, lahars and landslides and landslips forming, etc., there is a moisture deficit and there are no nearby sources of primordia plants. One of these sites is the western part of the caldera, represented by pumice desert, sparsely populated pioneer plant species and some shrubs, which still passes the initial stage of primary succession. In the rest of the inner part of the Ksudach caldera and slopes of Shtubel cone active demutational processes take place, which mark continuous step primary succession to form vegetation formed by various embodiments of integrated meadow and mountain-tundra communities with inclusion bush forms *Alnus fruticosa* and, to a lesser extent, *Betula ermanii*. Considerable participation in the overgrowth of the pumice desert is taken by small bushes and shrubs (Salix arctica, Rhododendron camtschaticum, Empetrum nigrum), which are similar in their structural and functional characteristics to pioneer herbaceous perennials. Biomorphological adaptive features of these species are as follows: short stature, high degree of branching leading to dense curtains formation and compensating desiccation of individual runaway systems, depositing along the substrate and buried in the substrate of skeletal axes, which allows plants to increase the safety of the renal pool in underground environment, more permanent by physical factors. In these processes *Pinus pumila* does not play a significant role.

This work was supported by the RFBR (project No. 18-05-00967) and on the topics of the State Administration of the IG RAS (registration No. 01201352491 (0148-2014-0016)) and IMGG FEB RAS (registration No. 115012770156 (0285-2014-0002))

Keywords: mountain-tundra communities, pioneer species, pumice desert, pyroclastic deposits, relief, geomorphological processes.

BACK

SOILS OF POST-CATASTROPHIC GENESIS

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Soils of post-catastrophic genesis represent soils, in which a continuous developmental trend was interrupted by a catastrophic event. Catastrophic events can caused by natural or anthropogenic triggers. Most soils affecting by natural catastrophess are located in mountainous areas. But most of the soils affected by anthropogenic disasters are located on the plains.

In this study, we focus on soils formed after anthropogenically induced catastrophic events. Ploughing and creating new settlements are examples of anthropogenic catastrophic triggers. They lead to abrupt changes in soil geochemistry and morphology. As a result, soils with new classification status come into being. Such changes can be irreversible, or a return to the original, pre-catastrophic classification status may take a relatively long period of time, on the average of the order of millennia.

We think that the total areas of the soils after anthropogenic disasters over the all historical period are larger then after natural catastrophes.

Keywords: soils, catastrophic, natural, anthropogenic, area.

BACK

SOILS AND LANDSCAPES UNDER LONG-TERM IMPACT OF HAZARDOUS INDUSTRIAL WASTES: CASE OF RECULTIVATED DUMPING SITE IN THE CITY OF KURSK

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Legally closed or abandoned landfills preserve high environmental risk for surrounding areas for many years after ceasing of waste disposal. Moreover in some cases even recultivated industrial waste disposal sites can use as illegal landfills. Such secondary usage of abandoned and partially restored dumping sites often followed with extraction and excavation of buried industrial hazardous wastes and overlapped highly contaminated grounds can aggravate negative environmental impact on neighboring areas. Our study focuses on the long-functioning and now legally closed waste dumping site in the city of Kursk, central part of European Russia. It was opened in the mid of 1950-s nearly south of Kursk suburbs for waste disposal from several local industries –accumulators, industrial fiber and rubber. Hazardous wastes with high heavy metal content especially Pb, Cd, Ni were stored in the small flat-bottom valley with original steppic meadow vegetation. In the 1980s this dumping site was closed and recultivated but nowadays is used for illegal industrial and municipal waste disposal.

In our research reconstruction of the whole life history of this landfill and neighboring landscapes under its impact was conducted with remote sensing data time series and repeated geochemical soil and vegetation testing. Highly detailed aerial imagery were used for monitoring spatial structure of loaded dumping site and detection of fires for the period of active waste disposal in the 1950-1970s. Time series of vegetation indexes from multispectral middle and high resolution imagery allow to detect and map the process of recultivation and restoration of vegetation cover in the 1980s, mechanical disturbances and secondary waste disposal sites in the 1990–2010s. According to the results of repeated geochemical analysis (2000–2017) of the technogenic surface formations, soils and vegetation the whole area in study is highly contaminated with heavy metals especially with cadmium. Persistable extreme high content of

cadmium in surface formations, soils and vegetation (up to thousand-fold excess above background) is connected with excavation of contaminated grounds and buried wastes and their reallocation under the secondary use of the dumping site.

Research is supported by Russian Scientific Fund, project № 14-27-00133.

Keywords: abandoned landfills, secondary waste disposal, remote sensing, heavy metal pollution.

BACK

ENDOLITHIC SYSTEMS OF EXTREME ENVIRONMENTS AS MODELS FOR THE EARLY DEVELOPMENT OF SOILS ON EARTH

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Modern subaerial endolithic systems (comprise endolithic organisms, hard rock they inhabit and in situ altered organo-mineral byproducts) of extreme environments provide the closest appropriate proxy to render the soil progenitors in Precambrian when firstly cyanobacteria and much later fungi and lichens started to colonize silicate hard rocks. Right from the times when subaerial niches on hard rocks experienced high UV-radiation levels and other stresses the porous interior of rocks was a much more secure place to sustain life also enabling better nutrient and more constant water supply. Using an actualistic approach we demonstrate that transformation of silicate rocks by endolithic organisms is one of the possible pathways for the beginning of soils on Earth. This process led to the formation of soil-like bodies on rocks in situ and contributed to the raise of complexity in subaerial geosystems through fine earth production, provision of preferential spots for further organic matter sorption and, thus, the soil cover build up. Endolithic systems of the most extreme environments on Earth lack the noise from vascular plants and are among the best available natural models to explore organo-mineral interactions of a very old “phylogenetic age” (cyanobacteria-to-mineral, fungi-to-mineral, lichen-to-mineral). We will discuss in the presentation the structure, composition and weathering mechanisms in endolithic bio-abiotic systems providing the evidence for soil-like processes that occur in these formations at both poles: East Antarctica oases and High Arctic archipelagos. Subaerial endolithic systems leave various organic and inorganic signatures in the landscape. The bleached and stained patterns are among the most prominent trace fossils. This could be the key to decrypt the record of the ancient endolithic systems on Earth.

This work has been supported by the Russian Foundation for Basic Research, Project 16-04-01776 and Russian Scientific Foundation, Project 14-27-00133.

Keywords: endolith, Precambrian, organo-mineral interactions.

BACK

FINE EARTH FROM THE GLACIO-NIVAL SYSTEM AS A SOURCE OF ORGANIC MATTER FOR SOILS OF THE SCHIRMACHER OASIS (EAST ANTARCTICA)

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Within extreme environments of Antarctic oases, where vascular plants are absent and existing plant communities have a low biological productivity, it is important to estimate how the fine earth of glacio-nival systems may contribute to the formation of soils within such oases, e.g., whether the fine earth accumulated within perennial snow patches and glaciers can act as an additional (or initial) source of nutrients for oasis soils. To help answer this question a study was conducted within the Schirmacher oasis (19 km long and 0.7-3.5 km wide) located in the centre of Queen Maud Land (Princess Astrid Coast, 70o44'-70o46' S, 11o21'-11o54'30'' E) at a distance of 90 km from the Lazarev Sea. The glacio-nival complex around oasis included perennial and seasonal snow patches, adjacent parts of the ice shelf and the Antarctic ice sheet. Samples of fine earth were taken from the following locations: (a) cryoconite holes on the glacial ice surface, (b) residual fine-earth accumulations at the locations of former cryoconite holes, where the ice sheet had melted (up to 100 m away from the edge of the ice sheet), (c) perennial snow patches (monitored by the authors for more than 10 years), (d) snow patches formed over the last year or two and (e) fine-earth accumulations from the ice shelf areas adjacent to the oasis. The samples were analysed for the following parameters: contents of organic carbon and nitrogen (CHNS analyzer), isotope composition of carbon, radiocarbon age of the organic matter (OM) from cryoconite holes and perennial snow patches (AMS dating). The data obtained on the OM properties and the radiocarbon age of fine earth within the glacio-nival system of the Schirmacher oasis allowed us to make the following conclusions: (1) the marginal zone of the Antarctic ice sheet has localized accumulations of OM with properties similar to those of OM from some soils of the studied oasis, (2) fine earth of cryoconite holes, which is being released from the melting ice sheet, acts as an important source of biogenic elements (C and N) for soils within oasis, (3) snow patches, both perennial and annual, do not act as significant carbon reservoirs within oasis, (4) cryoconite material can also serve as a

source of ancient carbon for the soils. Earlier studies by the authors have revealed that most soils and soil-like systems at this site have radiocarbon ages (MRT) of 450-500 years, but that some soils and soil-like systems with relatively low OM contents are more than 1000 years old. These new findings on the age of OM from cryoconite holes confirm our suggestion that carbon of a ‘glacial’ origin can make an important contribution to soils of the Schirmacher oasis.

This work has been supported by the Russian Science Foundation, project No.14-27-00133 and by the RFBR, project No. 17-04-01475

BACK

THE DETAILS OF CARBON ISOTOPE PROFILES FORMATION IN SOIL-LIKE BODIES UNDER THE COMMUNITIES OF PHOTOTROPS IN KARST CAVES

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Biogeochemical processes occurring in subterranean environment (caves and mines) can be defined as "extreme", because of many environmental factors are limited, absent or have specific character. In these specific ecosystems, the process of formation soil-like objects occurs as a result of interactions between the biota and the mineral layer bordering it, but this process significantly differs from soil formation on the “normal’ sun-light surface.

The method of stable isotopes allowed to characterize the features of subsurface cycles, and to study the influence of local factors on the processes of biomineral interaction. We investigated phototrophic communities (mosses, algae, cyanobacteria, ferns, vascular plants) located at cave entrances and communities that develop under the artificial cave lighting. In addition to the subsurface biomass, we studied soil-like bodies formed under the influence of cave biota which is represented by a transformed mineral rock. Several caves were selected as basic objects: limestones and gypsum, characterized by different levels of anthropogenous impact and located on the territory of Russia and bordering countries (caves: Divya, Kungur Akhshtyrskaya, Novoafonskaya, Krasnaya).

Our data showed that the stable carbon isotopes of the phototrophic communities phytomass are strongly enriched with "light" isotope 12C, probably due to the relatively closed cycle of carbon (low gas exchange with the atmosphere) in subsurface space and the repeated assimilation of carbon dioxide. This is partly reminds the so-called "canopy" effect (Brooks et al., 1997), which is repeatedly amplified in subterranean environments in comparison with land ecosystems. This hypothesis is confirmed by the trend of accumulation of the 12C isotope in phytomass and soil-like bodies with distance from the entrance of the cave, which is due to the reduction of air circulation. The change in the isotopic ratios for the deposition of the phototrophic communities phytomass (only for vascular plants) into the cave's soil-like bodies showed a shift toward saturation with a heavy 13C carbon isotope. This confirmed the well-

known regularity for soils on the surface. Probably, there are local ecosystems based on a prokaryote life where the cycle of carbon is connected with biota vitality only. In this case, the deposition of carbon in soil-like bodies could be insignificant.

Keywords: Phototrophic community, soil-like body, cave, karst, subterranean environment, carbon isotope, stable isotope, mass spectrometry, extreme environmental conditions.

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BACK

ESTIMATION OF THE ADMISSIBLE IMPACT OF ZN FALLOUTS ON THE ECOSYSTEMS OF THE CENTRAL RUSSIAN FOREST-STEPPE

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Zinc (Zn) is a priority pollutant of the biosphere and relates to elements of hazard class I. Mobile compounds of Zn have a toxic effect on the soil biota even in low doses (Kabata-Pendias 2010). The studied area is located in the northern part of the Central Russian upland and is influenced by fly ash emissions of the Schekinskaya heat power plant. To quantify the acceptable level of the exposure to Zn compounds on ecosystems the critical loads were determined by the balance equation, proposed by the European Coordination Centre for effects (De Vries and Bakker 1999; Manual… 2004). Critical loads were calculated for the humus-accumulated horizon, which is the main habitat of soil biota (Bashkin 2004). Parameters of the admissible impact include the allowable annual uptake of Zn by solid soil phases, the absorption of Zn by herbaceous vegetation and the removal of Zn from the root habitable soil layer with the downward filter flow, which have no negative ecological effects for ecosystems (De Vries and Bakker 1999; Manual… 2004; Posch et al. 1999). Zn will be accumulated in soils due to high absorption soil characteristics. It can cause the disturbance of ecosystems operation and exceed maximum permissible concentration (MPC) in soil in the future. Therefore, the maximum time limit, when the MPC in soil in case of annual addition of Zn can be achieved, was taken to be 100 years (Bashkin 2004; Manual… 2004). It is supposed that power generation technology in heat power plant will change over this period. It will reduce Zn loads on ecosystems to the environmentally safe level. The allowable uptake of Zn in solid soil phases was determined by means of the adsorption isotherm in view of achieving MPC in fishery reservoir water in the equilibrium solution. According to experimental data, obtained with sorption isotherms for investigated soils, the annual uptake amount of Zn in solid soil phases with no exceeding of MPC in fishery reservoir water in the soil solution is within 4,6 to 5,2 g/ha/year (fig. 1). The data variability relates to differences in the soil texture, the content of silt fraction and organic matter. When the concentration of Zn in the soil solution is at a level

of MPC in fishery reservoir water the removal intensity of Zn beyond the ecosystems with surface and subsurface runoff does not exceed 14,8 g/ha/year (fig. 1). The allowable accumulation of Zn in the biomass of agrocenoses crops, when the MPC excess is not observed, reaches 152 g/ha/year (fig.). It has been found that grassland ecosystems with podzolized chernozems and floodplain meadows with alluvial soils (about 20 g/ha/year) are the most vulnerable to the addition of Zn (table 1). Agrocenoses with agrochernozems are potentially capable of withstanding heavy loads of Zn (over 170 g/ha/year) due to the annual alienation of agricultural crops (table 1) (Tobratov and Solovieva 2012).

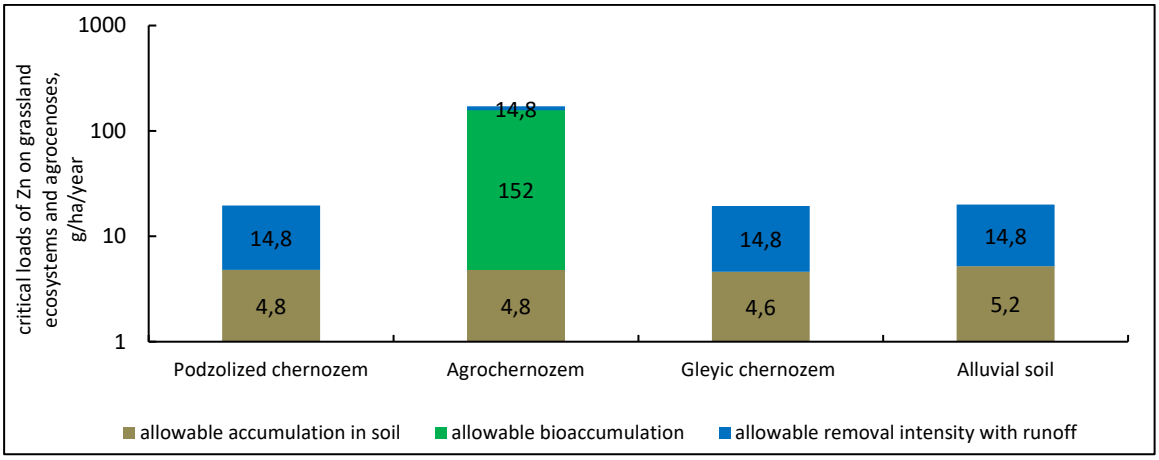

Fig. 1. The ratio of critical loads parameters of Zn on grassland ecosystems and agrocenosis

The comparison of calculated critical loads with amounts of Zn annual atmospheric fallouts in the affected area of the Schekinskaya heat power plant, which were determined by V.P. Uchvatov (Uchvatov 1994, 2009), reveals that the addition of Zn compounds to forest-steppe landscapes over a period of 1977-1991 were 11 and 95 times lower than the calculated critical loads for grassland ecosystems and agrocenoses (table), respectively.

Table 1. Critical loads of Zn on grassland ecosystems and agrocenosis

Soils /grassland ecosystems, agrocenoses	Critical loads of Zn, g/ha/year	Critical loads exceedance over Zn fallouts in the area of influence of the Schekinskaya heat power plant (number of times)
Mixed grass meadows with podzolized chernozems	19,6	10,9
Mixed grass meadows with gleyic chernozems	19,4	10,8
Agrocenoses with agrochernozems	171,6	95,3
Floodplain meadows with alluvial soils	20,0	11,1

Therefore, the emissions of the Schekinskaya heat power plant do not cause dangerous pollution of ecosystems because of their high capacity for self-purification against Zn.

Keywords: zinc, critical loads, ecosystem, fly ash, heat power plant.

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BACK

SOILS OF MOUNTAIN ULTRA-CONTINENTAL CRYO-STEPPE LANDSCAPES, SOUTH-EASTERN ALTAI: FEATURES OF EXTREME PEDOGENESIS

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We aim to study the morphogenetic specificity of mountain ultra-continental cryo-steppe landscapes' soils on the South-Eastern Altai. Three studied soils combine landscape-altitude sequence: Skeletic Kastanozems Cambic under a cryoxerophyte steppe with alpine elements (2400 m), Skeletic Cambisols Protocalcic under a cryoxerophytic steppe (2200 m) and Skeletic Cambic Calcisols Yermic under a deserted cryoxerophyte steppe (1900 m). All those soils are united within a cryoarid soil type in Russian soil classification. Soils are developed under extreme cold, ultra-continental water deficit conditions (negative mean annual air temperature, annual temperature amplitude up to 55°C, mean annual precipitation about 100-200 mm). Abundance of low-decomposed fine plant residues, silt cappings, ooid and lens-like microstructure, postshclieren texture, frost-shattered aggregates are typical features of these soils owing to cryogenic processes. Para-extreme lithological conditions (substrates contain 30-80% (by volume) coarse fragments) determine localization of pedofeatures on the surface of rock fragments.

The upper part of the soil profile (0–40 cm) is divided into 2 horizons (dark brown A and dull yellowish brown B). Both are characterized by granular microstructure, abundance of low-decomposed plant residues, silty-clayey-humus coatings on mineral grains and plant residues. Dry, weakly decomposed root felt is accumulated in the first Bk. The Bk horizons are very stony, characterized by a variety of multi-layered calcite and humus pendants on gravels and stones. Upper facets of gravels and stones are covered by cryogenic clayey-silt-sand cappings.

Key differences between three objects are as follows. The most humid object has the thickest humus horizon with well-developed structure and microfeatures related to mesofauna; the most distinct and developed cryogenic ooid aggregates in B horizons. The most arid object

has yermic properties: elements of desert pavement, and vesicular and laminated crust over humus horizon, contains carbonates all over the profile. Ferritization and carbonatisation of plant residues are maximally expressed here. The lower Bk horizons has carbonate cementation. Thus cryoarid soils are polygenetic. Bk horizons of these soils contain evidences of former intra-soil migration of carbonates and humus accumulated in the form of pendants on rock fragments, and the upper horizons contain features, which are predominantly corresponding to nowadays environment. Following soil processes correspond to a contemporary arid-semi-arid ultracontinental cold conditions: 1) accumulation of specific organic matter in A horizon; 2) biogenic micro-structuring; 3) cryogenic processes: frost shattering, frost sorting, formation of silt cappings in particular, structuring; 4) recrystallization of calcite and in pendants followed by possible short distant eluvo-illuvial redistribution of carbonates; 5) ferritization and carbonatisation of plant residues.

This study was supported by the Russian Science Foundation, project no. 14-27-00133 (theoretical foundations, field studies), micromorphological study was accomplished with support of Russian Foundation for Basic Research, project no. 17-04-01526.

Keywords: steppe soils, mountain soils, cryogenesis, calcite pendants, silt cappings, micromorphology.

BACK

POSTER

ON THE NEED FOR STUDYING THE SPATIAL ORGANIZATION OF MATTER FLOWS OF VARIOUS RANKS ON THE EARTH'S SURFACE

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Life itself challenges natural sciences with the task of obtaining data concerning the spatial organization of matter flows on the Earth's surface. This kind of information makes it possible both to reveal the regularities in changes of natural circumstances (including the climatic ones) and develop progressive technologies of forecasting and timely use of the energy found in possible negative (for human beings) processes. According to appropriate research, the entire space is filled with organized flows of structured matter of different ranks (including water). Failures of this organization produce earthquakes, tsunamis, tornados, water floods, spontaneous combustion foci, etc., and, on the global scale, the Earth's pole system may alter. The Earth's surface is a base area for interaction between oppositely directed flows: the main ones (from the outer space) and the ones depending on them (from the Earth's interior).

