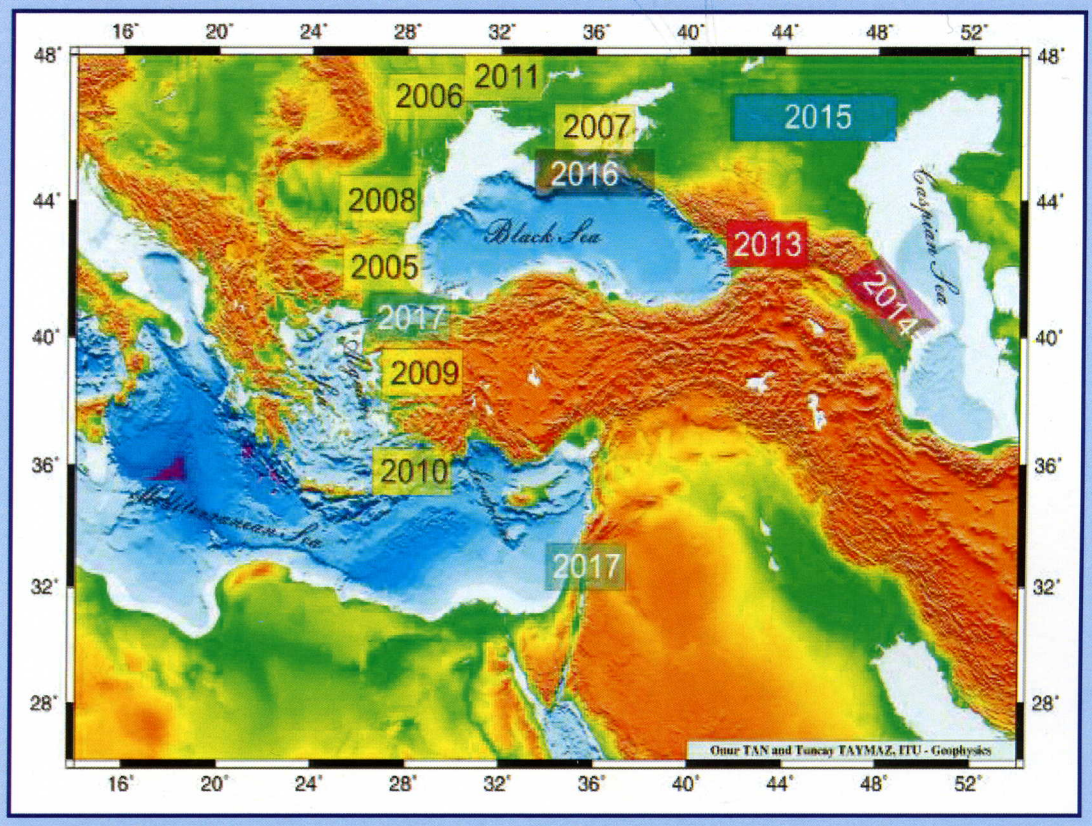
United Nations Educational, Scientific and Cultural Organization

IGCP 610
From the Caspian to Mediterranean: Environmental Change and Human Response during the Quaternary (2013-2017)



Proceedings of the Third Plenary Conference

Astrakhan, Russia
22-30 September 2015

http://www.avalon-institute.org/IGCP610/index.php

COMPARATIVE ANALYSIS OF HOLOCENE CLIMATE CHANGE AND ENVIRONMENTAL DYNAMICS IN SEMIARID AND ARID REGIONS OF RUSSIA (KUBAN RIVER DELTA AND LOWER VOLGA RIVER REGION AS AN EXAMPLE)

Bolikhovskaya, N.[1], Richards, K.[2], Kaitamba, M.[3], Porotov, A.[1], Faustov, S.[1]

[1] Faculty of Geography, Lomonosov Moscow State University, Moscow, 119991, Russia
[1] *nbolikh@geogr.msu.ru*
[2] *alexey-porotov@ya.ru*
[3] *faustovs@rambler.ru*
[2]KrA Stratigraphic Ltd., London, UK
kr@paly.co.uk
[3] State University of Abkhaziya, Sukhumi
lanak@mail.ru

Keywords: the Holocene, paleoenvironments, palynology, geochronology, Black Sea and Caspian Sea Regions

Introduction

The results of the geological-geomorphologic, lithological and palynological studies as well as ^{14}C dating of the Holocene sediments within the southern part of the Taman Peninsula and the Lower Volga Region allowed to reconstruct the changes of climate and vegetation and to specify the features of the environment evolution in semiarid and arid areas of the South of European part of Russia during the Holocene.

Results and discussion

The southern part of the Taman Peninsula

The Taman Peninsula is one of the southernmost semiarid regions of Russia that is located in the southern steppe zone with predominance of the herb-cereal and cereal formations in vegetation cover. The detailed reconstructions of the changes in climates and environments on the Black Sea coasts of the Taman Peninsula in the middle and late Holocene were based on materials of geological and geomorphologic studies, lithological and pollen analyses, as well as ^{14}C dating of the delta deposits from various parts of the Kuban river delta. Pollen analysis and radiocarbon dating of lagoon, alluvial, lacustrine and subaerial deposits from 6 complementary boreholes permitted the identification and characterization of 17 phases in vegetation and climate evolution of this region over the last 7000 years (Bolikhovskaya et al., 2004, 2014).

The obtained record of climate and environment changes on the Black Sea coasts of the Taman Peninsula gives evidence for the general trends in the climate evolution against the background of noticeable changes in the local environments due to the sea level fluctuations. Steppe and forest-steppe environments prevailed in the southern half of the Taman Peninsula, and probably in the lower reaches of the Kuban River, over the most part of the studied Holocene time interval (from ~7000 to 300 cal BP). The most warm and dry climate conditions were reconstructed for several phases marked by the dominance of herb, herb-grass, and *Artemisia*-Chenopodiaceae plant communities; they are dated at 4100–3950, 3500–3300/3200, 2800–2400, 1650–1300, and 1000–900/800 cal BP. The two most humid periods of maximum moisture correspond to the intervals at 4500–4300 and 3950–3500 cal BP and are noted by widely spreading of broad-leaved forests (mostly of beech, oak and hornbeam) in the region. The changeability of climate, as well as that of phytocoenotic successions grew essentially (almost three times) during Subboreal and Subatlantic sub-periods during the last 4500 years of the Holocene. The late Atlantic sub-period of the Holocene (6000–4500 cal BP) featured the forest-steppe prevalence over most of the time, while during the following ~4000 years zonal and transitional types of vegetation – broadleaved forests, forest-steppes and steppes – replaced each other more than 15 times.

The results of palynological study of the deltaic sediments which have been obtained during the coring in the inner part of delta (core 1-98) were used as a base for paleoenvironmental record. At the depth of 12 m of this core a layer of basal peat was been found for which ^{14}C age is 6908–6640 cal BP. That

allows characterization in detail of 14 stages in the development of vegetation and climate in the interval from ~ 7,0 to 1,0–0,8 cal BP. Pollen assemblages from the upper part of sedimentary cover (core 12-09) reflect the latest phases in the development of vegetation during the Subatlantic period (approximately from 800 to 400 yrs BP). They showed that the arid phase with domination of steppes (~ 1000–900/800 cal BP) was replaced by more humid climate conditions and prevailing of forest-steppe landscapes. A distinctive feature of a vegetation cover of this phase (~ 800–500 cal BP) is significant contribution of coniferous species (mainly Scots pine and spruce) in mixed coniferous-broadleaf forests. The following steppe phase (~ 500–300 cal BP) was characterized by predominance of open landscapes represented by herb-grass steppe on the slope and adjoining uplands together with swamp and bog communities in delta lowland.