Any natural object is an indicator of interaction within the entire open system of matter flows. Some natural objects develop while outer space flows prevail; other objects develop while flows from the Earth's interior prevail. Using diverse experimental data, changes of natural objects were studied with due regard to fractal systems of independent matter flows in three orthogonal planes. New science based data on the role of natural objects in both global and regional systems of Earth's adaptation to changes were found. Identified were the places of interaction of flows from the outer space with the Earth's surface, zones of terrestrial matter compaction and intensification of decompaction distribution (opposing each other), channels of direct connection of the Earth's surface with the Earth's core, with the low-rank cores of matter accumulation; found out were the indicators of processes that promote either the positive development of the planet or its gradual destruction. The human race has to discover its 'niche' in the unified system of matter flows.

Keywords: adaptation systems, various-rank Earth’s changes, natural dynamics, fractal system, independent flows of Earth’s matter.

BACK

Geopolitics and regional development

POSTER

BACK

GEOPOLITICAL SITUATION AS A FACTOR IN THE DEVELOPMENT OF RUSSIA'S FOREIGN TRADE

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Recent years are marked by an increase in geopolitical tensions. The era of globalization has replaced the period of glocalization. Increasingly, armed conflicts erupt in different parts of the world. Often clashes began to occur not in the territories of the "clash of civilizations", but far from "civilizational faults". Along with information about the bloodshed, we increasingly hear in the media such words as: restrictions, embargoes, trade war.

Economic measures have always been the companions of geopolitical conflicts, however, at the end of the 20th century at the beginning of the 21st century a relative calm in their application could be observed.

A new round of trade wars is associated with the strengthening of Russia's positions in the international arena. After the war in Georgia in 2008, the annexation of the Crimean peninsula and the entry of Russian troops into Syria, the country was under the influence of a number of economic instruments on the part of mostly Western countries.

In addition to the sanctions that are directed at individuals against Russia, "sectoral sanctions" are used which imply a ban on investments in infrastructure, transport, telecommunications and energy sectors, as well as oil, gas and minerals extraction. It is forbidden to supply equipment for these sectors, as well as providing financial and insurance services for them.

In response, the Government of the Russian Federation, in addition to the sanctions lists, in 2014, declared a food embargo to the countries of the European Union, the USA, etc.

All of the above is a loud political step, which certainly has economic consequences. However, as the study showed, the impact of the geopolitical backdrop on the geography of Russia's foreign trade as a whole is not so great.

Analysis of the dynamics of Russia's foreign trade with countries that introduced sanctions and with recognized allies showed that in most cases there is no correlation between international relations and mutual trade. Today, Russia's foreign trade is virtually independent

of the geopolitical situation. Changes in commodity turnover in most cases are related to the economic situation and depend mainly on fluctuations in prices for specific goods of mutual trade.

Keywords: sanctions, trade wars, Russia's foreign trade, geopolitical situation.

BACK

GEOGRAPHY OF GEOPOLITICAL TRANSFORMATION OF THE WORLD

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In the modern world, the crisis of neoliberal globalization is observed, which is accompanied by a large-scale geopolitical transformation and the formation of new centers of economic and military-political might. The world entered the epoch of global geopolitical instability. The West, led by the United States, is gradually losing its monopoly on world domination and exclusivity. But the new geopolitical architecture of the multipolar world will be born in protracted conflicts on the fronts of the Great multidimensional civilizational spaces.

In geopolitics there are fundamental differences in approaches to international relations. Western regionalism shows an aspiration for world hegemony and expansionist liberal values. Eastern (Chinese) regionalism denies the creation of expansionist international alliances and the desire for world hegemony. China denies the postulates of classical geopolitics, is equally a sea and continental power, and opposes expansion and balance of power, offering a non-confrontational model of the world order.

The report, based on monitoring visits to large regions of the world, examines the geographic features of the geopolitical transformation of the world. The main fronts of confrontation between the key geopolitical players of the West and the Non-West in the transitional epoch of global instability are the Middle East, Eastern Europe, South-East Asia with the South China Sea, and the Caribbean region. Major events (conflicts) will occur on the Eurasian continent.

In the process of global geopolitical transformation, the absolute, not only military, but political and economic dependence of Europe on the United States was revealed. As a result of the many challenges that Europe faces (Brexit, the crisis in the eurozone, the migration crisis, the crisis in Ukraine, etc.), the EU has been surrounded by three hot fronts - Muslim Arab, Orthodox Eastern European (Ukraine) and domestic anti-Christian. At the same time, if the crisis in the eurozone split the eurozone (monetary union) geographically between the North

and South, the financial and migration crisis has drawn a line between the old and prosperous Western Europe - and the new members in the East from the former socialist lagoon.

Russia, as the longest-standing power of the world, is experiencing in the regional development a powerful geopolitical pressure from the great continental and maritime powers. Therefore, the geopolitical problem of the search for a state identity in regional development is topical for Russia.

Keywords: geopolitical transformation, regionalism.

BACK

KEEPING A DISTANCE IN THE NO-MAN'S LAND: THE DIVERGING FORTUNES OF BELARUS AND UKRAINE

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Belarus and Ukraine have a lot in common. They are East Slavic countries culturally close to Russia and situated between it and the European Union. For centuries, both Belarusians and Ukrainians oscillated between Russia and Poland until Russia ultimately gained the upper hand. Cultural proximity to Russia has long had a self-effacing effect; consequently, a craving developed to keep a "safe" distance from Russia in order to either obtain or retain a separate identity. There are, however, at least two ways of "distancing." One of them pursues the path of ethnic nationalism that emphasizes Western allegiances, establishes a divergent vision of history, and leverages anti-Russian sentiment that would be as robust and extreme as is public impression and appreciation of cultural proximity to Russia. After all, severing bonds with a close relative requires and leads to more acrimony than just parting ways with a casual acquaintance. This is the way of distancing that Ukraine has effectively chosen and is paying the price. There is, however, an alternative way invoking nationalism of civic variety that would recognize multiple versions of historical memory, bilingualism, and divergent geopolitical leanings. This is the way that Belarus seems to be cautiously embracing. The paper discusses the preconditions and implications of this type of nation building, including its immediate consequences and poses the hypothesis of Belarusianization of Ukrainian nationalism in the foreseeable future. This stands in contrast to publicized misgivings of Belarus becoming yet another Ukraine.

BACK

ECONOMIC DEVELOPMENT AND HEALTH TRANSITION IN INDIA: A SOCIO-DEMOGRAPHIC PERSPECTIVE

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The globalised world of 21st century is driven by economic growth. The relative power of nation states also depend upon the relative size of national economies. The size of country's economy is measured by GDP at purchasing power parity, which is the product of its population and its per capita GDP at PPP. In this sense, India is one of the large economies of Asia. The large population size and its growth rate offsets the economic growth. The population growth rate of recent decade reveal the stabilizing trend with decline in fertility rates in almost all states of India though with variations. The substantial fall in population growth rate in various states of India is also followed by demographic and social challenges in terms of dwindling se ratio, nutrition, and health and disease pattern. In this context, the present paper studies the spatial pattern of demographic transition vis a vis economic development in India. It further relates demographic transition with health and disease transition in states of India. Based on secondary and primary data, the paper outlines how different states with varying levels of economic development are responding to the existing social and health transition.

BACK

BANK SYSTEMS AND THEIR CURRENT STATUS WITH THREE EXAMPLES FROM THE ASIA AND THE CENTRAL- AND EAST-EUROPEAN REGION

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The Russian, Chinese and Hungarian banking systems have been facing to different problems throughout their development. Currently their regulation is quite different despite of the fact that their basic state was almost identical. Both three banking systems were built up on the model of the one-tier Russian banking system. The banking systems in the 50's were extremely strictly regulated everywhere, besides the remarkable governmental role engagement, they put up the sources primarily for the improvement of the domestic industry. The Russian banking system is currently vigorously concentrated. More than half of the entire balance sheet is given by the five largest banks and these are mostly owned by the government.

Geographically these are focused as well since more than half of the banks are located in Moscow or in its surrounding region. In the recent years the Chinese growth got less and less consistent wherein an enormous part were played by the banking system. The bank activity has been consumedly increased in China which has resulted the conception of the internationally recognized giant banks. In line with the booming of the investments the loan stock has also raised from which a substantial part came off through the unconventional banking system. With analyzing the correspondences and differences of the variant developing ways, current problems can be demonstrated and it raises questions with regards to the further regulations.

These works introduce us to the banking system of the country in detail, give us some data and describe their effects onto the economy.

Keywords: Banking system, geopolitics, Russia, China, Eurasian Economic Union.

BACK

GEOPOLITICS, IDENTITY AND SPATIAL DEVELOPMENT OF RUSSIA

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Geopolitics is a state identity that is turned to the outside. Identity reflects the ideas of future development, which take into account the experience of the past, the cultural-civilizational, social and economic identity of the state, the specificity of its history. Since 1917, Russia's identity and geopolitics have changed several times under the influence of economic and political dynamics within countries and in the external environment, causing an adjustment of state priorities and mechanisms for their achievement.

Changes in Russia's identity since 1917 pursued the ultimate goal of overcoming the backwardness of the West. In her catching up development, she could rely largely on her own strength. Excessive spending on the development of new resources and a more even distribution of the economy required the mobilization of state efforts and large casualties from the population. The raw materials sector allowed to accumulate funds for development. But extensive development in conditions of isolation from the developed part of the world could not become a reliable basis for development.

Over the past 100 years, various models of space management have been tested, reflecting the conditions of a "beleaguered fortress", a bipolar world order, a shocking attachment to Western values and sovereign democracy in a polycentric world system. In market conditions, a huge social and interregional inequality characteristic of tsarist Russia was revived in Russia. In the economy, as before, the metropolitan region dominates. For 100 years, it has not been possible to overcome the Eurocentrism of the Russian space. But today it has fairly developed inland areas and cities. A number of transport routes of world importance linking European and Pacific Russia have been built. The country has no agrarian overpopulation, but there are serious problems in the form of a shortage of human capital in quantitative and qualitative terms. Russia is making efforts to accelerate the development of the Far East and strengthen its position in Eurasia.

Keywords: Russia revolution USSR world identity geopolitics plan market transformation catching up development eastward shift.

BACK

THE RESULTS OF REGIONAL BORDER AND MIGRATION RESEARCH FROM SPATIAL AND TEMPORAL PERSPECTIVES IN HUNGARY

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National borders and border zones come into being; they are continuously growing in number, yet, at the same time, they are also being transformed under the influence of local, national and international political and economic conditions. The authors of this paper may also contribute to the research analysis of border zones by describing possibilities for social and economic cooperation and promoting a complex and interdisciplinary framework in which cooperation is likely to function.

Our point of view includes three components:

Firstly, the changing role of national borders suggests that regionalization, a result of international cooperation, may have a beneficial influence on reducing conflicts, may lead to economic wealth and a better quality of life.

Secondly, in our research Hungary's eastern and south-eastern borders -Hungarian-Serbian-Romanian - are considered, zones, which have always shown significant asymmetries.

Thirdly, in addition to outlining the problem-areas in general, it was one of our intentions, too, to introduce the 'golden age' of these regions.

In the early 21st century, due to some alterations in the country's economic and social spatial structure, the following changes occurred:

- spatial differences have become more explicit
- the model of market economy got back to the geographical space
- the opening of borders and the changing social systems of the Eastern European countries have resulted in the multiplication of cooperational possibilites in the region

- regionalism has come to the foreground in Hungary, too.

Regional problems have lately been driven into the background with migration becoming a prominent issue instead.

In relation to aspects of migration the opinions differ within the European Union. Socio-organizational principles of multiculturalism do not stabilize the operation of western-style nation-states, instead, they threaten with the development of ’parallel societies’, or, in a social sense, the emergence of ’cleft states’.

When investigating the European context of migration it can be concluded that, on the one hand Hungary represents a perfect example of Eastern European states.

On the other hand, due to its geographical location and EU membership, Hungary is a key player in migrational processes.

Keywords: borders, region, regionalism, international cooperation, migration.

BACK

POSTER
0SPATIAL URBAN STRUCTURE AS A BASE OF THE ADMINISTRATIVE DIVISION: EXAMPLE OF CROATIA

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The presentation shows the evolution of the administrative division of Croatia in XX – beginning of XXI centuries. The main pattern of evolution of the administrative division is instability of its political-territorial levels. Over the last hundred years in Croatia, there were 12 major administrative reforms, which were mainly caused by changes in the internal political and economical situation.

It was revealed that in Croatia there are 4 hierarchic ranks of the established structure of the settlement system, urban areas of influence and administrative and economic relations. These 4 ranks formed 4 hierarchic levels of political-territorial cells. 6-9 big regional centers and their areas of influence created the first rank, 21-27 small regional centers – the second rank, 87-125 big local centers – the third rank, 500-700 small local centers – the forth rank. The stability of these hierarchic ranks led to the fact that the levels of the administrative division clearly complied with them. During the administrative reforms the levels just moved from one political-territorial rank to another. Despite the reforms there is the stability of many political-territorial units of each rank.

Keywords: administrative division, Croatia, political-territorial cell, hierarchic rank, stability.

BACK

GIS: changing the culture of spatial data integration

POSTER

- *GIS Mapping Of Environmental Dangers And Risks — An Effective Tool For The Development Strategy Of The Region*

  Irina Petrova

- *Comparing The Parameters Of Erosion Gullies Based On Multi-Source Remote Sensed Images*

  Liping Chang

ABANDONED SETTLEMENTS AND PROCESSES OF SOCIAL «DESERTIFICATION»: MULTIDATA ANALISYS

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In the post-Soviet era, many territorial administrative (later municipal) units in Central Russia are characterized by a decrease of rural population because of both natural and migratory demographic processes. An insignificant period of rural population increase has been noted in the early and mid-1990s due to more active migrations, in particular an influx of people from the former Soviet republics to rural areas, redistribution of population from Asian to European Russia, and a food crisis (resulting in move of some people to rural areas for private subsidiary farming). However, a trend to concentration of population in catchment areas of large central places has resumed to the late 1990s. In these circumstances, rural settlements in the south of Central Russia as well as all local rayon-level administrative centers are less affected by depopulation while maximum decrease of rural population at the turn of the 21st century is typical for settlements of Nonblack Soil regions to the north and north-east of Moscow oblast' (province).

The main object of this research is vanishing rural settlements (villages and hamlets) which become abandoned due to various socioeconomic and physiographic (poor accessibility) factors. These settlements consist of small, mainly single-staged houses with adjoining vegetable gardens. Areas adjacent to houses are surrounded by trees and bushes, there are also other small structures such as sheds, bath-houses, etc. The number of houses in these settlements does not exceed dozens, some hamlets consist of single structures. This type of settlements has a characteristic appearance used for their identification on space images: houses range along single road (axial housing system) while gardens and vegetable plots are stretched behind the houses.

Vanishing of rural settlements is one of acute socioeconomic problems in modern Russia. Many researchers examine in details the genesis of this process and describe social and

demographic mechanisms inducing a gradual depopulation of Russian villages. It is noted, in particular, that this process was triggered in the late 1940s – the early 1950s when a course was set for an enlargement of kolkhozes (collective farms). The tendency kept on after initiating of a policy aimed at a 'prospectivity' assessment of villages in the 1960s. The trend to depopulation of rural settlements persisted up to the 1990s and was still aggravated then through a policy of 'optimization'.

Studies in rural areas are complicated through lack of real data on population number, especially on a level of individual settlements. Countryside de jure population figures include also those inhabitants, who live in towns and cities for months at a time, while neglecting holiday residents coming from urban areas, who may raise population number severalfold in the summer. The research was aimed at the development of algorithms for detecting and accounting de facto population in small villages on a base of remote sensing and statistical data.

The research was based on visual interpretation technique which rests on the theory of interpretive indicators for objects recognition on images. The theory was developed in relation to visual interpretation of aerial photos, but it remains effective to handle both space images and their digitized pictures on monitor screen. In order to interpret ultra-high-resolution images, both direct (geometrical, brightness, and structural) and indirect interpretive indicators were used.

As a result of the research, interpreted space images were obtained. They relate to areas in Central Federal District (CFD) with settlements, which are already abandoned (according to statistics and topographical maps), and which are in the process of abandoning. These results of images interpretation give most reliable information on indicators of life-sustaining activity in the settlements and on the state of buildings in them.

Just in the course of image interpretation certain classes of building clusters were distinguished due to their state, and, accordingly, interpretive indicators were specified for these classes, which should be displayed on a summary map. The state of building clusters was assessed on a base of such external morphological properties as planning patterns as well as availability and character of vegetation features.

The analysis of images of different seasons allowed to distinguish objects which stand out against a background thanks to their specific brightness and geometric patterns; that means that these objects indicate some changes. Variability and alternations, characteristic of some types of land use, refer to the fact, that they have properties which differ sharply from properties of other objects in the terrain (for example, lack of vegetation cover because of intensive

haymaking, plowing up, etc.); thus, it is a reason to classify a settlement otherwise. Just such objects as well as peculiarities of seasonal variability are especially emphasized in this work.

The use of the Earth remote sensing data allows for the conclusion whether there are indicators of human activities in a rural settlement or not. Besides that, a detailed analysis of the Earth remote sensing data permits to reveal the type of rural housing – for the purposes of permanent or recreational (dacha) dwelling – because these types make different impact on land use pattern. Nevertheless, the number of de facto population can be assessed with a certain approximation only.

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Using Internet Traffic measurement tools to map the geopolitical borders of cyberspace: a case study on the Black Sea region

Despite its appearance of technical unicity and immateriality, Internet is far from being free from political borders. Even if it does not require a visa, a packet of data sent from Paris to Moscow will take physical routes that are not fortuitous. Two elements influence the path taken by data: first, the physical shape of the network (backbones, cables, servers…). Second, the fact that the Internet is made of a multitude of smaller networks (Autonomous Systems) that are virtually connected to each thanks to agreements passed by network administrators (for instance, Internet Service Providers). On both of this dimensions (physical and virtual), geopolitical borders and conflicts have an influence on the shape of the Internet.

This paper aims to present a methodology developed to map how geopolitical situations can have an impact on the lower levels of cyberspace (infrastructures, AS, etc.). This methodology is based on two consecutive dimensions. First, the acquisition and the geolocation of data produced by third-party applications, tools and probes originally dedicated to bandwidth measurements and network optimization such as the RIPE Atlas Network or CAIDA database . Second, the cartographical analysis of such results, in the sense of Yves Lacoste's critical approach of geopolitics .

For this paper, we will focus on the Black Sea region, where we conducted a series of measures that tended to show, on one hand, how the political fractures that shape this area have an impact on the regional structure of the Internet. On the other hand, the analysis of the measures show how the lower layers of cyberspace became an area of rivalries for most of the countries in the region.

Keywords: abandoned settlements, depopulation, remote sensing, satellite images.

BACK

GLOBAL AND NATIONAL PRIORITIES OF DEVELOPMENT OF AGRICULTURAL TECHNOLOGIES IN DIFFERENT COUNTRIES: RESULTS OF BIG-DATA-AUGMENTED RESEARCH

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The paper discloses an innovative approach to identify global and national priorities of agricultural technologies development, relying on big data analysis, namely text mining augmented by syntactic analysis techniques. The analysis is based on ontology of currently emerging and globally spreading agriculture-related technologies derived from the large array of documents. The process of development of the selected technologies was decomposed in geographic order describing their diffusion patterns in different countries taking into account sub-sectoral and national particularities. The sources for the analysis were heterogeneous and include some 14 million research papers, patent applications with both full-text data and additional structured metadata, analytical reports by main international organizations and national key players, media and news resources. The tools developed for the analysis enable large-scale collection, extraction and processing of data relevant to agriculture. The results are visualized through semantic charts, or automatically generated ontologies, geographical maps and co-occurrence matrix matching technologies with countries. Thus, the most relevant topics within the studied data and their inter-relationships in geographic context are revealed, and an extensive and an objective snapshot of spatial dynamics of innovation processes in agriculture obtained.

BACK

VIRTUAL RESEARCH ENVIRONMENT FOR ANALYSIS OF BIG GEOREFERENCED CLIMATIC DATA

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Volumes of georeferenced data produced by climatic models rather soon become comparable with volumes of remote sensing data and users should be able to process and analyze those amounts of information. One of answers to this challenge to users with limited or no specific background in computer programming and processing Big Data is given by Virtual Research Environment (VRE). It allows user to run data processing and analysis though Inrernet using embedded into VRE programs and algorithms (Candela et al. 2013; Gordov et al. 2016).