The Lower Volga region

The only fully arid region in the territory of the East European Plain lies in the North Caspian Lowland where desert and steppe-desert phytocoenoses form the zones of desert and semi-desert.

The first results of detailed palynological and geochronological studies of the deposits and reconstruction of the Holocene sequence of vegetation and climate changes in the Lower Volga region were available by in the late eighties (Bolikhovskaya, 1990). Subsequent investigation of the lacustrine and flood-plain deposits exposed near Solenoe Zaimishche settlement (5 km to the south from Chernyi Yar) and in 8 boreholes on the Damchik area at the delta of Volga (Bolikhovskaya, Kasimov, 2010; Richards et al, 2014) resulted in the comparative analysis of the evolution of Holocene climate and phytocoenotic successions. These data permitted characterization of the landscape evolution of the desert steppe environments in the regions of the Volga-Ackhtuba floodplain and deltas of Volga River delta that currently belong to the zone of semi-deserts. A comparison of the composition of the palynological assemblages and the relative participation of the representative of the dendropalynoflora in the cores at Volga-Akhtuba (Solenoe Zaimishche) and Volga River delta (Damchik) has shown that obtained profiles of the delta sediments are suitable for a study of vegetation and a climate changes in the maritime zone of the Caspian Sea and, therefore, for obtaining data about sea level change. The results of the palynological study and ^{14}C datings of the most informative sediment profiles have allowed reconstruction of the multiple changes of zonal types of vegetation and transformations of the zonal and intrazonal vegetable formations in the Holocene landscapes of the northern the North Caspian lowland. The reconstructed paleo-climatic stages were correlated with the Holocene transgressions and regressions of the Caspian Sea (Bolikhovskaya, Kasimov, 2010; Richards et al, 2014). The following peculiar features of the landscape-climate changes at the Lower Volga River Region and climatically induced variability of the Caspian Sea level during the Holocene have been established. For the last 11.5 cal ka BP, the evolution of vegetation and climate comprises approximately 26 phases of changes. Their chronological limits are defined on the base of more than 40 ^{14}C datings and age interpolations.

Unlike the steppe areas of the European Russia, the studied arid region has not been occupied by forest zone during the Holocene. In the early and middle Holocene between 11500–2600 cal BP, the climate was more favorable and humid than recent in the Lower Volga River region. In this period the forest-steppe and steppe landscapes predominated. These landscapes underwent seven forest-steppe and seven steppe non-consecutive phases during their development.

Between 2600–840 cal BP, the development of the predominant steppe landscape included 8 phases of change which were characterized by transformations of zonal and intrazonal vegetative associations. During the last 840 years the desert-steppe and desert landscapes predominate over this territory. Their evolution includes not less than 4 climatically induced phytocoenotic changes.

The major trend of the Holocene climate change in this area is correspondence between three evident climate optima and maximum heat and moisture supply. The more pronounced among them was late-Atlantic optimum (~ 6970–5740 cal BP) which is characterized by the development of forest-steppe landscapes. The mixed oak forests woods with a hornbeam participation (*Carpinus betulus*, *C. caucasica*), a beech (*Fagus orientalis*), elms (*Ulmus laevis, U. foliacea*), a linden (*Tilia cordata*), a birch and other trees including also coniferous pine forests. They comprised the forest belt in the valley of Lower Volga River region. Very similar to each other, the late Boreal (~ 9500–9350 cal BP) and