Description and the first results of development of virtual computational information environment for analysis, evaluation and prediction of the impacts of global climate change on the environment and climate of a selected region is presented. The thematic virtual research environment (VRE) comprises an Internet-accessible computation and information instruments providing specialists, decision-makers and stakeholders with reliable and easy-used tools for in-depth statistical analysis of climatic characteristics, and instruments for detailed analysis, assessment and prediction of impacts of global climate change on the environment and climate of the targeted region. VRE under development provides computational processing services required in environmental monitoring, as well as presenting calculation results in the well known for geographers form of WMS/WFS cartographical layers in raster (PNG, JPG, GeoTIFF), vector (KML, GML, Shape), and binary (NetCDF) formats through relevant geoportal. Usage of the thematic VRE should facilitate integration of Big climatic Data in geography studies.

The work is supported by the Russian Science Foundation grant No16-19-10257.

Keywords: big data, beb-GIS, climate change, geoportal.

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BACK

ANTHROPOMETRIC DATA IN GEOGRAPHICAL RESEARCHES

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Anthropometric data – it is children's and adult's height, weight and theirs ratio. Adult height is strongly affected by nutrition and disease during the childhood, and affected by genetic factors during adolescence. Different researches from all over the world had shown that taller people earn more and are better educated and more satisfied with their lives than shorter people. They also experience more enjoyment and happiness, less pain and depression, and even lower blood-pressure. Moreover James M. Tanner noted that growth characteristics are the mirror of the social and economic conditions of society.

There are lots of anthropometric studies that are being held in different places and countries by biologists, physiologist and pediatricians. The main problem was to aggregate them together in order to see some geographical differences. In 2016 the work of NCD Risk Factor Collaboration was presented. This organization had collected, integrated and reanalyzed anthropometric data from 179 countries using more than 1400 surveys. The team of scientists, who were participating in collecting the data, was almost 800 people from all over the world. As a result they pooled worldwide population-based data to estimate height in adulthood for men and women born over a whole century throughout the world.

So the tallest populations live in Central and Northern Europe, and the lowest - in sub-Saharan Africa and South Asia. This relation didn't change since the century. The height of men born in Netherlands in the 1980s is 182 cm. They are 11 cm taller than theirs ancestors, who were born at the beginning of the century. Compare with the height of men born in Timur-Leste, who are 161 cm nowadays and were only 154 cm a century ago.

In Russia, the average body length of men increased by 9 cm during the century. Longitude study RLMS-HSE shows that in Russia tallest people are lived in cities, have parents with higher education and non-physical profession. Russians are higher than those who refer themselves to other nationalities. There are certain areas of tall and short stature that are reproduced from the time of research made by D.N. Anuchin about the geographical differentiation of the height of recruits at end of the XIX century.

Keywords: anthropometric data, height, weight, social and economic conditions, big data

BACK

MODELLING URBAN POPULATION DISTRIBUTION USING MULTI-SOURCE REMOTE SENSING IMAGERY AND LOCATION-BASED SERVICE NETWORKS

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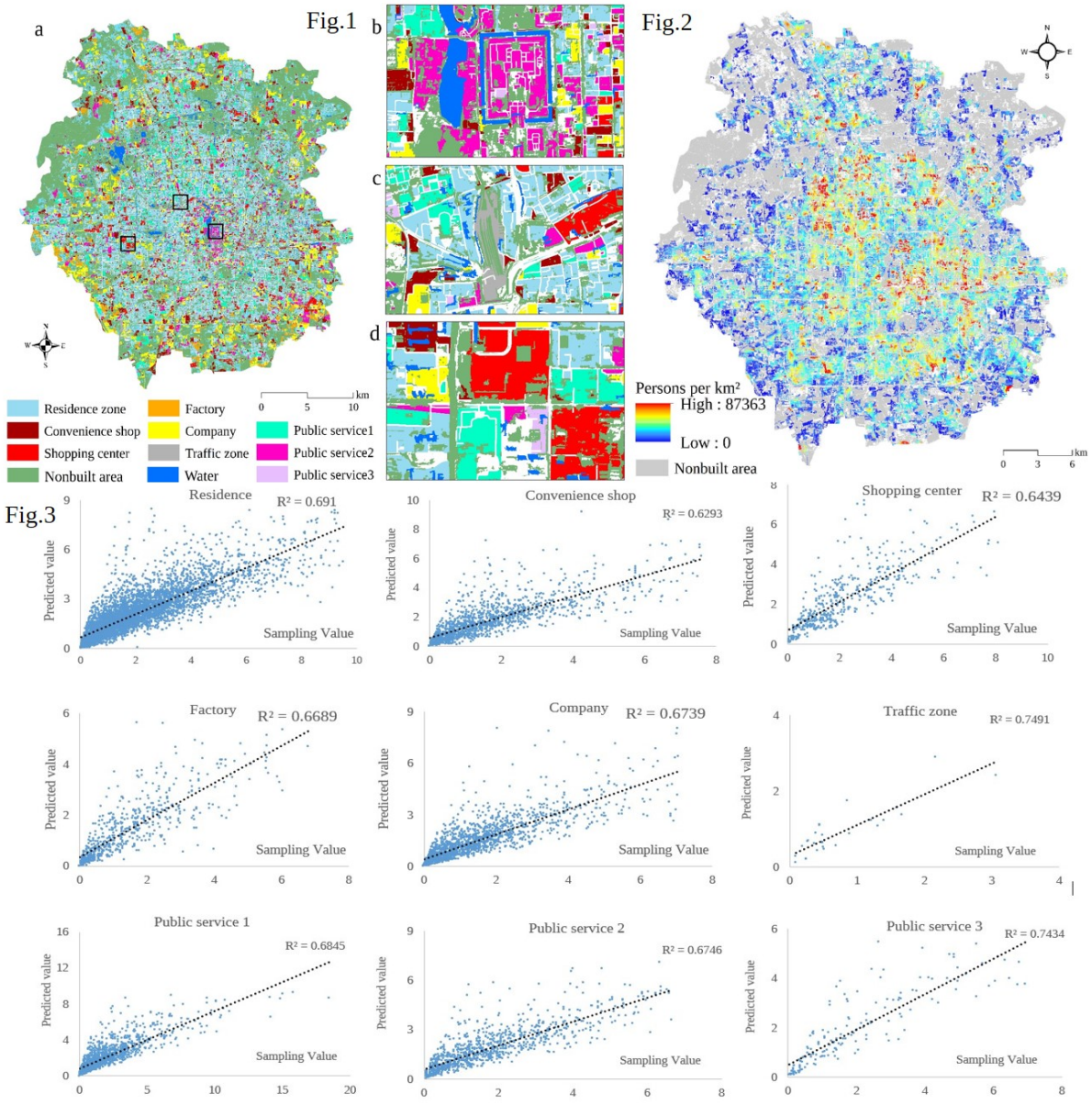
Detailed information about population distribution is essential for better urban planning. However, current population data is often limited to aggregated coarse-resolution and infrequent censuses. A fusion of satellite imagery and location-based service data (e.g., from mobile and social networks) open possibilities to provide accurate population counts and determine urban function zones (e.g., residential, shopping, business zones). By bringing an example of Beijing metropolitan area, we tested an approach to model population distribution with one-meter spatial resolution satellite imagery (Gaofen-2) and location-based data from OpenStreetMap and mobile service. Additionally, we used satellite recorded night-time lights data (NASA/NOAA Suomi-NPP VIIRS), which often serves as a proxy for economic activity and estimation of population density at an aggregated level. We also used geographically weighted regressions to detect the nonstationary spatial relationship between nighttime lights and population density acquired from the mobile service networks. Results indicated nighttime light data could estimate population density at intra-city functional zones level based on multi-source data fusion such as remote sensing and ground social data. Our geographically weighted regressions showed nighttime lights could predict population density even at finer –sub-city functional zone level and well capture across functional zones variability of the population. Developed method can be applied elsewhere, for instance, to assess population dynamic across space and time for other world urban agglomerations, such as Moscow and used for better urban planning.



Keywords: urban functional zones, population dynamics, urban planning, land use, remote sensing, big social data, nighttime lights.

BACK

ECONOMIC-ECOLOGICAL ZONING IN AQUACTIC SYSTEMS: ECOSYSTEM-BASED MANAGEMENT AS A PILLAR FOR A TRUE INTEGRATED ANALYSYS IN SOUTHERN BRAZIL

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Aquatic systems are a real challenge for zoning initiatives, given their intrinsic characteristics and the limitations of the current geographic database technologies in dealing with highly dynamic systems. Thus, this work presents a current initiative in Southern Brazil, where ecosystem-based management principles were adopted as a guide to not only propose planning units, but also to help selecting the most important information that truly should be integrated to give support to the final zoning and to the decision-making process in general. As a result, priority areas for environmental management were detected. A further step consists in the prognosis phase, where exploratory scenarios will be performed, and inter-systems process better understood.

Introduction

As GIS emerged in the 90's as the most powerful tool for environmental planning, a distorted idea of what data integration means was born: geographical data overlay started to be understood as an integrated approach. The ecological-economic zoning, an instrument of the Brazilian National Policy for Environment, is a clear example of such confusion: a forced combination of biological, physical and socioeconomic data, in a GIS environment, with no clear logic behind it, was applied in defining planning units, supposedly homogeneous areas considering a diversity of sectorial information. This analytical approach had led to endless diagnosis phases in the zoning process, where in any case (considering the 10 States where the ecological-economic zoning was already completed or is under development) the final

step of combining sectorial information to define planning units was not clear enough to be reproduced.

In the Rio Grande do Sul State, Southern Brazil, the ecological-economic zoning started in 2016. As the diagnosis phase progressed, the representatives of many sectors, understanding the zoning scenario as a stage for protecting their group interests, and in the face of an unclear impact of each diagnosis indicator in the result (the zoning *per se*), put the process in the same spiral found in other States of an ever-detailing diagnosis phase. A turning point was reached: a completely different approach was desperately needed or the whole process was fated to fail. Fortunately, it was soon enough to introduce a new way of thinking in terms of utilizing the almost 500 parameters assessed, some of then along the time: a synthetic approach. That means: planning units are no longer formed by a series of overlaying procedures, they are instead perceived as homogeneous areas considering their structure and functional attributes and then, they are characterized based on the vast sectorial information gathered during the diagnosis phase, as needed to propose directives. This core idea was finally successfully introduced as a way of conducting the work for the whole state. However, some specific areas bring an additional challenge: lagoon systems. The Rio Grande do Sul coastal zone was formed by sea level variations from Pleistocene to Recent, resulting in a significant lagoon system all over its extent. Two of them are of special concern, once they concentrate in their vicinity population and economic production: Guaíba Lake, and the Mirim-Patos Lagoon estuary system. These are the areas where the overlapping use of environmental systems reach the maximum level. And more: homogeneity perception must consider 3D aspects.

Thus, the goal of the present work is to present the environmental assessment of the Guaíba Lake, and the Mirim-Patos Lagoon estuary system, according to ecosystem-based management principles, in the context of the ecological-economic zoning in the Rio Grande do Sul State, Southern Brazil.

Metodology

Unlike typical continental environments, where geographic limits are detected and mapped much easier, and where changes do not occur so fast, aquatic systems are highly dynamic. So, limits between aquatic environmental systems are defined as a way of providing a platform to decision making and management, but it is crucial to keep in mind that they are merely an abstraction and would be much more accurately depicted as transition zones, which is not possible considering the current options of geographic databases.

To keep the whole data structure coherent with the political boundaries, the official water line was kept. To minimize the limitations that this fixed interface line cause, a buffer zone toward the continent was included, as a transition area, also making possible inter-systems analyses in the prognosis phase.

Inside the lagoon systems was considered important to distinguish, firstly, shallow waters, intermediate waters, and navigation channels. In Guaíba Lake, shallow and intermediate waters were then classified based on hydrosedimentological characteristics, that means, the predominance of erosion, deposition, or transitional behavior, based on the work of Nicolodi et al. (2010). This was specifically requested once the Guaíba lake is highly valuable for the mining sector. Mining, however, was prohibited by the Public Ministry in 2003, which required a specific zoning for the activity, given the multiple uses/beneficiaries of the lake. For the Mirim-Patos Lagoon estuary, this second classification was applied based on the geometry of the water body in relation to the predominant winds, differentiating shallow and intermediate waters in open and sheltered as well.

Once the spatial unit of analysis was defined, the assessment of 6 main themes was carried out: human uses/activites, population dynamics, overlapping uses, environmental vulnerability, environmental management capacity, and priority areas for management.

Overlapping uses and coastal vulnerability (a component of the environmental vulnerability) were analyzed based on the models of InVEST (acronym for Natural Capital Project). The technological danger was modeled in a GIS environment, considering factors of exposure and the intrinsic fragility of habits. Population dynamics assessment were based on census data, and the other themes assessed based on documental surveys. For the purpose of this work, specific methods for each theme will not be detailed, and most of them can be found in the work of Silveira et al. (2017), Possantti et al. (2017), Ribeiro et al. (2017), and Ramos et al. (2017).

Results

In the Mirim Lagoon, open intermediate waters are dominant, covering 83% of about 3.000 Km^2 of surface. In the Patos Lagoon estuary (932 Km^2 total area), this system covers about 40%, and more than 50% of the are is formed by shallow waters (about 28% consisting of open shalow waters, and 23% of sheltered shallow waters). In the Guaíba Lake, about 40% of the surface correspond to transional intermediate systems. The deposional intermediate systems are also well spread, covering about 30% of the area. Figures 1, 2, and 3 show the environmental systems in the study area.

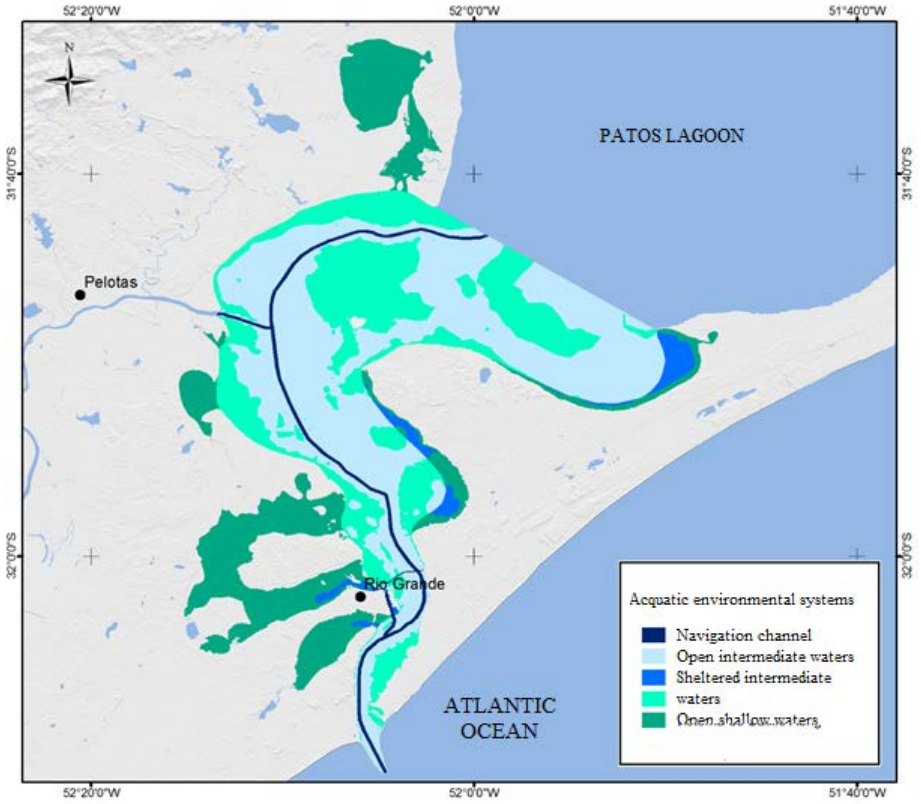

Fig. 1. Environmental systems in the Patos Lagoon estuary

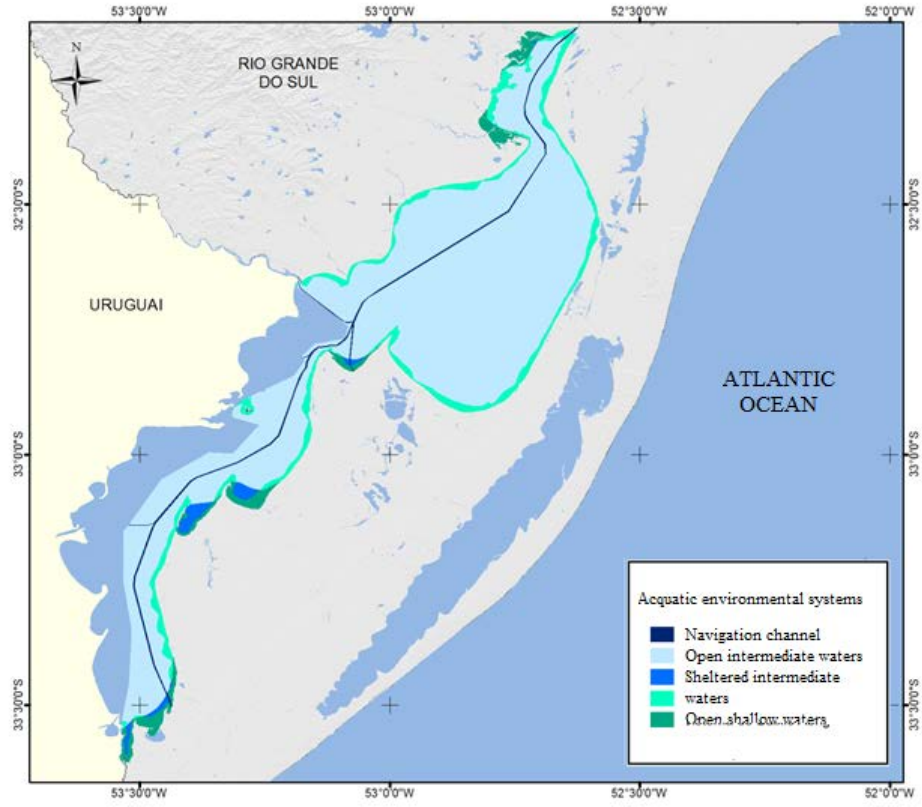

Fig. 2. Environmental systems in the Mirim Lagoon

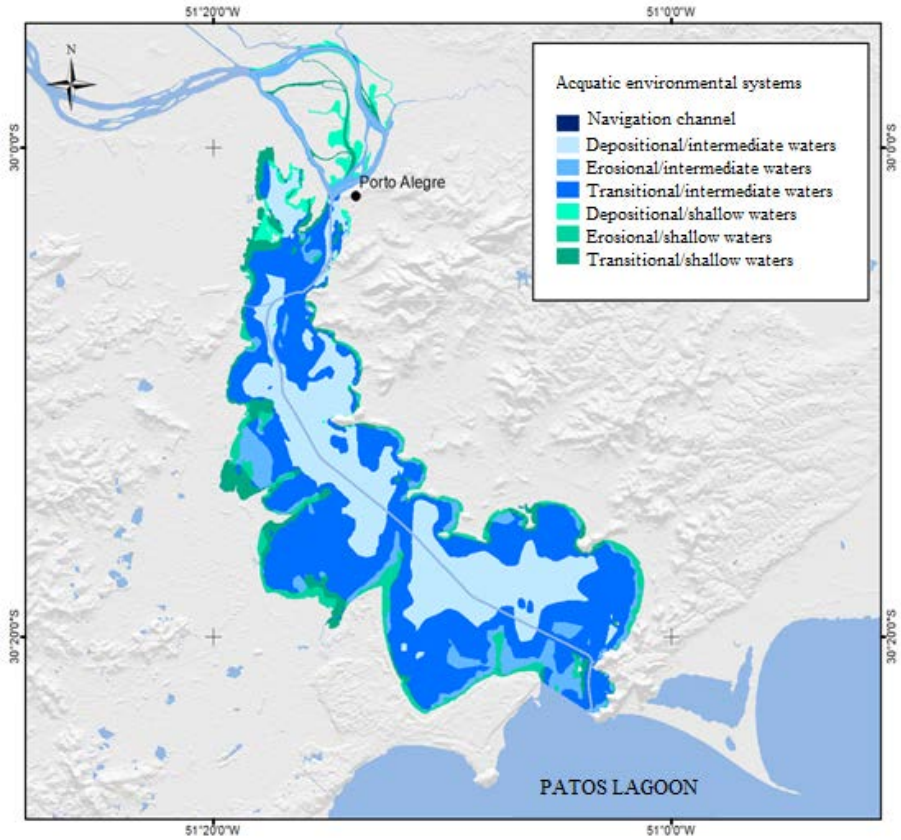

Fig. 3. Environmental systems in the Guaíba Lake

Among all three, the Patos Lagoon estuary concentrates the portions of the coast most vulnerable to a rapid water level rise. These basically coincide with the location of the most wind-exposed wetlands.

Also in the Patos Lagoon estuary, the highest population density are found. Its west coast experienced a growth of about 1000% between 2000 and 2010. And once again, the technological danger is the highest in the area, and conincide with the location of sheltered shallow waters.

Most of the conservation units in the area of Mirim and Patos have no management plan. However, all the municipalities in the vicinity are considered “licenser munipalities” (that means, capable of environmental licensing at local level).

In the Guaíba Lake, the portions of the coast most vulnerable to rapid water level rises are closed to the Jacuí Delta, corresponding to silt-sandy beaches and fragil geomorphological features associated to broader fetch areas. The most populated areas do not overlap areas with the highest coastal vulnerability, but do overlap with a high technological danger.

In terms of overlapping uses, the systems most used by human acticities are the navigantion channel and the intermediate waters, both erosional and transiotional.

In terms of environmental management capacity, it is important to enphasize that Porto Alegre, the capital of the state, with about 1,5 millions inhabitants, does not have an "exclusive" environmental zoning at municipal level (since it is part of the director plan of the municipality).

At last, given the inherent characteristics of the activities, all the three ports in the study area, even if they present good administrative indicators, it is not necessarily followed by good management indicators, for that reason must be considered as priority areas for environmental management.

Final comments

The zoning process of aquatic systems is peculiar in many ways, with emphasis on: (1) it requires the approach of specific themes, some of related to the adjacent continental areas; and (2) their boundaries and status are highly dynamic. As a consequence of the first point, it is important to say that systematic monitoring records do not reflect the reality, considering the desirable scale of assessment. Documental survey is key in this case. As well as the development of GIS-based models in the pursue of some answers related to subjects very poorly studied, such as the technological danger. As a consequence of the second point, it is important to remember that the limits of the spatial units were adopted to facilitate the decision-making based on a geographical database, but they are under the influence of winds and hydrological processes, making them move constantly.

All the pre-existing GIS-based models adopted are free. Those we created are fully reproducible, considering not only the algorithms, but also the simplicity required in terms of input data, always looking for the most effective use of available data to support the decision-making process. Both can be updated as soon as new data are available.

In the prognosis phase of the project, exploratory scenario will be performed, so that the relative importance of different human activities can be simulated, and the decisions ab

Acknowledgements

This work was funded by Codex Remote-Acquaplan-GITEC Brasil-GITEC GmbH Consortium, with resources do the World Bank to support the ecological-economic zoning of the Rio Grande State (also known as ZEE-RS Project).

Keywords: EBM, lagoon systems, environmental zoning.

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BACK

SPATIAL DATA INTEGRATION: CONVERSION OF BAD SPATIAL DATA TO IMPORTANT RESOURCE FOR DEVELOPMENT

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One of the main tasks of Geography – changing the cultures of different societies as implementation and development inside the culture the samples of actions which require the growth of knowledge about territories. In modern time the diffusion of innovations is one of the most effective ways to change the cultures. The essential part of GIS activities is to design of culture-centered innovations taking into account specific features of cultures of different societies.

As the result of spatial data integration activities in Russia (as well as in the countries in Asia, Africa, Latin America) in different areas we observe huge volumes of discrepancies between data which are integrated from different sources in GIS for decision-making and regional economic activities. This phenomenon is called "bad spatial data". Traditional culture makes you look at "bad spatial data" as barriers for development. During last 10 years we have created the conceptual approach and technological GIS solutions which convert "bad spatial data" into an important resource for the development bringing wide range of effects, especially with a short-term payback.

Our concepts and solutions have been realized in different municipalities and regions. It shows as that it is necessary to change the coulure of spatial data processing among decision-makers, lawyers, economists, geographers and IT- specialists which work for regional development. 0ne of the most suitable start point is the increasing and optimizing of incomes of local and regional budgets from land and immobility taxes. Usually during the first year the result relation "income/expenses" is from 3 to 30. So such projects are "self-financing" work. On the base of this profit we develop other linked services for business and people. This approach realizes the conditions for regional impact investing as well as the transaction costs reducing from the start point situation.

Institute of Geography RAS and The Department of Regional Economics of the Faculty of Economics of the Peoples' Friendship University of Russia are starting the intention to create the joint basic department for propagation of the mentioned decisions for students from different countries of Asia, Africa and Latin America. The goal is to create the new practical competences and propagate the decisions in different developing countries.

Keywords: GIS, spatial data integration, bad spatial data, changing the culture, regional impact investing, transaction costs.

BACK

GEOGRAPHY OF THE GLOBAL TELECOMMUNICATION TRAFFIC AT THE BEGINNING OF THE XXI CENTURY

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The newest information and communication technologies (ICTs) have shrunk geographical space and time more than ever by enabling the information – a key resource of the modern world – to overcome easily any physical barriers and state boundaries. ICTs form the global information space, where from almost every place on the Earth it is possible to communicate with almost any other place. Understanding the spatial patterns of telecommunication flows and their relationships with the socio-economic spatial structure becomes more and more critical in the modern information age (Guldmann, 2004). With this aim a study of global telecommunication traffic flows geography over the last two decades has been undertaken for different types of telecommunication traffic: Internet, voice traffic (mobile, fixed and VoIP) and traditional postal traffic.

As a result, spatial patterns of voice and Internet traffic flows revealed for the world regions, as well as a place of BRICS, the USA and other countries in these flows. Different patterns of international telecommunicative interactions revealed for different countries and regions. Geographical and geopolitical aspects of the international information security problem analyzed. Conclusions are made about a significant decentralization in a regional distribution of the Internet traffic flows over the beginning of the 21st century, as well as a diminishing profile of the USA and a rise of BRICS countries' role in the Internet traffic governance. Indicators developed, and spatial disparities in a level of telecommunicativeness and communicative openness of countries evaluated. The study revealed shifts in geography of the world telecommunication traffic over the beginning of the XXI century. The analysis has shown that the obvious trend of the latest decades is a rise in a share of the international traffic in communicative interactions conducted by the newest ICTs, and a decline in the share of the international traffic in traditional ICTs' traffic flows. Thus, when moving from traditional to the newest ICTs, a spatial scale of communication grows from mostly local to international, and international traffic is constantly migrating from traditional to the newest

telecommunications. This study expands the understanding of international integration and globalization processes in their communicational aspects.

Keywords: information and communication technologies, telecommunications, telecommunication traffic, voice traffic, Internet traffic.

BACK

DEVELOPMENT OF IDEAS ABOUT THE GIS INTEGRATION OF CELESTIAL BODIES DATA

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The cartography of extraterrestrial objects goes the way that for thousands of years traditional terrestrial cartography has taken place. This is the definition of the shape and size of the celestial body, and the choice of a mathematical surface for transferring data about the territory from the physical surface of the body, and working with incomplete rapidly changing and often contradictory data. Only all changes occur at a much higher rate and at a different level of technology development.

To date, there is a large amount of heterogeneous data for celestial bodies. GIS Integration of these data requires the creation of a mathematical and geographic basis, in particular, the derivation of cartographic projections of a triaxial ellipsoid because the International Astronomical Union added this ellipsoid to the main mathematical surfaces for approximating the physical surface of celestial bodies.

The derivation of the projections for the triaxial ellipsoid allowed us to reinterpret the formulas for the projection of an ellipsoid of revolution, which is the main approximating surface for mapping the Earth. The requirement to study the formulas of the actual cartographic projections and the formulas for their distortions is associated with new problems that arise, in particular, when transforming the cartographic images presented in a raster format. Analysis of the correspondence of formulas to the nature of the image is also useful when creating new software products and using existing ones.

The report identifies some of the problems that arise in extraterrestrial cartography, the solutions to which should be sought in the past of traditional cartography and vice versa, such questions as allow us to see the inconsistencies that arise in mapping of the Earth. A technique for deriving formulas using cylindrical projections and maps in these projections is also presented.

Keywords: GIS integration, cartography, map projections, extraterrestrial cartography.

BACK

ASSESSMENT OF FOREST FRAGMENTATION IN UTTARAKHAND, INDIA USING REMOTE SENSING AND GIS TECHNOLOGY

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Spatial pattern as well as rates of forest fragmentation were assessed using digital remote sensing data for the state of Uttarakhand in India. This state has undergone marked forest fragmentation over the period of time. Landsat 7 and Landsat 8 data has been classified to attain analyse the forest fragmentation during a time period of 15 years which is from year 2000 to year 2015. 5 tiles were required for 100% spatial coverage of the study area. Firstly unsupervised classification was performed with 85 classes and 25 iterations. Then the 85 classes were further narrowed down to 8 classes namely: Dense Forest, Open Forest, Scrub Forest, Agriculture, Wasteland, Water, Urban and Snow. Pixels of features like water bodies and snow were mixing together and hence hybrid classification was performed to differentiate between these two feature classes. Statistical filtering with median and minimum function with window size 3 X 3 was used to identify between settlements and fallow agricultural land. This helped to eliminate pixels from settlement class which were not actually settlements. Then Landscape fragmentation tools has been used to obtain the fragmentation map of the study area. There has been significant changes in the land cover categories in the time period of 15 years, in some categories one can analyse huge changes have taken place on the contrary there has been very minute increase or decrease in some classes. In total dense forest accounts for 36.82 % in 2000 which has decreased to 26.06% in 2015, there has been 10.76% decrease in dense forest. There has been 4.28% increase in open forest, while only 2.61 % increase in scrub forest category. With the help of landscape fragmentation tool the fragmentation map has been divided into 5 classes: Patch, Edge, Perforated, Core (within 250 acres), Core (within 250 to 500 acres) and Core (more than 500 acres).

Through this paper the extent of degradation of forest resource during a period of 15 years has been analysed. Therefore, a temporal study has been done. This report discusses not

only the change in forest resources and land-use/cover pattern qualitatively but also quantitatively.

BACK

TELEVISION CARTOGRAPHY AS WAY OF VISUALIZATION OF STATISTICS

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The paper discusses problems of identification of television cartography as information service. It reveals specifics of creation maps in the conditions of a television format of broadcasting and functions of the television cartography as well. According to experience of a news stream of TV-channel «Moscow 24» as source of dynamic databases the results for the spatial analysis are considered.

Keywords: television cartography, infographic, statistical data arrays, BigData.

BACK

CONCEPT OF THE ONTOLOGICAL GEOGRAPHICAL GIS MODEL

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The ontological GIS-model is created on the basis of formalized methods for calculating the indicating parameters of the ontogenetic interconditionality of structural components of geosystems. The indicating parameter adopted the magnitude of the intensity of the integrated geophysical fields formed as a result of cosmoplanetary effects. Coherent with a full spectrum of impacts, geophysical fields are visualized on the basis of information contained in the spatiotemporal structure of geosystems by the method of structural mask of energy geographic fields. A structurally similar visualization of geophysical fields is performed through the gradient fields of parameters that determine the structure of the geoobject or geosphere (for the relief they are parameters of the field of heights; for the atmosphere they are parameters of the temperature field, etc.). Structural principles of visualization of endogenous, exogenous and "real" (corresponding to the structure of geosystems) integrated geophysical fields are formulated.

The hierarchical structure of the space-time field of tectonic stresses is calculated: general – continual; background, moving tectonic blocks; Local as the result of the interaction of tectonic blocks. A model of the information-mathematical 3D geometric relief surface is developed, structurally similar to the field of tectonic stresses, with respect to which a gradient field of incoming solar radiation is constructed. Visualization of the "real" geophysical field is suggested to display the values of bioproductivity by gradient fields.

The ontogenetic connection of visualized geophysical fields with the course of geographic processes makes it possible to use their parameters as predictors of point forecasting, as evidenced by the first developed: a model of point-forecasting of time of flood onset and level (patent No. 2480825) and a model of point-forecasting of earthquakes (patent No. 2641510).

GIS is intended for: forecasting, parameterized ordination of geosystems, research of self-organization processes; construction of ecologically balanced landscapes.

BACK

THE MONITORING METHOD OF ECONOMIC FOREST IN SOUTHERN JIANGSU BASED ON THE HIGH-RESOLUTION REMOTE SENSING IMAGES

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Forest resources are essential to sustainable development of forestry, which are the basic natural resources and strategic economic resources in China. The forest informatization management of forest is an important part of current forestry development. As the main part of forestry industry, economic forest which integrates economic benefits, social benefits and ecological benefits, has occupied an important position in the development of forestry industry. In recent years, with the continuous expansion in the field of high-resolution remote sensing application, especially the improvement of spatial resolution and the application of country scale, remote sensing provides a strong support to extract, monitor and manage economic forest.

In this paper, using GF-2 which has the high resolution and GF-1 which has the medium resolution as data sources, making full use of the complementarity between multi-source remote sensing data. Meanwhile, combined with digital elevation model, forest patches, the survey data and other auxiliary information, uses ENVI and eCognition as the data processing platform of remote sensing and IDL programming language to extract economic forest. Choose southern Jiangsu as the study area, which has the features of the crushing field, scattered forest and economic forest types with regional characteristics. Establish the features knowledge set of spectral characteristics, phonological features, spatial characteristics to mining endemic information of economic forest. Then, construct multi-classification model based on pixels and image objects, respectively. To be specific, selects unsupervised classification, supervised the traditional classification and decision tree classification based on knowledge as the classification model based on pixels, uses multi-

scale segmentation algorithm and the combination of multi-level, multi-rules and multi-classifiers which are threshold classification, fuzzy classification and the nearest neighbor classification to realize oriented-object classification. Finally, from qualitative and quantitative perspectives, verify and check the classification results and the extraction accuracy of economic forest, and conclude that the best method for monitoring economic forest in southern Jiangsu is the object-oriented classification As a consequence, the paper realizes the monitoring method of economic forest in Southern Jiangsu based on the high-resolution remote sensing images. In addition, it provides a rapid, accurate and practical technical process for practical production.

BACK

POSTER

GIS MAPPING OF ENVIRONMENTAL DANGERS AND RISKS - AN EFFECTIVE TOOL FOR THE DEVELOPMENT STRATEGY OF THE REGION

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The methodology of compiling the GIS of dangers and risks was proposed. it was approved for the Kursk region. Natural, anthropogenic and natural-anthropogenic dangers affecting the development of crop production were considered. They were differentiated for real and potential dangers. On their basis, the risk of crop production was estimated. The risk was estimated through the damage from the decrease in the price of land. This indicator was given preference since it is complex, in contrast to the evaluation of yields, it takes into account such factors as pollution of agricultural land, gully and soil erosion, etc. The structure of the proposed maps is open and provides for the receipt of additional information in the form of thematic layers with an attribute base attached to them.

The proposed approach allows to study various scenarios of modeling and forecasting of danger and risk: to change the number of dangers considered; change the number of danger gradations (or portray danger continually without gradation) and their score; calculate the risk for different recipients and/or their aggregate; to vary cost (for example, market or cadastral value of land) and grade scores; zoning of the territory according to the degree of this or that danger and risk; predict the dynamics of dangers and risks.

Keywords: Environmental danger, environmental risk, GIS mapping.

BACK

COMPARING THE PARAMETERS OF EROSION GULLIES BASED ON MULTI-SOURCE REMOTE SENSED IMAGES

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In this study, based on multi-source remote sensed images including Pleiades, Spot5, GF-1, Alos and ZY-3 images and DMC aerial photos, combined with DEM data, using qualitative method, parameters of erosion gullies extracted from different remote sensed images were analyzed comprehensively. Two investigation units were selected in survey area for field verification. The erosion gullies were extracted by visual interpretation. The results showed that: (1) Pleiades and DMC could express exactly the parameters of erosion gullies for their higher spatial resolution, while time and manpower cost increased in the meantime. (2) The expression ability of each source for the types of erosion gullies are much different. Compared with Pleiades and Alos, ZY-3 and GF-1 remote sensed images are the ideal sources to extract stable gully, dissected gully and gulch gully, considering the economic cost simultaneously. (3) Comparing with the field investigation data of gullies, the parameters of number, length and width extracted based on ZY-3 AND GF-1 images approximate.

Keywords: multi-source remote sensed images; gully erosion; ideal data source; comparison methods; field investigation.

BACK

Global Studies in Human Geography

POSTER

BACK

RUSSIAN FEDERATION IN THE SYSTEM OF GLOBAL RATINGS ON THE LEVEL AND QUALITY OF TOURISM DEVELOPMENT

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International ratings play an important role in shaping the country's image nowadays. A rating place is not an end in itself but a tool for positioning a country in a system of specified, particularly economic, coordinates. The first international ratings were presented by the World Bank and the World Economic Forum (WEF) in the 1970s. Today, according to the Analytical Centre the Government of the Russian Federation, there are about 200 of them (Ershov 2017). Some of the ratings have marketing or PR nature; others are aimed at management efficiency and investment attractiveness. In addition to various targets, they also differ in methodological grounds. Despite the controversial nature of their content, methodology, statistical data collecting, processing schemes and expertise systems, they are nevertheless very helpful in recognizing development trends, identifying bottlenecks and problem areas showing prospects and opportunities.

The study focuses on the main global ratings on the level and quality of tourism development:

1) The World Tourism Organization (UNWTO) ranking by international tourist arrivals;

2) The World Council for Travel and Tourism (WTTC) ranking by tourism contribution to key macroeconomic indicators;

3) The WEF Tourism and Travel Competitiveness Index rating.

The **UNWTO ranking by international tourist arrivals** started in the beginning of 1950s. It is based on open data published regularly by national tourist administrations. Russian Federation has been represented since the early 1990s. There has been a generally positive dynamics of Russia's position in this global ranking over the last 25 years (Table 1).

Table 1 – Russia's position in the UNWTO ranking by international tourist arrivals

	Year					
	1994	1995	2000	2005	2010	2015

Rank / international tourist arrivals (million)	23/ 3,3	18/ 9,3	7/ 21,2	11/ 19,9	13/ 20,3	10/ 31,3

Source: UNWTO Tourism Highlights 1996-2016.

In recent years the growth of international tourist arrivals in Russia was caused by a range of factors. In 2015-2016 Russia's tourist market was strongly influenced by sharp fluctuations in the rouble's exchange rate against world currencies, the fall in oil prices, the ban on travelling abroad for certain categories of Russian citizens and by temporary closure of Turkey and Egypt – the most popular holiday destinations among Russians. As a result, the country had a unique situation which was extremely favourable for domestic as well as for inbound tourism development. The reorientation of outbound tourism flow to domestic destinations and the growth of inbound tourism flow are presented on Figure 1.

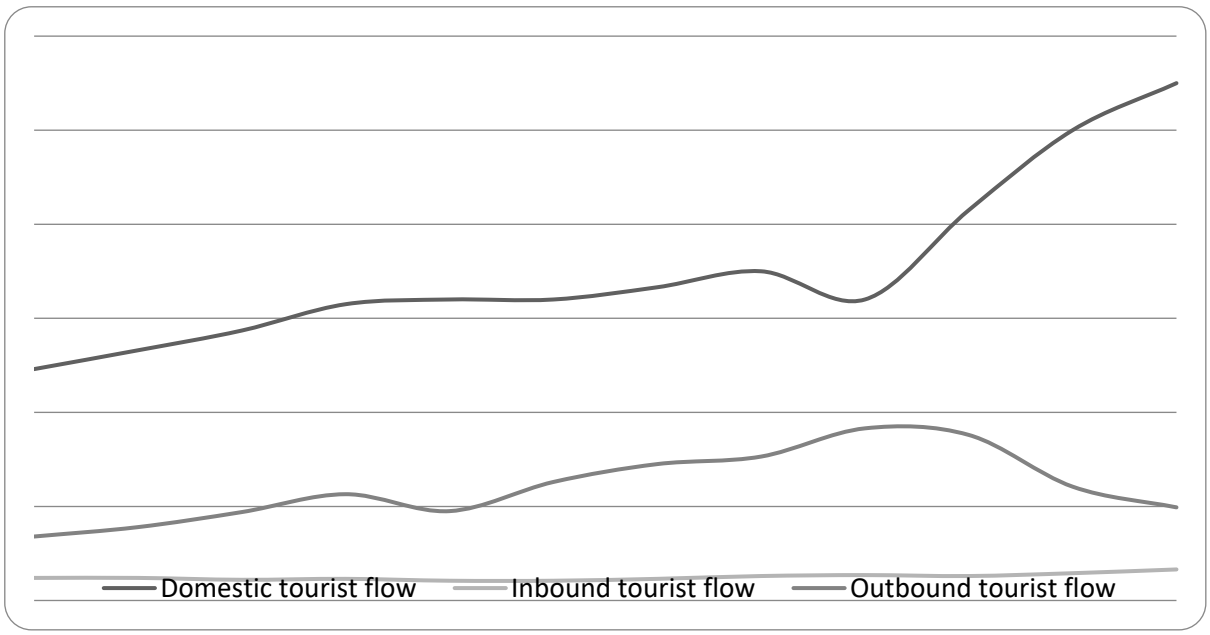

Fig. 1. Dynamics of domestic, outbound and inbound tourist flows in the Russian Federation, 2005-2016 (million trips)[1]

Sources: Russian Federation Federal State Statistics Service (ROSSTAT).