middle Sub-Boreal (4770–4040 cal BP) optima were characterized by cooler conditions but higher humidity. They are distinguished by the dominance of the forest-steppes and, in some phases, steppe landscape. However they differed from the optimum of the Atlantic period because environmental conditions were less favorable for growth of broad-leaved forests. These three stages correspond to maximum transgressive stages of the Caspian Sea basin. The climatic phases with cool and relatively wet conditions also bear evidence of transgressive stages of the Caspian Sea. First, the forest- steppe phase between ~ 11500–10350 cal BP, which correspond to the "Sartass stage" of the Upper-Khvalinian transgression of the Caspian sea during which pine forests and fir-spruce forests were widespread on the exposed coastal territories of the northern Caspian Sea Region. Phases of relatively cold and humid conditions were established for the time intervals ~ 5540–4770, 2600–2340 and 500–250 cal BP. Besides, transgressive phases of the Caspian Sea coincided with climate deterioration towards warmer and more humid conditions that existed; the warming and humidifying took place in the intervals 8900–8400, 3770–2780, 2080–1720, 1600–1400, 1270–1030 and 670–500 cal BP. The reconstructed climate minima, as well as intervals of relatively warm and arid climate correspond to regressive stages of different magnitudes. The two most pronounced climate minima with respect to warmth and humidity occurred in the early Boreal subperiod and in the first half of the late Subatlantic subperiod of the Holocene. The first minimum coincides with "the Mangyshlak regression" between 10350–9500 cal BP, and the second – with "the Derbent regression" between 1400–670 cal BP. The time interval 9500–1400 cal BP comprises the one phase of sharp warming and aridification of climate conditions at ~ 2780–2600 cal BP and five phases of sharp cooling and drying at ~ 9350–8900, 8400–8240, 5740–5540, 4040–3770 and 2340–2080 cal BP, which could coincide with the short-term, but large fall of water level in the Caspian Sea. The most prominent event occurred at ~ 8400–8240 and 4040–3770 cal BP. All phases of climate cooling and aridification were marked by the domination over a vast territory of dry steppes and semi-deserts in which the leading part were played xerophytic sagebrush and haze (*Artemisia*-Chenopodiaceae) associations.

Conclusion

Thus, the comparative analysis has shown that during the Holocene the forest zone never extended into the territory of the Lower Volga River Region, and in the area of the Black Sea delta of the Kuban River never were the invasions of the zonal desert and desert-steppe communities.

The study was supported by the Russian Foundation for Basic Research (grant no. 14-05-00227).

References

Bolikhovskaya N.S. 1990. Paliniindikatsiya izmeneniya landshaftov Nizhnego Povolzhiya v poslednie desyat' tysyach let [Palynological indication of environment changes in the Lower Volga region during the last 10,000 years]. In: Lebedev LI and Maev EG (eds) Voprosy geologii I geomorphologii Kaspiyskogo morya [Problems of Geology and Geomorphology of Caspian Sea]. Moscow: Nauka, pp. 52–68 (in Russian).

Bolikhovskaya N., Kaitamba M., Porotov A., Fouache E. Environmental changes of the Northeastern Black Sea's coastal region during the Middle and Late Holocene // Impact of the Environment on Human Migration in Eurasia. Chapter 17. Dordrech: Kluwer Academic Publishers. 2004. P. 209-223.

Bolikhovskaya N.S., Porotov A.V., Kaitamba M.D., Faustov S.S. Razvitie prirodnoy sredy i klimata na territorii Chernomorskoy delty Kubani v poslednie 7 tysyach let [Reconstruction of the changes of sedimentation environments, vegetation and climate within the Black Sea Part of the Kuban River Delta area for the last 7000 years], *Vestnik of Moscow University*. Series 5. Geography. 2014. Vol. 1, pp. 64-74 (in Russian).

Bolikhovskaya N.S., Kasimov N.S. The evolution of climate and landscapes of the Lower Volga Region during the Holocene // *Geography, Environment, Sustainability*. 2010. No 2 (V. 3), pp. 78-97.

Richards K., Bolikhovskaya N.S., Hoogendoorn R.M., Kroonenberg S.B., Leroy S. A.G., Athersuch J. Reconstructions of deltaic environments from Holocene palynological records in the Volga delta, northern Caspian Sea // *The Holocene*. 2014. Vol. 24(10), pp.1226–1252.