In 2015-2016 the number of outbound tourist trips decreased, and this reduction was the most significant for the last 20 years. At the same time the amount of domestic tourists, which has been stagnant for several years before, has notably increased. The shift in consumer behaviour was not only due to economic reasons, but due to patriotic rise in the society and the deployment of information and propaganda campaigns aimed at creating Russia's positive image of an attractive tourist destination («Seven Wonders of Russia» project, the launch of the

[1] The amount of inbound and outbound tourist flows is given according to the previous (up to 2014) methodology of statistical accounting in order to ensure data comparability and long dynamic series presentation.

«Russia. Travel» National Tourism Portal, «Time to Rest in Russia!» advertising campaign, etc.).

The analysis of tourism statistics over the past 20 years shows a 1.6 increase in the inbound flow to the country. In 2015-2016 the key role in the inbound tourism growth was played by the low rouble exchange rate against major world currencies. Recent active advertising campaigns abroad and the opening of «Visit Russia» National Tourist Offices in several countries also affected the situation.

Detailed inbound tourism analysis shows the activation of new, predominantly Asian markets in Russia. This trend is connected with the overall global Asia-Pacific, primarily China, tourism growth, aggravation of tensions with the West and the shift of Russian political vector to the East supported by simplified visa regime for some Asian countries. The share of Asian countries in the inbound tourist flow to Russia has increased about 5 times, from 9 to 42% in the last 20 years. Starting from 2014 China generates the biggest tourist flow to Russia.

Consequently, the UNWTO ranking by the number of international tourist arrivals reflects the changes in the spatial structure of Russian tourist market in recent years.

The WTTC ranking by tourism contribution to key macroeconomic indicators is being carried out since 1990s. Today the study covers 185 countries, 26 regions and integrated economic groups in the world (WTTC 2017). It contains the most comprehensive estimates of tourism economic impact based on Tourism Satellite Account (TSA) methodology. The WTTC ranking takes into account the number of jobs and the value-added chains produced in tourism and other industries directly supported by tourism, as well as their share in total employment and GDP of the countries. In this way, the countries are able to track their own progress in tourism, to carry out national TSA, to compare tourism contribution with other sectors of economy, to use new tools for modelling development scenarios and the effectiveness of state tourism policy assessment.

At present, the UN Statistics Division, which has approved TSA methodology, continues to assess tourism direct contribution to economy only. The WTTC acknowledges that tourism is connected with many branches of economy and has wide multiplicative effect. The Council admits that the overall tourism contribution to economy is much broader and tries to evaluate not only direct but also indirect, induced and aggregated economic impact of tourism (Travel & Tourism Economic Impact Research Methodology 2017).

In 2016 ranking by tourism contribution to GDP, employment, investment and exports (in absolute terms) Russia held high positions from 14 to 32 (Table 2). In most cases the values of indicators have exceeded the world average level substantially. However, the analysis of

macroeconomic indicators of tourism development in relative (fractional) terms shows the availability of large, unrealized reserves in Russia.

Table 2 – Russian Federation ranking by tourism contribution to key macroeconomic indicators, 2016

Macroeconomic indicator	Value		Russian Federation ranking
	World average	Russian Federation	
Travel and tourism's direct contribution to GDP (US$bn)	19,1	15,8	23
Travel and tourism's total contribution to GDP (US$bn)	57,3	62,6	18
Travel and tourism's direct contribution to employment (thousand jobs)	843,9	869,4	18
Travel and tourism's total contribution to employment (thousand jobs)	2152,9	3365,4	14
Travel and tourism investment (US$bn)	4,4	5,9	24
Travel and tourism export (US$bn)	7,6	11,4	32
Travel and tourism's direct contribution to GDP (%)	3,1	1,3	178
Travel and tourism's total contribution to GDP (%)	10,2	5,0	168
Travel and tourism's direct contribution to employment (%)	3,6	1,2	176
Travel and tourism's total contribution to employment (%)	9,6	4,7	164
Travel and tourism contribution to total capital investment (%)	4,4	2,1	171
Visitor exports contribution to exports (%)	6,1	3,5	148

Source: WTTC 2017.

The extension of value-added chains and the increase of local companies' involvement in their production are important reserves for tourism development in our country. According to the UNWTO estimates, there are 10 to 20 chains running during a seven-day stay of a visitor in a remote tourist centre. They involve 30-50 different companies from sightseeing bureaus, specialized tourist literature shops and insurance companies to souvenir shops, currency exchange points, taxis, etc. (Public-Private Sector Cooperation… 2000).

The involvement of new participants in value-added chains helps to develop multiple relationships and to form integrated partner networks between them. The exchange of knowledge, information, goods and services between enterprises in tourism and associated industries results in construction of new value-added chains and the growth of tourism contribution to the national economy. This problem can be solved within the framework of tourism and recreational clusters.

The WEF Tourism and Travel Competitiveness Index rating was developed by the WEF in cooperation with the UNWTO and WTTC with the active participation of the leading representatives of tourism industry. The WEF defines national tourism and travel competitiveness as the ability of the country and its institutions to provide sustainable development of this sphere. Special index for competitiveness assessment was made. Methodologically the index is built on 90 indicators which are combined in 14 groups and four sections (Table 3).

In 2017 the Tourism and Travel Competitiveness Index was calculated for 136 countries. International organizations' statistical data were the main sources of information; one-third of the data set was obtained through expert surveys of more than 15 thousand business representatives. The final report contains detailed profiles of every tourist destination which include details of their ranking positions as well as guidance on their key competitive advantages and disadvantages.

Table 4 – The WEF Tourism and Travel Competitiveness Index indicator groups and sectors*

<table>
<tr><td colspan="4">Travel & Tourism Competitiveness Index – 43</td></tr>
<tr><td>Enabling Environment</td><td>Travel and Tourism Policy and Enabling Conditions</td><td>Infrastructure</td><td>Natural and Cultural Resources</td></tr>
<tr><td>Business Environment – 105</td><td>Prioritization of Travel and Tourism – 95</td><td>Air Transport Infrastructure – 22</td><td>Natural Resources – 39</td></tr>
<tr><td>Safety and Security – 109</td><td>International Openness – 115</td><td>Ground and port infrastructure – 78</td><td rowspan="3">Cultural Resources and Business Travel – 25</td></tr>
<tr><td>Health and Hygiene – 5</td><td>Price competitiveness – 11</td><td rowspan="2">Tourist Service Infrastructure – 55</td></tr>
<tr><td>Human Resources and Labour Market – 46</td><td rowspan="2">Environmental Sustainability – 71</td></tr>
<tr><td>ICT Readiness – 49</td><td></td><td></td></tr>
</table>

* The indicators' values for Russian Federation according to 2017 data are given in italics.
Source: WEF 2017.

Russia is in the top third of the Competitiveness Index rating list. Despite the obvious inaccuracy of several assessments (the level of safety and security and epidemiological situation in Russia, in particular) the whole index gives a true picture of tourism development in the country.

The global community recognizes high natural and cultural potential of Russia as a tourist destination. The tourist offer competitiveness in terms of low rouble exchange rate is also favourable. However, the country does not sufficiently use its potential (the final 43rd position is between Indonesia and Turkey). The rating helps to understand the factors

hampering inbound tourism development, such as unfavourable business environment, environmental sustainability problems, low level of international openness and tough visa regime, in particular; poor quality of ground and port infrastructure.

The rating also indicates insufficient governmental attention to tourism development. Russia ranks 84th according to the share of tourism and travel government expenditures in state budget and has almost the same position on the effectiveness of marketing and branding to attract tourists. In addition, there is lacking timeliness in providing tourism and travel data. The improvement of the country's position in «Prioritization of Travel and Tourism» and «Infrastructure» sectors can be achieved through the implementation of the Federal Target Program «Development of Domestic and Inbound Tourism in the Russian Federation».

The analysis of global ratings on the level and quality of tourism development shows that Russian Federation is represented in a number of international rating systems and tourism development indices. Recently, the attempts to suggest independent tourist ratings have been made in this country. It requires raising the «rating literacy» in travel and tourism specifically, raising awareness of a wide range of travel and tourism stakeholders about the most important approaches to composition and application of tourist ratings. It helps to create conditions and incentives for improving rating methodology and turning ratings into effective tools for tourism development in Russia.

Keywords: tourism, global ratings, competitiveness, Russian Federation.

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BACK

INTERNATIONAL MIGRATION AND ITS GEOGRAPHICAL IMPLICATION

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When did the modern era of international migration start? Some say it began just after the Second World War or in the 1960s. Tackling this problem one should take into account both geographical and non-geographical criteria. As far as geography is concerned radical transformation of intercontinental migration started in the late 1950s and finished in the 1960s. Since that time Europe has begun to attract numerous migrants from Africa, Asia and Latin America. But international migration still remained in the state of decay. Only after 1970 the long-term rise of immigration started in the U.S.A. and even later, after 1975, the share of international migrants in population began to grow steadily on the world scale.

On the basis of the UN statistics the main "suppliers" of migrants to the countries of Western Europe have been determined as well as geographical shifts in the origin of migrant population that have taken place during the last quarter of a century. As discovered by the author, there have been two waves of migration directed to the European core countries and originated initially in Southern and then in Central and Eastern Europe. An unprecedented transformation of the structure of the US population coursed by the inflow of migrants from Latin America and Asia is also described.

The size and scale of chief global migrant flows (South-South, South-North, etc.) are also analyzed. It is noted that asynchronous demographic transition in the world regions has a comparatively limited impact on international migration. The report studies migrants' remittances to the homeland that are second only to foreign direct investment and play an especially important role in developing economies and in the world financial system as a whole. According to the research conducted by the author, the contribution of international migration to the world economy far exceeds the proportion of migrants in the population of the Earth.

Keywords: international migration, geography of migration, demographic processes, migrants' remittances.

BACK

GEOGRAPHY OF THE GLOBAL TELECOMMUNICATION TRAFFIC AT THE BEGINNING OF THE XXI CENTURY

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The newest information and communication technologies (ICTs) have shrunk geographical space and time more than ever by enabling the information – a key resource of the modern world – to overcome easily any physical barriers and state boundaries. ICTs form the global information space, where from almost every place on the Earth it is possible to communicate with almost any other place. Understanding the spatial patterns of telecommunication flows and their relationships with the socio-economic spatial structure becomes more and more critical in the modern information age (Guldmann, 2004). With this aim a study of global telecommunication traffic flows geography over the last two decades has been undertaken for different types of telecommunication traffic: Internet, voice traffic (mobile, fixed and VoIP) and traditional postal traffic.

As a result, spatial patterns of voice and Internet traffic flows revealed for the world regions, as well as a place of BRICS, the USA and other countries in these flows. Different patterns of international telecommunicative interactions revealed for different countries and regions. Geographical and geopolitical aspects of the international information security problem analyzed. Conclusions are made about a significant decentralization in a regional distribution of the Internet traffic flows over the beginning of the 21st century, as well as a diminishing profile of the USA and a rise of BRICS countries' role in the Internet traffic governance. Indicators developed, and spatial disparities in a level of telecommunicativeness and communicative openness of countries evaluated. The study revealed shifts in geography of the world telecommunication traffic over the beginning of the XXI century. The analysis has shown that the obvious trend of the latest decades is a rise in a share of the international traffic in communicative interactions conducted by the newest ICTs, and a decline in the share of the international traffic in traditional ICTs' traffic flows. Thus, when moving from traditional to the newest ICTs, a spatial scale of communication grows from mostly local to international, and international traffic is constantly migrating from traditional to the newest

telecommunications. This study expands the understanding of international integration and globalization processes in their communicational aspects.

Keywords: information and communication technologies, telecommunications, telecommunication traffic, voice traffic, Internet traffic .

BACK

THE NEW NONSTRICT INVARIANT IN THE WALTER CHRISTALLER'S CENTRAL PLACE THEORY

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One of the postulates of the central place theory is the assumption of a constant *k* parameter – proportionality factor relating a city population to the total population served by that city – at all levels of the Christaller's hierarchy. Nevertheless, we did not find a rigorous proof of this assertion (underlying the Beckmann-Parr equation) in the bibliography on the central place theory. If this postulate is assumed true, it also remains unclear – whether for all or only for strictly defined *k*-values.

We have established that if the chosen *K*-value of the Christaller's hierarchy is constant at every lattice level, the Beckmann-Parr equation holds for all meaningful values of *k* – that is potentially for $k \in (0; 1)$. At the same time we found that the range of *k*-values for an ideal Christaller's lattice is bounded above by not an asymptote at $k = 1$, but an exact almost twice smaller value equal to $K - \sqrt{K^2 - K}$. Since the latter changes very slightly during a radical rearrangement of the lattice from $K = 3$ to $K = 7$, we can state that we have discovered the new nonstrict invariant in the central place theory – the maximum value of *k*.

Keywords: central place theory, proportionality factor relating the population of a city to the total population served by that city, constancy, maximum value, nonstrict invariant.

BACK

THE IMPACT OF RELIGIOUS COMPETITION ON THE AFRICAN RELIGIOUS LANDSCAPE IN THE 20TH – BEGINNING OF THE 21ST CENTURIES

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The redistribution of major religions during the 20th century caused the transformation of global religious landscape. Christianity and Islam were the most dynamic in terms of their religious landscapes shifts. Over the course of the past century their demographical centers were drifting to the south towards Africa. Due to the high rates of demographical growth and the wide field for missionary activities (especially in Sub-Saharan Africa), the Black continent sought world religions attention (and still does). The activation of world religions led to a dramatic decrease of ethnic religions share in the region's population. Concurrently, a growing competition between Christianity, Islam, their denominations and versions, and some ethnic religions took the form of political, social, cultural, economical, and even violent conflicts.

We propose a modified religious diversity index as basic identifier of the religious landscape structural changes. It allowed us to propose the four-phase model of religious competition cycles: initial religious replacement (RR_0), sustainable replacement (RR_1), religious parity (RR_2) and final replacement (RR_3). Revealed, that the religious landscape of the majority states in Africa passed transformation which resulted in replacement of ethnic religions with Christianity or Islam. The exceptions are the states of North Africa, Somali and Djibouti which were predominantly Muslim during the whole period under review; Madagascar and Togo where religious landscape is still characterized by the parity of ethnic religions and Christianity; and Guinea-Bissau which is preserved in the phase of the parity between Islam and ethnic religions for more than a half-century.

Keywords: modified religious diversity index, model of religious competition cycles, Africa.

BACK

GEOGRAPHY OF FOREIGN DIRECT INVESTMENT IN MODERN WORLD ECONOMY

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The modern stage of the globalization of the world economy is marked by a rapid increase in the export of capital in the form of foreign direct investment (FDI) and their accumulated volumes, and the expansion of the geography of the investment process. Foreign direct investment grew rapidly with significantly greater rates than the dynamics of economic growth. The ratio of global FDI to the gross world product for 35 years has increased 5-fold from 6.2% in 1980 to 35% in 2016.

The global "web" of investment interrelations is a multilevel hierarchical structure, ordered both at the intercountry and interregional levels, as well as within the global centro-peripheral system. Each country and territory is involved in a variety of FDI-relationships of different types of hierarchy and grades of dimension. There is a noticeable asymmetry in the spatial structure of foreign direct investment. It manifests itself in the division of countries and regions of the world into net exporters and net importers of capital in the form of FDI, in varying degrees of territorial concentration of accumulated exported and imported FDI, in the opposite trends of the spatial distribution of gross and specific indicators of accumulated FDI by countries of the world.

Basis of the global investment system forms a triad of Europe – Asia – North America, which accounts for 91-92% of accumulated foreign direct investment in the global economy with the core accued to Europe.

One of the major elements of geography of FDI is offshore jurisdictions. Their role is significantly increased in the processes of foreign direct investment. The main FDI partners of the majority of developing countries are offshore jurisdictions. All these indicate the existence of so-called round-tripping FDI that accompanies the development of many emerging economies.

Keywords: foreign direct investment, globalization, transnational corporations

BACK

CHANGES IN THE SILVER CONSUMPTION IN THE WORLD ECONOMY OVER THE END OF XX – THE BEGINNING OF XXI CENTURIES

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Considerable changes have occurred in the structure of the global silver consumption over the past two decades. The growth in volumes of metal use in some economic sectors and the drop in demand for it in others were caused by many factors.

Industries that use silver can be divided into two groups: the first are interested in silver because of its physical and chemical properties; the second are based on its precious and hoarding features (though they are also caused by the basic properties of the metal). Unlike gold, for silver the first ("technical") use prevails. However, the ratio between these two groups has been reaching equality in recent years.

Each group is characterized by its own factors and patterns that cause the modern changes. The development of the first group industries is mostly lead by scientific and technological progress. Here, electronic and electrical industries are leading by consumption of silver. Also the first group includes the production of brazing alloys and solders, the growing photovoltaic manufacturing and the "fading" photofilm industry.

In the latter group of industries, a principal factor of development is the market conditions in the world economy and the metal prices, which depend on these conditions. The second group industries include the jewellery, the silverware production and the manufacturing of silver coins (mostly, bullion). And these industries respond differently to the same factor.

The study has shown that the development of the industries' territorial structure is generally subordinated to the spatial evolution of the world economy and the global value-added chains. The latest significant shifts in this sphere include the continued silver consumption increase in China (in different industries), the loss of the US leadership, the post-recession recovery of silver use in India. However, some industries of silver consumption have undergone only small changes in their territorial structures (for example, the coinage); almost no spatial changes revealed in the photofilm industry.

BACK

SOLAR ENERGY COMPLEX: SPECIFICS OF ITS TERRITORIAL ORGANISATION

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Solar energy is one of the most rapidly growing industries of the world energy complex. Great potential for solar energy development is attributed to such global factors as the need to ensure national energy security, growing concern about the environmental consequences of the use of fossil energy sources, active innovative activity in the field of alternative energy sources etc.

This study is dedicated to the comprehensive geographical analysis of world solar energy, in which special focus was given to its territorial organization, a new term was devised – solar energy complex – that allowed to carry out a classification of countries based on the specifics of its development.

The development of the world solar energy complex is accompanied by its spatial expansion. If in the early stages of the development of solar energy its territorial structure had a pronounced "euromonocentric" character, the now happening process of the emergence of new poles of growth has led to the appearance of a polycentric model of its territorial structure. In this model three main centers are distinguished: European - led by Germany, Spain, Italy and, Great Britain; American with the United States and Asian - where the main poles of growth are two countries - China and Japan.

This research revealed that nowadays the most important feature of solar energy complex territorial development is its rapid development in Asian countries, so to say “Eastern drift”. During the period 2012-2015 share of Asian countries in the world photovoltaic capacity increased from <20% to 38%, and in solar thermal power - from 68% to 74%, while the share of European countries fell significantly from 69% to 42% and from 17% to 11%, respectively. A similar change in the “development vector” was observed in the production of components and equipment for the industry, as well as in the service sector (design, monitoring, advertising, etc.), i.e. in sectors where often the same companies operate.

Keywords: renewable sources of energy, solar energy complex, territorial organization

BACK

EVOLUTION OF INDIAN FEDERALISM: PROPOSED STATES

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According to the official definition, India is a Union of States: a federal union with a complex system of interactions in the sphere of socio-economic development of the country as a whole and its certain regions. India has the most diverse national-linguistic and confessional population structure in the world. Though Hindi and English are official languages of India, some 450 languages are spoken in the country; among them 22 are official regional languages. In addition each state has its own official language.

Socio-economical development of India, the formation of nations and consolidation of peoples were followed by the evolution of its administrative-territorial structure, which currently includes 29 states and 7 union territories established at the beginning of the 21st century. Although, most of the states include regions requesting to provide them a state status. The study shows that a half of the regions (21) seeking statehood are located in the Central, Eastern and North-Eastern areas of India and have particularly low level of socio-economic development. The Northern region contains 6 units of this type, the Western region – also 6, and the Southern – 11 units.

The conducted study has revealed the major factors that underlie these processes and demands: 1) ethno-linguistic (self-identification and self-determination); 2) economic (striving for economical growth); 3) poor governing (request for administration reform and rationalization). These factors often overlap.

This study expands the understanding of federalism processes in India, its factors and geographic patterns.

On the basis of the UN statistics the main “suppliers” of migrants to the countries of Western Europe have been determined as well as geographical shifts in the origin of migrant population that have taken place during the last quarter of a century. As discovered by the author, there have been two waves of migration directed to the European core countries and originated initially in Southern and then in Central and Eastern Europe. An unprecedented transformation

of the structure of the US population coursed by the inflow of migrants from Latin America and Asia is also described.

The size and scale of chief global migrant flows (South-South, South-North, etc.) are also analyzed. It is noted that asynchronous demographic transition in the world regions has a comparatively limited impact on international migration. The report studies migrants' remittances to the homeland that are second only to foreign direct investment and play an especially important role in developing economies and in the world financial system as a whole. According to the research conducted by the author, the contribution of international migration to the world economy far exceeds the proportion of migrants in the population of the Earth.

BACK

A GEO-ECOLOGICAL TRANSITION

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The deterioration, on a large scale, of the ecological situation during the industrial era was followed by a period of complicated multi-vectored positive and negative ecological processes in the world at large and within certain regions. Eco-positive processes can be observed in the highly developed postindustrial countries whose societies have displayed a demand for an ecological recovery of their respective economies. This trend produced a shift of the epicenter of ecological troubles - located at the turn of the 20th century in the countries of the Global Economy Center towards its Semi-periphery. If the current trend of change in the global ecological situation persists, the next few decades may see its general stabilization.

On the whole, the modernization of economies in the late 20th and early 21st century became an important factor that boosted the ongoing eco-positive processes in the world economy. The parallel development of eco-negative and eco-positive processes in different macro-regions across the world determines the increasingly mosaic structure of the global ecological panorama. It has become a truism that the ecological situation in the world is worsening. But more probably, in this century's first decade it has not been deteriorating, but only becoming more complex in spatial terms. This is yet another proof of the fact that the world has entered the phase of ‘ecological bifurcation’. Thus, it can be hoped that, once this phase is over, it will be followed by the phase of eco-economic stabilization.

Today we may see enough evidence of the ecological shift approaching its ‘inflexion point’. Take, for example, the increasingly visible eco-positive processes in developed countries. They will continue and become more intense alongside the ongoing economic modernization, technological progress, the improving living standards and the development of civil society. With time, these processes will also begin to be visible also in the ‘catching-up countries’. This complicated multi-phase process, in the long-term perspective, will at least prevent an ‘ecological apocalypse’. Under the optimistic scenario, it will herald an end of the period of long-standing and tough antagonism between the two *ecos* - economics and ecology.

This antagonism was the natural outcome of the 20th century – ‘industrial’ and full of humanitarian disasters, in which ‘there was no place for ecology’. The post-industrial era that we are entering now, with its new socio-economic and ecological trends that we may witness, offers us a chance of overcoming the tendencies that may be perilous for our planet and humanity.

BACK

POSTER

ENVIRONMENTAL PERIODS AND DEVELOPMENT OF HUMANITY

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The analysis of climatic time series reveals their hidden periodicities. But, if these harmonics are reliable, they, as their environmental causes, should impact to other Earth systems including human society and should be traced in history. Some hypothesis of appearance of environmental cycles in history were formulated, including the conceptions of A.L. Chizhevsky (Chizhevsky.1924) concluded that 11 year cycle of solar activity impacts to the mankind development, M.A. Bogolepov (Bogolepov.1921) explained some historical events by the reaction of communities of people for the unfavorable for them changes of environment related with combinations of harmonics revealed in the hydrometeorological time series, and many other researchers.

This work is aimed not only to formulate, present and discuss the problems of analysis, modeling and prediction of hydrometeorological and climatic time series and relate their hidden periodicities with any human activity or social process, but also to show the way of development of the combination of revealed periods into the chronological system embracing and structuring all human past.

Figure 1 illustrates the time series of water runoff of the Neva (*a*) and Dnieper (*b*) Rivers. These time series were analyzed by the method of “Periodicities” (Babkin.2005) from their beginning to 2000. The last five years of 2001 – 2005 were applied for the computation of the training forecasts of river runoff and estimation its results by the new independent data.

The time series are added by the revealed sinusoids with the periods of 29 and 28 years respectively. There is the high correlation of the time series and the sinusoids (η). The results of training forecasts by these sinusoids are better than the predictions by the mean values of time series. These periods were revealed also in large number of different hydrometeorological time series.

The period of 29 years may be in presence in the history of the Soviet Russia and World Communist Movement. It is the cycle of the death of the most powerful and ideologically

motivated communists. Friedrich Engels – co-author of conception of Marxism died at August 5, 1895. V.I. Lenin dyed at January 21, 1924, 29 years after F. Engels. I.V. Stalin – secretary-general of the communist party and prime minister of Soviet Union died at March 5, 1953. Head of the USSR L.I. Brezhnev died at November 10, 1982.

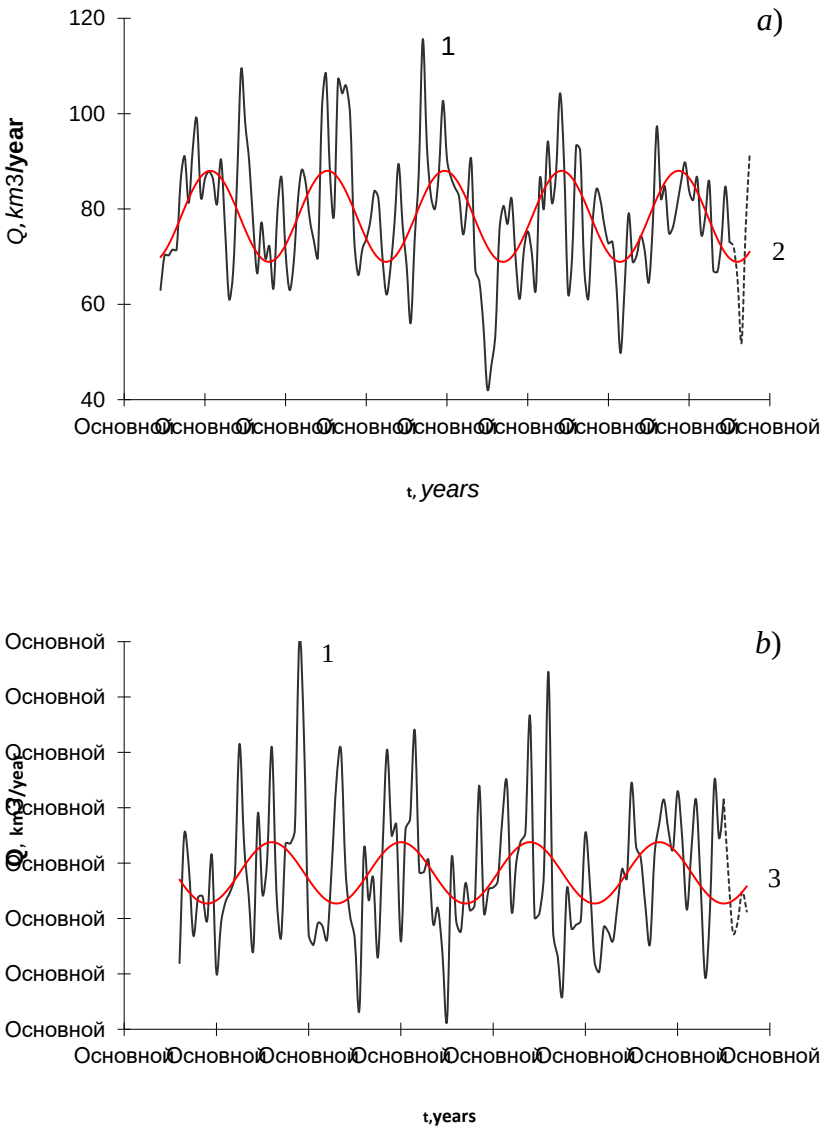

Fig. 1. Variation of runoff of the Neva River, Novosaratovka (*a*) and Dnieper River, Smolensk (*b*): 1 – observation data (time series were analyzed from their beginning to 2000, dotted line shows the training forecast interval 2001 – 2005), 2 – sine with the period of 29 years (η_2 =0,516), 3 – sine with the period of 28 years (η_3 = 0,320)

The Soviet Union collapsed at 1991. But in 2011 there were the deaths of the Heads of the States originated by the former Soviet Union copying its social organization and political

system. Muammar Khadafy of Libya died at October 20, 2011 and Kim Jong II of North Korea – at December 17, 2011.

The period of 28 years is the calendar cycle. It is the time interval for what the calendar dates stand for the same days of the week. This period was interpreted by the Velimir Khlebnikov, Russian writer of the beginning of XX century, as the cycle of alternation of generations. He concluded that the leaders resolving the opposed political or ideological and world-outlook tasks are born very often through 28 years as the Peter the Great – the Emperor of Russia and the Ivan Mazepa – Hetman of Zaporizhian Host. The new generation of people confront with the older generation born 28 years before.

This period is also could be revealed in the past of Russia and former Soviet Union. The 28 year is the time interval between the Great Russian Revolution of 1917 and the victory of USSR in the Second World War. The Serfs Emancipation in Russia of 1861 and the Great Revolution are separated by two cycles of 28 years.

If the periods with the length of 28 and 29 years are available in the variations of environmental processes and human past, their combination should cause the cycle of their multiplication with the length of 812 years. This complex long cycle, if it is reliable, can be applied as the chronological unit for the systematization of the human past – its subdivision for approximately equal time intervals with the own socio-historical sense and meaning of each of them. Such systematization could be valuable because the environmental cycle of 812 years is external for society.

The period of 812 years should be calculated from the important point in human past. Such important point is the Creation of the World (expelling of the Adam and Eve from Paradise) as its beginning. There are different dates of Creation of the World of the Christian theologians and Bible researchers. Let us consider the date of October 6/7, 3761 BC, which is the beginning of the Hebrew Calendar – official calendar of the State of Israel.

Because the Creation of the World was completed near the end of 3761 BC of Gregorian calendar, let us to calculate the time from the next year – 3760 BC, which embraces the most part of the first year of human past. The chronological system, including the years of boundaries of 812 year cycles, is presented in the table 1. The years Before Christ are characterized by the minus.

The years of completing of the cycles are the 2948 BC, 2136 BC, 1324 BC, 512 BC, 300 AD, 1112 AD and 1924 AD. The closest for us year of this dependence is 1924. From the Creation up to our time the 7 full cycles are revealed. The number 7 characterizes certain

fullness and completeness, and, as a rule, namely it is used for the description and classification of various processes and states.

According to Russian philosopher N.F. Fedorov and British H.G. Wells (Wells.1914) the sense of the history of humans is the formation of their universal community. The most whole and universal community of people is the United Humanity. Let us to subdivide the historical time for the two eras, which boundary is the 1924. We will call time before 1924 by the Era of Separated World, and after – the Era of United Humanity. The concept of the "Era of Separated World" was applied by Russian science fiction author I.A. Yefremov (Yefremov.1957).

Most simple human community is the family. Between family and United Humanity we could introduce five more forms of communities or levels of the organization of people – the clan, the tribe, the polis (the city-state or the principality), the nation and the union of nations. The specified forms of community are presented in table 1 in the 7th column to each of which the cycle of the chronological table corresponds at the end of which the historical events, caused its origination, occurred. Events are specified in the 4th column, their leaders – in the 5th column. In the 3th column the level of a community of people and a cycle at the end of which it was initiated, is characterized by the index.

Let us the intervals of 812 years long, according to chronological terminology of I.A. Yefremov and H.G. Wells (Wells.1922), to call by the ages. Era of Separated World could be subdivided for sequence of the ages named by the communities of people of that time of the highest level (table 1, a column 6). This sequence consists from an archaic age at the time moment of Adam and Eve's expelling from Paradise (age of lack of any community among the people), age of families, age of clans, age of tribes, age of policies, age of nations, age of unions of nations which comes to the end with the Era of United Humanity.

In every age the community of people with the highest index is subject of historical process. Such community interacts with other communities as it as lower levels, building the relations of war and peace, domination and submission, market exchange and competition and the other. So, in the age of tribes, one tribe can subdue another tribe, the relations of Spartans and

Table 1. Eras and ages of human past

Era	Cycle (age)	Age index	Great Revolutions (events and processes of formation of human communities of next level)	Great personalities	Name of the age	Forming human community	Opening direction for social development
1	2	3	4	5	6	7	8
Era of United Humanity							
Era of Separated World	1924 – 1112	7	Great October Socialist Revolution and formation of USSR, foundation of the League of Nations	V.I. Lenin Thomas Woodrow Wilson	Age of unions of nations	United Humanity	Communistic
	1112 – 300	6	First Crusade and formation of Christian States in the Western Asia and Palestine	Godfrey of Bouillon Bohemond I Tancred of Galilee	Age of nations	Union of nations	Capitalistic
	300 – (–512)	5	Completing the epoch of Three Kingdoms and formation of China, War of the Eight Princes	Wu of Jin Jia Nanfeng	Age of poleis	Nation	Feudal
	–512 – (–1324)	4	Expelling the Tarquin the Proud from Rome, overthrow the monarchy and formation of the Roman republic	Lucius Junius Brutus Spurius Lucretius Tricipitinus	Age of tribes	Polis	Slaveholding
	–1324 – (–2136)	3	Development of Monotheism	Akhenaten Tutankhamun Moses	Age of clans	Tribe	Subslaveholding
	–2136 – (–2948)	2	Creation of Ark	Noah Shem Japheth	Age of families	Clan	Primitive communistic
	–2948 – (–3760)	1			Archaic age	Family	
		0	Expelling of Adam and Eve from Paradise	God		Archaic	

Helots are an example of that, but, the tribes related by the domination and submission during its age don't become the polis.

Often poleis conquered other poleis, or entered with them into alliances or other relations. Sometimes, formations of the poleis combined with each other by various relations reached the large sizes and involved in themselves the huge mass of the population, an example of that is Rome. But the poleis related with each other in its age didn't become the nation.

The nations obeyed each other, but related with each other, in its age they didn't become the union of nations. The unions of nations were at war and traded with each other, but victories of some unions and defeats of others, as well as their peace relations, didn't lead to their association into the United Humanity.

According to Karl Marx doctrine sense of history is the consecutive alternation of socioeconomic formations which are the primitive communism, slaveholding, feudal, capitalistic and communistic (Marx.1859). Let us apply these concepts to specify the ages on all its extent as the new direction of humanity development rather than the steady society. So, merger of unions of nations into the United Humanity opens for it the possibilities of communistic development.

Association of nations into the unions of nations opens the possibilities of development of capitalism in them. Combination of poleis into the nations gives for them the possibility of development of feudalism, and association of tribes into the poleis – developments of the slaveholding relations, table 1, column 8. Association of families into the clans creates the prerequisites to the primitive communistic development of society. Also let us consider the subslaveholding direction of development opening for the association of clans into the tribes, which was not specified by Marx.

In 1924, at the moment of the end of the age of the unions of nations and the Era of Separated World V.I. Ulyanov (Lenin) and Woodrow Wilson (on February 3) died, and also the First Constitution of the USSR including the Declaration of the Creation of the USSR and the Treaty on the Creation of USSR was adopted by the Second Congress of Soviets of the Soviet Union on January 31.

V. I. Lenin – the leader of the Great October Socialist Revolution which exposed some indications of origin of United Humanity – principally new community of people. This revolution step out the solution of the political and social problems of countries and nations, and their unions, having set the aim of formation of society of a brotherhood of labor people of the whole world and their association after victory of socialist revolutions in other countries.

Almost simultaneously with origination of the united humanity on the basis of communism, the most developed capitalist countries under the leadership of the U.S. President Woodrow Wilson made an attempt of association of the world in the form of League of Nations – the first political body of United Humanity. Slightly earlier, in 1913 at Wilson's presidency the Federal Reserve System of the USA – a financial basis of association of the world was created.

The League of Nations was based on the declaration of Fourteen Points of Wilson presented to the Congress of the USA on January 8, 1918. This declaration was devoted to the principles of the world arrangement after the victory of the USA and its allies in World War I. Creation of the League of Nations was undertaken for the protection of the interests of the winners in this war – leading capitalistic powers. Nevertheless, Fourteen Points of Wilson partly repeated some of provisions of the Decree on Peace and other ideas of V.I. Lenin and slogans of the Great October Socialist Revolution, as they were the reaction to them of the capitalist world. Wilson's points formulated the need of cancellation of secret diplomacy, guarantees of the peace to the great and small nations, the rights of the nations of the former empires of Europe and Russia for creation of their own states, and for Russia – to find its own way of development.

The human history subdivided for the two eras: the time before Lenin (or Wilson) and the time after V.I. Lenin. We can conclude that the new era after the death of V.I. Lenin begins, because the state of human society changed qualitatively. Before Lenin in all ages the mankind was divided, though the extent of this division successively reduced, the labor was an object for exploitation though its form and degree changed. After V.I. Lenin the tendency of uniting of humanity originated and the new direction of its development – communistic, liberating the labor from the exploitation, opened.

The key events and processes caused the formation of human communities of the higher level than it was before are structured in the table 1 accordingly to the regularities of variation of environmental characteristics. The revealing of their general regularities and the consequences for the later years could be a tool to predict the mankind development in the future.

The interesting conclusion from the analysis of the table 1 is that the number of full ages and their length of the time of humans from Creation of the World up to now coincide with the international telephone code of St. Petersburg: 7-812. Such identity of the time and the code permits to specify the time as informational category rather than physical. The identity

of the time of humans and the telephone code of St. Petersburg points out that this city could be the capital of the United Humanity in the future.

Keywords: Environmental periods, human chronology, Great Revolutions and human communities, conception of time.

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BACK

Half a Century of French-Russian Comparative Approach to Urban Geography

BACK

NEW PARADIGMS IN URBAN GEOGRAPHY

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In the 1970s, in France and in the Soviet Union the urban geography had a common purpose; she focused the attention on land planning. But here similarities end. Within the Soviet Union, people adopt an ideological stance with the intent to build a “renewed humanity”: “settlement system” and “economic basis” are among the main tools used. In France, purposes are seemingly more neutral, which means they focus on achieving a territorial balance. Framework and tools seem to be more objective (master schemes). Strangely enough, both countries promote the same solution: the “new city”.

Forty years later, everything has changed. Just as elsewhere in the world, most stated objectives are no longer spatial, but socio-political: enhancing urban attractiveness, fairly distributing income, improving daily lives especially in the area of transport and housing, safeguarding environment are among the key challenges. Apparently, ideology receded, which is not so certain when one considers that some people accept the rules –or the absence of rules- of financial capitalism while others would opt for new rules (“deglobalisation”, “degrowth”) or new “regulations”.

We propose to illustrate this new guidelines through the study of the place of institutional and societal issues in building the Grand Paris urban policy

Nouveaux paradigmes en géographie urbaine

Dans les années soixante-dix, en France et en Union soviétique, on poursuit un but commun : l’aménagement du territoire. Mais là s’arrêtent les similitudes. En Union Soviétique, on s’appuie sur des principes idéologiques pour construire l’«homme nouveau » : le « système de peuplement », la « base économique », en sont les outils majeurs. En France, les finalités sont en apparence plus neutres, visant au meilleur équilibre des terrritoires, et les outils plus objectifs (schémas directeurs), même si leur but peut être aussi de limiter l’influence du parti

communiste et l'avènement d'une révolution « socialiste ». Paradoxalement, le même objet peut être mobilisé, ici et là-bas : la « ville nouvelle » .

Quarante ans plus tard, tout paraît avoir changé. Les objectifs affichés, comme partout dans le monde, ne sont plus spatiaux, mais clairement socio-politiques : l'attractivité des villes, la lutte contre les inégalités, l'amélioration de la vie quotidienne, spécialement en matière de logement et transports, la sauvegarde de l'environnement. Apparemment, ils sont dépourvus de connotations idéologiques. Ce n'est pas si sûr, entre ceux qui acceptent les règles - ou l'absence de règles - du capitalisme financier, et ceux qui voudraient en changer les normes (« démondialisation », « décroissance »), ou à tout le moins instaurer une nouvelle « régulation »

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DISPERSED CENTRAL PLACES IN RELATION TO THE RELATIVISTIC CENTRAL PLACE THEORY

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The Relativistic Central Place (CP) theory is thus named because it relativizes the total population of hierarchy levels and their locations in space. The hierarchy levels of CP are divided into heavy and light, depending on whether their populations are more or less than the predicted value. The heavy centers are shifted to the periphery of the system, and the light centers are generally concentrated around the main center. The formation of urban agglomerations is not the result of a big city's gravitational pull, but the uniformity of the urban settlement system at an area of 10^4-10^5 km^2. The CP system is in a condition of isostatic equilibrium when the heavy and light levels balance each other. The study of dispersed CP is the logical next step in the theory's development.

Multi-core CP can consist of several cities connected by a fast and efficient public transport system. The successful development of a dispersed multi-core CP requires the establishment of high-speed public transport connections with the CP of the higher hierarchical levels. Thus, the alternative to Moscow's unconsidered expansion could be the formation of dispersed CP of the second hierarchical level, absent in the Central Federal District, through the improvement of intra-core connections between the CP provided by the development of high-speed public transport connections with Moscow. Such CP could include cities such as Yaroslavl, Kostroma and Rybinsk north-east of Moscow; Vladimir, Ivanovo and Kovrov to the east, and Tula, Kaluga, Novomoskovsk and Obninsk to the south-west. As our calculations have shown, their formation would improve the correlation of the CP system to a condition of isostatic equilibrium. Moreover, this correlation could be further improved in future through the formation of a large multi-core CP Voronezh-Lipets-Elets.

Keywords: central place, dispersed central place, isostatic equilibrium, Russia.

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CITIES UNDER THREAT.
FIRES AND WILDLAND-URBAN INTERFACE IN THE MEDITERRANEAN

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In August 2010 when Russian lowlands are burning in great wildfires and Moscow is suffocating under a thick ash smoke, the media and public opinion realize that even the largest metropolitan areas may not be safe from the threat of wildfires. Most often, the authorities are summoned to report on their inability to prevent the development of such "catastrophic" events, while exceptional circumstances are used as a convenient excuse for what is seen as an obvious failure. In the Mediterranean though, wildfires are a permanent threat. Athens, Madrid and other big cities are regularly damaged by fires requiring the application of specific land planning measures.

Through the combined use of statistical and satellite databases, we will analyze and discuss the city-fire interactions across the Mediterranean Basin. Specifically, TERRA MODIS data reveal close connections between city and fire, despite planning policies whose main purpose is to create and maintain a spatial exclusion, the only measure capable of ensuring the safety of urban dwellers. Surprisingly, the most "protected" cities against "wildfires" are the ones that tolerate recurrent prescribed fires in their immediate outskirts, most often informally and outside binding legal frameworks. A systematic mapping of burned areas allows us to understand how much urban local bodies remain uneven in front of the "threat." Contrary to what most people think, fire is intrinsically related to urban development.

Keywords: Wildfires, Mediterranean, wildland-urban interface, forest fires, urban development, hazard.

Des cités sous la menace : incendies et interface ville-nature en Méditerranée

Lorsqu'en août 2010 de multiples incendies ravagent les plaines russes et viennent plonger Moscou sous une épaisse fumée de cendres, médias et population prennent conscience que les plus grandes métropoles ne sont pas épargnées par la menace des feux. Sommées

d’expliquer leur incapacité à prévenir l’apparition de tels événements, les autorités ne peuvent que constater leur impuissance et évoquent le caractère exceptionnel des circonstances. En Méditerranée, la menace des incendies de forêt peut être considérée comme permanente. Athènes, Madrid et d’autres grandes villes sont régulièrement touchées par des incendies qui nécessitent la mise en place de politiques d’aménagement spécifiques.

Par la combinaison de données satellitaires et statistiques, nous proposons d’analyser l’interaction ville-incendies sur l’ensemble du bassin méditerranéen. Les données TERRA MODIS, en particulier, révèlent que ces liens sont très étroits, en dépit de l’orientation des politiques publiques qui visent l’exclusion spatiale pour garantir la sécurité des citadins. Paradoxalement, les villes les mieux « protégées » sont celles-là mêmes qui, de manière informelle et souvent hors cadres juridiques, tolèrent dans leur voisinage immédiat des feux récurrents, volontaires et contrôlés. La cartographie systématique des zones incendiées permet de mesurer à quel point les territoires urbains sont inégaux face à cette « menace ». Contrairement à ce que pensent nombre de nos contemporains, les incendies sont des phénomènes intrinsèquement liés au développement urbain.

Mots clés: Incendies, Méditerranée, interface ville-nature, feux de forêt, métropolisation, risque.

BACK

"SOVIET GEOGRAPHY" VS. URBAN DESIGN AND ARCHITECTURE? THE ROMANIAN EXAMPLE

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The new Marxist–Leninist policy in the Soviet Union gave to the society the goal of the "*fabrication* of a new man in a new society in a new–shaped country of new–designed cities". If the ideological foundation was the "scientific historical materialism", this radical task supposed the *synergic synthesis*, in a sort of "applied science", of the "theorical" field of Geography and the "practical" ones of urban planning & design, architecture and construction technics. A revolutionary new way of reconsidering the identities and borders of all these fields, of their teaching and practice.

If in Romania, as in all the other countries of the Communist East Europe, the 50s–60s were politically engaged in the radical / violent social "cleansing", the beginning of the 70s changed completely the priorities which were now to build, much and quick. That explains (at least partially) why the "Modern Movement" social, technical an (most of) aesthetic concepts was read now in a sort of "post–ideological" pragmatically manner, quite similar on the both sides of the "Iron Curtain": massive industrialisation and recurrent projects vs. local identities, specificities, traditions, know–how… *mundialisation vs. localism.*

The Soviet history raised these questions and the answers proposed were, in a paradoxical way, the *avant-garde* of the actual ones everywhere: *the Geography as the subtle science of the Genius Loci payed the price of the mundialisation*; in the Soviet Union as everywhere.

The Romanian example of teaching and practicing urban planning & design and architecture is one among others of this radical evolution from political obsession to the neutrality of the "unique thinking"; the (Romanian) Geography payed one of the most considerable tributes of this process.

La «Géographie soviétique" vs. l'urbanisme et l'architecture ? l'exemple roumain

La nouvelle politique marxiste–léniniste de l'Union Soviétique assignait à la société le rôle de la «fabrication de l'homme nouveau dans une nouvelle société dans un pays remodelé de villes–nouvelles». Si la base théorique (i.e. idéologique) était le «matérialisme–historique–scientifique», cette tache radicale supposait la synthèse *synergique*, dans une sorte de *science appliquée*, du champ «théorique» de la Géographie et de ceux «fonctionnels» de l'urbanisme, de l'architecture et des multiples sciences du bâtiment; une voie révolutionnaire pour reconsidérer les identités et les frontières de tous ces champs, de leur enseignement et pratique(s).

Si en Roumanie, comme dans toutes les autres pays du Bloc Communiste, les années 50 à 60 ont eu la charge politique (et souvent violente) de «l'épuration», le début des années 70 a changé complètement les priorités qui étaient maintenant de construire, beaucoup et vite. Ceci explique (au moins en partie) pourquoi les concepts sociaux, techniques et (la plupart des) esthétiques étaient lus désormais d'une sorte de façon *non–idéologique*, très pragmatique, assez semblable des deux côtés du Rideau de Fer : l'industrialisation massive et les projets récurrents vs. les identités, les spécificités géographiques et historiques, les traditions et les savoirs–faire locaux… bref *mondialisation vs. localisme*.

L'histoire soviétique a posé ces questions très tôt et a proposé des solutions qui ont été, de manière assez paradoxale, à l'avant–garde de ceux d'aujourd'hui et de partout et la Géographie a payé un des tributs les plus considérables dans ce processus.

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COMPETITIVE CITIES, URBAN NEOLIBERALISM AND PLANNING TERRITORY IN EUROPE

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Since the end of the 1970s in occidental countries, and the beginning of the 1990s in the rest of the world, the conversion of national economies into neoliberalism has triggered an evolution of territory planning public policies, especially in European metropolises. Under the pretext of competitiveness and territorial attractiveness and under the threat of international competition of other global cities, the concerned authorities have carried out great planning territory operations (Euroméditerranée in Marseille, Guggenheim Museum in Bilbao, science park of Sophia-Antipolis) and set up international labels (Smart City in Amsterdam, Unesco Creative City in Barcelona) intending to integrate these cities in globalization. This communication aims to analyze the economic success of these policies and their dark side: socio-spatial segregation. These weaknesses question the relevance of urban neoliberalism.

Ville compétitive, néolibéralisme urbain et aménagement du territoire en Europe

Depuis la fin des années 1970 dans les pays occidentaux, et le début des années 1990 dans le reste du monde, la conversion des économies au néolibéralisme a engendré une évolution des politiques publiques d'aménagement du territoire, en particulier dans les grandes métropoles européennes. Sous le prétexte d'une recherche de compétitivité et d'attractivité territoriale et sous la menace de la concurrence internationale d'autres grandes métropoles mondiales, les responsables de ces villes ont entamé des grandes opérations d'aménagement d'intérêt national (Euroméditerranée à Marseille, musée Guggenheim à Bilbao, Technopôle de Sophia-Antipolis) et la mise en place des labels internationaux (Smart City à Amsterdam, Ville Créative à Barcelone) qui ont vocation à inscrire ces villes dans la mondialisation. Nous verrons cependant que la réussite économique de ces politiques engendre dans bien des cas une augmentation nette de la fracture socio-urbaine et de la ségrégation socio-spatiale remettant en question la pertinence de l'aménagement entrepreneurial.

BACK

THE SMART CITY AGAINST THE CITY. URBAN COUP BY THE ECONOMIC PRODUCERS OF THE SMART CITY

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The city is made up of an urban fabric that evolves as economic and social changes take place. In its time industrial capitalism has emerged a city whose technical provisions have allowed an intensive expression of flows. With the advent of digital, a cognitive capitalism is now an important factor in the competitiveness of companies. This is expressed in the current urban composition. Even if this immaterial capitalism (a brand, a patent, an algorithm, a property right) does not need a territory to develop, the fact remains that the city is a place where the actors of innovation must be present in order to spread and make their supremacies.

As a result, the previous urban governance system is undermined. The new economic players coming from the platform economy, but more generally those from the digital sector, constitute a economic ecosystem of weight in the orientation of public policies. Under cover of an optimal search of the means of public interventions, some cities give their management to private digital operators who guarantee elected officials transparency and control of public policy. How much did these new urban operators take over?

La smart city contre la ville. Coup d'Etat urbain par les producteurs économiques de la smart city

La ville est constituée d'un tissu urbain qui évolue au fur et à mesure des transformations économiques et sociales. En son temps le capitalisme industriel a fait émerger une ville dont les dispositions techniques ont permis une expression intensive des flux. Avec l'apparition du numérique, un capitalisme cognitif est désormais un facteur important de la compétitivité des entreprises. Cela s'exprime dans la composition urbaine actuelle. Même si ce capitalisme immatériel (une marque, un brevet, un algorithme, un droit de propriété) n'a pas besoin d'un territoire pour se développer, il reste que la ville est un lieu où les acteurs de l'innovation doivent être présents afin de se diffuser et fabriquer leurs suprématies.

En conséquence, le système de gouvernance urbaine antérieure est mis à mal. Les nouveaux acteurs économiques issus de l'économie des plateformes, mais plus généralement ceux issus de la filière du numérique constituent un écosystème économique de poids dans l'orientation des politiques publiques. Sous couvert d'une recherche optimale des moyens d'interventions publiques, certaines villes donnent leurs gestions à des opérateurs privés issus du numérique qui garantissent aux élus une transparence et un contrôle de la politique publique. Jusqu'à quel point ces nouveaux opérateurs urbains ont-ils pris le pouvoir?

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DEVELOPMENT OF THE CENTRAL PLACE SYSTEM OF THE MOSCOW URBAN AGGLOMERATION IN THE POST-SOVIET PERIOD

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An attempt was conducted to study the development of the Central Place system of the Moscow urban agglomeration in the post-Soviet period. The elements of the administrative territorial division were considered as the elements of the system. The methodology for the quantitative evaluation of the Central Functions value was created based on the integration of a complex of socio-economic indices.

The area of the Moscow agglomeration has expanded rapidly since 1991 due to the development of the public transport system as well as a program of modernization and reconstruction of the roadway network. Today, the capital agglomeration consists of Moscow, Moscow region and parts of the neighboring regions. The majority of second level agglomerations in the hierarchy, comprised of the cities of Moscow Region belong to the lowest hierarchical level; however, they “intercept” a part of potential commuters on route to Moscow.

A high level of relation was found between the radial-ring structure and the relatively uniform decrease in the average Central Functions value on moving from the center to the periphery. The concentric roadways of the agglomeration limit the distribution of the elements of the relevant levels. The rings are focused concentrically and broadly represent barriers between the hierarchical levels, though they are violated by the main radial expressways out of the center along which CF are higher than in the surrounding areas at large. Thus, an important structural change within the agglomeration is the far removal of elements of the lower levels from the city limits of Moscow.

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Keywords: Central Place, Moscow, Moscow urban agglomeration, Central Functions.

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Historical Geography and Climate Change: New Directions.

BACK

PERSPECTIVES FROM THE ARCHIVES: CARL SAUER AND "MAN'S ROLE IN CHANGING THE FACE OF THE EARTH"

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Groundbreaking geographer Carl Sauer (1889-1970) combined historical, archeological, anthropological, and ecological research to study how humans had shaped—and in many cases damaged—their physical environments. In this talk, I will examine how Sauer's comparative analysis of indigenous and Anglo-American cultures contributed to the birth of the modern environmental movement. I also will explore what we can glean from Sauer's work about how historical geographers can make significant and unique contributions to contemporary scholarship about how human activity has contributed to biodiversity loss, ecosystem degradation, and other pressing environmental problems.

Sauer, a professor at the University of California-Berkeley, began his career interested in how both Native Americans and white settlers had shaped the North, Central, and South American landscapes, and he examined how humans had intentionally and unintentionally altered the flora and fauna of various geographical regions. Sauer's research had indicated that humans had always to some degree damaged their environments; however, in the wake of the Dust Bowl of the 1930s, he worried that industrial agricultural techniques were causing unprecedented ecological destruction. During this period, the 1930s through the early 1960s, other scholars certainly were studying the effects of human activity on the environment, but Sauer made a distinctive contribution to the discourse by reaching back in time to examine the ecological impact of indigenous cultures in the 14th, 15th, and 16th centuries. This provided others with a baseline from which to study present environmental damage and allowed them to argue more forcefully that modern practices were indeed particularly harmful. Sauer was far from perfect: his tendency to equate "indigenous" with "primitive" was problematic, as was his inclination to make sweeping generalizations. However, as we think through how the methodological and conceptual tools of historical geography can be used to solve 21st-century challenges, Sauer's work provides guidance for how geographers can make important

contributions to contemporary scholarship about the urgent problem of anthropogenic environmental change.

BACK

THE LAND IS ALWAYS CHANGING: SPANISH VOYAGERS, THE EIGHTEENTH CENTURY ENVIRONMENT, AND THE COLLECTION OF CLIMATIC DATA

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During the reign of Charles III (r: 1759-1788) Spain sent twenty scientific voyages to the Americas. Spain had begun to send voyages to its colonies in the early eighteenth century and continued to dispatch scientific voyages during the reign of Charles' son, Charles IV. These voyages reexamined Spanish colonies in light of new eighteenth century scientific discoveries. Indeed, drawing up orders for the voyagers, Francisco Gil y Memos argued that voyagers be ready to "leave on important commissions […] constructing accurate charts [and] acquiring comprehensive data on meteorology, climate, general winds […]." The collection of climatic data was increasingly emphasized during the eighteenth century, partially motivated by the invention of new instrumentation to quantify qualitative perceptions. Scientific voyagers and major thinkers alike noted during the eighteenth century that humanity was having an impact on the natural world. Kant, Buffon, Cook, and Malaspina all note that there was a difference between climatic variability – such as in the untouched parts of the world that voyagers traveled to – and the noticeable changes occurring in Europe and America near major cities. This paper will focus on data collected in the vicinity of Nootka Bay by Spanish scientific voyagers in the context of these broader eighteenth century conversations about the environment. Finally, the paper will end by suggesting how this eighteenth century climatic data can contribute to contemporary discussions about climate change.

Keywords: scientific voyaging, Nootka Bay, climate data.

BACK

CHARACTERISTICS OF CIRCULATION CHANGES IN THE NORTHERN HEMISPHERE DURING THE ENTIRE 20TH CENTURY ACCORDING TO REANALYSIS

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Since the beginning of the 20th century, the rise of global surface temperature according to instrumental observations was not monotonous and was characterized by two global warming periods – warming of the mid-20th century and modern warming, separated by a period of global temperatures decline. Different reanalysis datasets – global gridded data on atmospheric characteristics obtained with the atmospheric models with assimilation of various empirical data - are increasingly used for the analysis of the climate change. Due to significantly lower quantity and quality of observational data in the first half of the 20th century, as well as the use of various models and assimilation data, the ability of reanalysis to reproduce changes in climatic characteristics for the 20th Century requires quantitative assessment.

Here we analyze evolution of the surface air temperature (SAT), sea level pressure and geopotential height in the Northern Hemisphere (with a focus on the northern Extratropics) according to three reanalyses covering the entire 20th century: NOAA-CIRES 20th Century Reanalysis and ECMWF ERA20C and CERA20C and compare them to GISS/NASA GISTEMP and HadSLP2 Hadley Center gridded datasets based on station observations.

Spatial trend structures, area averages and indices of leading atmosphere circulation modes are inter-compared focusing on the Early Twentieth Century Warming period. It is revealed that reanalyses data differ significantly between each other and observations within the entire 20th century, most strongly in the first half of the 20th century, at high latitudes. An overall assessment points to European reanalyses as to relatively more realistic product, with relatively best results shown by CERA20C. In particular, the temperature and pressure evolution in NOAA-CIRES 20th Century Reanalysis represents significant discrepancies in climatic characteristics throughout the 20th century.

Keywords: climate change, surface air temperature, sea level pressure, Arctic, Arctic amplification, reanalysis.

BACK

HISTORICAL PARADOXES OF AGRICULTURE IN THE RUSSIAN NORTH

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The plowing agriculture of the Russian North in the first half of the second millennium AC is full of puzzles and paradoxes. The main of them are the following: 1. The taiga zone of the East European plain was the main agricultural region of Russia till the middle of the 17th century though it was characterized with rather severe climate and poor soil. 2. In spite of essential natural differentiation due to the large extension of the forest zone the amazing uniformity of agriculture and monotony of economics was characteristic within the whole forest zone of Europe, including Russia, up to the end of the 15th century: the same prevalence of the three-field system, similar set of crops, similar agricultural tools, and, at least, the same instability and discontinuity of yields and their similar values. 3. The difference is found in peculiarities of selective spatial agricultural land use that resulted in different historical types of agricultural landscapes in different regions, which stand in close relation with their settlement spatial patterns. 4. Since the 16th -17th century this uniformity had been destroying somewhere in Russia and Western Europe. For example, the settlement pattern changed in the Central and Northwestern Russia but remained in the Baltic countries, Russian Pomorie and near Urals area. 5. The different development of agricultural landscapes due to the new appeared difference of their settlement patterns resulted in the paradox of yields in the end of the 19th century, when it became higher in the cold North (Archangelsk district) than in less severe Novgorod and Vladimir districts, for instance. 6. The agricultural development of the region in the 20th century is totally paradoxical from the agricultural land area stability in spite of dramatic change of the rural settlement patterns till the striking collapsing of the agriculture when the Soviet Union broke down. These paradoxes could be explained basing on historical data and Earth science approaches for examining historical agricultural landscapes.

Keywords: agricultural landscape, rural settlement pattern, selective spatial agricultural use.

BACK

THE HISTORY OF GEOGRAPHICAL STUDY AND TOPOGRAHIC MAPPING OF THE SMOLENSK PROVINCE IN THE XVIII – XIX CENTURIES

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The Smolensk province, being a border area in the west of the Russian Empire, occupying a unique geographical position and possessing rich natural resources, constantly attracted the attention of authorities and researchers.

The unique geographical and strategic position of the Smolensk province contributed to the widespread organized scientific study of its natural environment conditions and resources. A special role in these studies belongs to mapping of the territory.

The first topographic works on the territory of the Smolensk province are connected with the study of natural resources and the establishment of transport routes. In 1701, M. Tsyzyrev conducted a route-eye survey of the Western Dvina River from its upper reaches to the city of Polotsk. In the first half of the 18th century geodetic works were carried out to establish the pier on the river Gzhat as well as hydrological research to compile the project of connection of the rivers Vorya and Gzhat.

The topographic works particularly developed during the General Survey in 1765-1800, which was carried out at 3 hierarchical levels: a province, a county and a dacha. The result of these works are the first atlases of the Smolensk province.

In the XIX century, a systematic topographic mapping of the territory of the Smolensk province began. In 1812, the department of the maps and the quartermaster unit created the first semi-topographical map of the Smolensk province. In the middle of the XIX century, significant geographic and cartographic results were due to military expeditions by F.F. Schubert, K.I. Stiernskanz, and P.A. Strelbitsky.

In the late XIX century, A.A. Tillo compiled the first hypsometric map of European Russia, on which the relief and hydrographic network of European Russia and the Smolensk province were correctly depicted.

Thus, Geographic and cartographic works of XVIII - XIX centuries on the Smolensk province are major sources of study of geographical research and development of Russian cartography.

Keywords: Smolensk province, topographic mapping, geographic and cartographic works of XVIII - XIX centuries.

BACK

LOST LANDSCAPES OF THE ANTHROPOCENE

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Historical Ecology is a program of study that reconsiders the role of anthropogenic influences in shaping landscapes mistaken as “pristine,” “virgin,” or “wilderness,” by the colonial mind. The program deconstructs the Pristine Myth with a model of reciprocal co-determination between human culture and the landscape. This marks an intentional shift from the environmental determinism of Julian Steward and the later Cold War anthropologists, to whom many writers and scholars attribute the problematic stereotype of the primitive tribesman. Native peoples are thought to have been limited to band level complexity due to the barren environment, but the historical ecology literature reconsiders case study examples as evidence of sophisticated low-level food production practices that approach the complexity of agricultural technology. Hunter gatherers may have manipulated landscapes with fire, transplanted plant species, and altered entire ecosystems. Civilizations known to have practiced agriculture may have also tended “wild” forests and marshes to produce resources. Yet while even Steward at least acknowledges that the Numic speaking tribes practiced regenerative environmental interactions like broadcast seed sowing, seed selection, and the planting of gardens, the historical ecology literature often dwells on the role of Native Americans in driving species extinct and altering landscapes through resource use. Native peoples are even sometimes thought to have yielded engineering-scale impacts, though smaller population sizes may have mitigated damages.

This paper explores the limits of this line of argumentation by considering the archival evidence in support of the aesthetics, biodiversity, expansive crown structures, carbon storage, and other ecosystem services fostered by indigenous cultures. Regardless of whether we choose to describe these historical landscapes as “pristine,” numerous sources suggest that native peoples played a critical roil in regulating soil moisture and water cycles, controlling plant disease in understory species, preventing soil erosion, managing succession after disturbances, and expanding the niche parameters of now declining mollusk, fish, ungulate, and vegetation

populations that served and continue to serve as inputs to complex food webs. It is clear that native peoples worked to expand resources even if they also had other impacts.

While I stop short of romanticizing the un-adulterated historical landscape as an Edenic paradise, there are numerous examples that suggest native peoples actively cultivated resiliency and expanded the niche parameters of important species.

Finally, I draw from global history and human geography to explore case studies from the pre-colonial world in order to argue for an alternative understandings of "The Anthropocene." The term was popularized in a 2002 article penned for the academic journal *Nature* by Paul Crutzen, who argued that humans drive planetary-scale environmental changes through increased CO2 emissions, deforestation, the disruption of half of all globally accessible fresh water through dam building and river diversion, and by nitrate pollution and industrial emissions. While the debate over The Anthropocene has motivated important awareness and served as a teaching device on college campuses around the world, the focus on planetary-scale footprints has neglected another important driver of environmental change—the local removal of native peoples and their tending, hunting, and low-level food production practices. When scaled to the global level, how has the displacement and loss of the Earth's indigenous communities impacted ecosystem-level resilience to climate change and hindered the ecological mechanisms that allow landscapes to restructure after disturbance? How can knowledge of these indigenous practices inform restoration and climate change mitigation efforts?

BACK

Interaction Between University And School, Curricula And Textbooks, Teacher And Students, Training And Practice — Geographic Dimensions And Interpretation Of Global Understanding.

BACK

ACHIEVEMENTS OF PUPILS IN THE REPUBLIC OF CROATIA IN THE GEOGRAPHY EXAM AT THE STATE GRADUATION EXAM

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The state graduation exam in the Republic of Croatia has been implemented since 2010 and it consists of a mandatory and elective part. Geography is an elective subject at the state graduation exam that is taken by candidates whose only purpose is to meet one of the requirements for continued education, i.e. enrolment into desired study program. The goal of the paper is to determine the state of achievements of tested outcomes of pupils taking the Geography exam, and the analysis of determined contents of examination general geography, social geography, regional geography of the world and Croatian geography. Based on the analysis of continued monitoring (from the school year 2009/2010 to 2016/2017) of state graduation exam results in Geography, the authors attempted to answer some of the following key questions: What are the achievements of candidates at the end of secondary education? What is the structure of students applying for the Geography exam in the State Graduation Exam with regard to the finished secondary school? Are there any changes in average achievements? Are there any differences in pupils' achievements according to cognitive levels of knowledge and according to tested fields? Are there differences between the acquired geography knowledge and the development of geographic skills, especially cartographic literacy? The paper contributes to the development of educational geography that, amongst else, explains the rules of acquiring geographic knowledge and skills, as well as achievements of pupils at certain education levels and in life-long learning. The paper applies the methods of qualitative and quantitative analysis of tested elements.

Keywords: Geography, Educational Geography, State Graduation Exam, Pupils' achievements.

BACK

CONCEPTUAL-DIDACTIC MODELS OF THE NEW SYLLABUSES OF *GEOGRAPHY AND ECONOMICS* AND ACADEMICAL GEOGRAPHY IN THE BULGARIAN SCHOOL

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The article presents conceptual-didactic models of new syllabuses in the Bulgarian school as a result of educational reforms. By preserving the national tradition, education is synchronized with new European standards which require that at the end of their education young people acquire key competences at a level which prepares them for the life of adults and creates a basis for future education and professional life.

New accents and dimensions are being established which requires profound research and reflection upon the achievements of academical geography education in our country as well as the necessity to form new philosophy for its development and as well for secondary school.

The conceptual-didactic models covers only the obligatory training of geographical education during upper secondary and high level of up-to-date syllabuses to the new academic year was made.

Keywords: conceptual-didactic models, syllabuses, Geography and economics, educational reforms.

BACK

COLLABORATION BETWEEN GEOGRAPHY INSTITUTIONS OF HIGHER EDUCATION AND SCHOOLS IN CROATIA – CHALLENGE AND OPPORTUNITY

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The contemporary approaches in geography disciplines based on the use of information and communications technologies (ICT) and new scientific research methods result in new knowledge relevant for its transfer to primary and secondary level of education. To teach geography in primary and secondary schools in Croatia, in accordance with new scientific knowledge and by using ICT, it is necessary to continuously enhance geography teachers' competences. Here all geography institutions that are involved in scientific research and higher education have the opportunity for better collaboration with schools. The example of such collaboration are national professional meetings organized by Croatian Geographical Society and the Department of Geography, Faculty of Science, University of Zagreb, with the support of the Croatian education and teacher training agency. The paper presents the example of organization and planned learning outcomes of the 3-day professional meeting oriented on advancement of geography teachers' competences in the field of developing practical geographical skills, and attitudes of participants on its' future professional development. During three days three different workshops were held. First day (Module 1) included topics: the use of relevant international databases for preparing and conducting geography teaching, development of geographic skills in the field of hydrogeography, and tracking, testing and evaluation of geographic skills in the field of hydrogeography. The second day (Module 2) included workshops QGIS, development of geographic skills in the field of climatology and cartography in geography teaching in primary and secondary schools. The third day (Module 3) included practical use of QGIS, development of geographic skills in the field of geomorphology, and tracking, testing and evaluation of geographic skills in the field of geomorphology in primary and secondary schools. The survey that has been conducted afterwards gathered information from 200 participants about the necessity for professional training in the field of using computer and software in planning and teaching, making exercises for development of practical geographical skills and digital teaching materials, as well as

making exercises for testing the development of practical geographical skills. As expected, the biggest necessity is using QGIS, with the continuous support for teachers and students, which represents a huge professional, methodical and organizational challenge.

Keywords: geography teacher competences, geography teaching, practical geographical skills, QGIS.

BACK

GEOGRAPHY PRE-SERVICE TEACHERS' CARTOGRAPHIC CONTENT KNOWLEDGE

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Cartography is a key part of geography teachers' pedagogical content knowledge (PCK). Cartography course holds a key place in undergraduate teacher training program at the Mongolian National University of Education. Under the geography education standards which started since 2002 in Mongolia, competence-oriented knowledge and skills became core of the subject curricula. It means that student should not learn only by memorizing facts, but they must be competent to apply their knowledge in solving problems in daily life. Lately geo-information technology, especially Geographical Information System (GIS) and remote sensing, is becoming more important in geographic education as a part of cartography contents.

The research has been conducted to evaluate the pre-service geography teachers PCK. Totally 127 pre-service teachers from the bachelor degree programme of Mongolian National University of Education were participated in the study. The study has both qualitative and quantitative parts. Quantitative part covers a survey with 16 questions designed to evaluate cartography content knowledge and skills of the participants. Findings of the study indicate that the pre-service teachers in general have gained an advanced level of knowledge, however lacks of the confidence to apply their knowledge in real life situation. This study will be useful in updating the cartographic content in geography education of all levels including in service teacher training.

Keywords: Pedagogical content knowledge, Cartographic content knowledge, Cartographic competence, Pre-service teachers.

BACK

SITUATIONAL MODELS OF SCHOOL GEOGRAPHICAL EDUCATION IN THE TRAINING ON „GEOGRAPHY OF COUNTRIES" IN SELECTED SOUTHEAST EUROPEAN COUNTRIE

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Contemporary social realities form a new perspective towards the value of geographic knowledge and cognition, the significance of geographic erudition as a part of general knowledge and a style of social behaviour.

One of the characteristic features of contemporary education is its globalization. Up to the present moment it is necessary to form a conceptual theoretical-constructive model of geographical education in three aspects: consistent, functional and technological, as well as to establish respective modules that stimulate the creation of an environment for learning.

Presented situational models of School Geographical Education aims at the enrichment of the methodological literature of comparative geographical education as well as at suggestions for improvement of geographical education through foreign experience which would be significant for the theory and practice of the comparative geographical education, for making decisions in the field of education policy of one's own country.

Keywords: syllabuses, Situational models, Geography of countries, comparative geographical education, curriculum.

BACK

GEOGRAPHICAL EDUCATION IN RUSSIA: WHERE TO BECOME A GEOGRAPHER?

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Modern geographic education in Russia is a complex system that combines various areas of training and specialization. Professional geographers are trained in nearly all regions of the Russian Federation. Russian universities nurture geographers who are experts in a wide range of topics from oceanology to urban studies, and who are prepared for a variety of activities from school teaching to ecological expertise. At the same time, the thing that all graduated geographers have in common is their attention to spatial differences in nature and society.

Geography in Russia is considered as one of the natural sciences, or particularly as one of the Earth sciences. This study includes an analysis of enrollment of students on the first bachelor and first master courses of the branches of geographical educational in year 2017. Collected data shows that higher geographical education can be obtained in 179 institutions (159 universities and 20 university subsidiaries). Geographical education can be obtained in 76 out of 85 regions of the Russian Federation. Such regions as Moscow (16 universities), St. Petersburg (7) and Krasnodar Territory (5) have the most number of institutions. Higher pedagogical education in the field of geography can be obtained in 63 universities in Russia, which are located in 54 regions. 27 of these universities are pedagogical, and the rest are so-called classical universities. Educational specialisation"geography" exists as a particular specialisation at the bachelor level (in 51 universities and two subsidiaries) and at the master level (in 41 universities). Thus, geography as a particular specialisation exists only in a small share of Russian universities with geographical education. Geographical bachelor’s degree can be obtained in 48 regions of Russia. Only in Moscow, St. Petersburg and Bashkiria it can be obtained in more than one university. Geographical master’s degree can be obtained only in 40 regions of Russia (only in St. Petersburg it can be obtained in more than one university).

Total number of higher education institutes that offer geographical education (including both budget and contract places) differs in Russian by more than 20 times. The largest possible number of students enrolled in 2017 was recorded in the Bashkir State University — 229 places (including full-time, part-time and correspondence training). The second place is occupied by the Moscow State University, where only full-time education is represented — 185 places.

Keywords: geographic education, Russia, universities.

BACK

Lakes In A Changing World

- Lake Ladoga Digital Bathymetric Models: Development Approaches
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- Present-Day Chemical Composition Of Baikal Water — Habitats For Baikal Organisms
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- Determination Of The Anthropogenic Factors Role In Urban Lakes Development According To Multy-Proxsy Paleolimnological Research
  T.V. Sapelko, N.V. Ignatieva, A.V. Terekhov, M. A. Guseva, D.D. Kuznetsov, A.V. Ludikova

- Response Of The Lake Baikal Basin Rivers Runoff To Climate Change
  E. Garmaev, A. Ayurzhanaev, S. Andreev

POSTER

- Geochemistry Of Waters Of Upper Volga River In Modern Conditions
  Galina Shilkrot, Svetlana Suslova, Tatiana Kuderina

BACK

LAKE LADOGA DIGITAL BATHYMETRIC MODELS: DEVELOPMENT APPROACHES

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The creation of digital bathymetric models (DBM) of lakes allows not only for storage of the data on depths and shorelines in a standard format, but also for the estimation of major morphometric characteristics of the reservoirs. To calculate the water, thermal, and chemical budgets of large lakes, it is important to know their hypsometry. We developed a new digital model of Lake Ladoga, the largest European lake, which was done to identify and correct topographic data errors, as well as to identify more depth points. The produced bathymetric model of the lake allowed the updating of morphometric characteristics. The lake-bottom grid of 0.5×0.5 km with 70190 depth points of interest was produced using the Kriging procedure with the mean error ME = 0.05 m and root mean square error RMSE = 5.6 m. The statistical characteristics of the lake depth and slope are determined on the basis of the advanced digital model of the lakebed relief. The form of the lake depression corresponds to the convex type (microtype) and bears similarity to lakes Erie, Huron, Vanern, and Malaren. We describe how the bathymetric model has been developed and the morphometric characteristics of the lake have been corrected. We also discuss results of its application in limnological investigations.

Keywords: digital bathymetric models, morphometric characteristics, Lake Ladoga.

BACK

PRESENT-DAY CHEMICAL COMPOSITION OF BAIKAL WATER - HABITATS FOR BAIKAL ORGANISMS

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Chemical monitoring of the Baikal water includes control of dynamics of chemical components in the pelagic and littoral areas of the lake, as well as their input from atmosphere and with waters of the lake tributaries. The monitoring system allows the assessment of historical trends of chemical components in the lake and forecast of possible changes in the biota habitat. In 2010-2016, ten Baikal expeditions were carried out at Lake Baikal to investigate qualitative and quantitative composition of dominant groups of phyto-, bacterio- and zooplankton, as well as gas and ionic composition, nutrients, organic carbon, and persistent organic pollutants in the entire pelagic area of Lake Baikal. Enormous amount of data was obtained on chemical composition of Baikal water. According to these data and the results of previous investigations, the ionic composition of water was stable at all depths in the open parts of the lake. We also observed seasonal variability, vertical stratification and latitude differences in dynamics of nutrients, organic matter and gas components. Like in the previous years of investigations, in 2010-2016 the dynamics of nutrients in the pelagic area of Lake Baikal depended on phytoplankton productivity. Concentrations of pollutants in Lake Baikal, such as persistent organic pollutants (POP) and heavy metals, were low and did not directly affect the composition of water and biota. The waters of the littoral zone of Lake Baikal: Chivyrkuy and Barguzin bays and Maloye More were polluted by large settlements (Listvyanka, Severobaikalsk, Baikalsk, Slyudyanka, and others) located on the coast of Lake Baikal because of unsatisfactory operations of sewage treatment plants, numerous tourists visiting these areas, and ships sailing at Lake Baikal. The increase of nutrient concentrations in the littoral area of the lake disturbed the belt structure of phytobenthos and caused mass development of filamentous algae of the genus *Spirogyra* sp., thus negatively affecting the littoral biocenosis of the lake. This study was supported by research projects No 0345–2016–0008.

BACK

DETERMINATION OF THE ANTHROPOGENIC FACTORS ROLE IN URBAN LAKES DEVELOPMENT ACCORDING TO MULTY-PROXSY PALEOLIMNOLOGICAL RESEARCH

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Lakes are accumulators of natural and anthropogenic changes over a long period of time. The sediments sequence of lakes located near large cities reflect their development both in the period before the human impact and during the period of active influence of human activity. To identify human impact on various components of lake ecosystems, we explore Suzdalskoye lakes (St. Petersburg) using multy-proxsy paleolmological analysis. Suzdalskoye lakes are a system of three small natural lakes of glacial origin: the Upper, Middle and Lower Suzdalskoye lakes. We reconstructed the dynamics of various components in the lake ecosystems during the Holocene. The periods of the beginning of human impact are established. A high content of Ca, Ba, V, Zn, Cu in the bottom sediments of the upper layers of the bottom sediments of lakes is established, connected with the anthropogenic factor.

BACK

RESPONSE OF THE LAKE BAIKAL BASIN RIVERS RUNOFF TO CLIMATE CHANGE

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It is of great interest to study the effect of climate change on the elevated mountainous terrain of the Baikal region and on the formation of river runoff. Modern climatic trends in the basin of Lake Baikal are expressed in an increase in the surface air temperature and in decreasing atmospheric precipitation. Analysis of the data revealed that between 1999 and 2017, there are positive trends in air temperature for almost all meteorological stations in the region. At the same time, we note that during this entire period, the negative trend in the amount of atmospheric precipitation is clearly expressed in the Russian part of the catchment area, while in the Mongolian part it is positive in recent years. This circumstance facilitated the establishment of a low water period from the end of the 20th century.

Analysis of water flow in the main tributaries of Lake Baikal revealed that the water content of rivers over the last 20 years has decreased from 20% to 90% relative to the average for observation period, depending on their size and location. Thus, the average annual flow rate of the Selenga River in 2017, which is largely influenced on the water level of the receiving reservoir, was only 60% of the average. Many small streams have simply dried up everywhere. Over the past two decades, more than 700 rivers have disappeared in Mongolia.

The river flow of the southern part of the Lake Baikal basin was reconstructed using the method of dendrochronological analysis. Reconstruction models explain up to 60% of the annual flow rate variance. Since the middle of the XVII century in the region, periods of high water and droughts with cycles of various frequencies with a peak of spectral density of 32 years have been identified. The observed long period of low water availability is not unique. Similar periods were observed in the past, for example, in the first half of the 18th century the drought lasted more than 25 years.

The reported study was funded by RFBR according to the research project № 17-29-05083.

Keywords: Lake Baikal basin, river water content, temperature and precipitation trends, reconstruction of water discharge, dendrochronology.

BACK

POSTER

GEOCHEMISTRY OF WATERS OF UPPER VOLGA RIVER IN MODERN CONDITIONS

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The chemical composition of natural waters is an important indicator of the ecological condition of landscapes and, consequently, the status of the living environment of a man. It can also be considered as an indicator of dynamics processes in landscapes in modern conditions under the powerfully influence of anthropogenic factor and climate change.

Our studies of lakes, rivers and ground waters were conducted in the basin of the Seliger Lake and the Upper Volga lakes up to the town of Selizharovo from 2002 till present. The purpose of the research is to evaluate changes in the geochemical fluxes in the basin of the lake under the changed character of environmental management in the area. Industrial and agricultural production was replaced in the 1990s by intensive development of the coast of reservoirs (villages) and by the development of tourism.

Studies have shown that due to the condition of the of lake Seliger's waters has improved, i.e. lake was deevtrophicated. The phosphorus content in the waters of the upper Volga River's lake is currently low and corresponds to indexes of pure and slightly polluted waters. The concentration of toxic microelements, heavy metals including, in waters of the lake doesn't exceed standards for management of reservoirs and, moreover, the standards for drinking water. The only exception is iron (Fe) high concentration of which is inherent in the waters of the study area.

However, it was detected that of negative impacts selitby on the groundwater composition has increased. This is manifested, first of all, in high content (up to 1 and > mg/l P) of phosphorus in them (monitoring of drinking wells). However, there migration of P with groundwater from previously accumulated their reserves in soils and a peat deposit of the pool has been increased. Both of these phenomena are confirmed by the observations and in the

other parts of Central Russia. The reason for this may be coupled with anthropogenic factors and climate change.

Geochemical studies of river water basin of the upper Volga River shows, that the content of some trace elements such as Ti, Cr, W, Ba, Sr (along with Fe)-in the surface waters exceed their klarki for river water in the World. Obviously, unpolluted, more mineralized groundwater are the sources of these trace elements in rivers. This fact is confirmed on the base for perennial studies for the chemical composition of the spring waters on the coast of Selizharovskogo pless of the Seliger Lake. Thus, ground waters play a significant role in the water feeding of the Upper Volga River.

Modern features of composition of lake waters, rivers, and springs and wells in the Seliger basin are reveled and confirmed observations in other parts of Central Russia are bench marks when tracking water content changes and the evolution of landscapes of the Upper Volga River.

The work was carried out within the framework of the state task of IG RAS on the topic No. 0148-2014-0020 (No. of state registration: No. 01201352471).

Keywords: geochemical studies, trace elements, waters of lake, groundwater, the basin of the Seliger Lake.