NATURAL HAZARD AND RISK RESEARCH IN RUSSIA

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Abstract. Following a discussion among participants of the *Third International Conference on Debris Flows* in Yuzhno-Sakhalinsk in September 2014, a need was identified to make Russian research available to the international hazard community. This is of vital interest and will provide substantial added value to progress in natural hazard and risk research inside and outside of Russia. Below, an overview on the historical roots of research on different hazard types in Russia is provided, and major factors that have influenced research are reported. Individual contributions were collected and recently published by Springer Nature in a special volume of the scientific journal *Natural Hazards*.

Key words: Natural hazards; risk; Russian Federation, USSR, research.

The history of natural hazard research in Russia can be divided into several successive periods. First studies on hazards started at the end of the 8th century, when various chronicles were established (Borisenkov and Pasetskii, 1988). As for other regions of the world, the information in these documents was mainly qualitative, and the most prominent hazard types recorded were floods, droughts, windstorms, hail, and severe frosts. The descriptions chronicled included the geographical location of individual events, some spatial characteristics and the observed consequences. These roots of natural hazard research were enriched by more sophisticated observations once knowledge on hazard triggers increased. More quantitative scientific investigations on the territory of the contemporary Russian Federation started in the middle of the 19th century, when measurement devices allowed for reproducible observations, and scientific education reached broad levels of the population. Since then, the genesis of dangerous natural phenomena, their distribution and conditions of initiation have been studied, and quantitative information on multiple hazard types are available for the Russian territory.

At the end of the 20th century, the ratification of Russia’s “State complex scientific-technical programme” on “Safety of population and industrial objects accounting for the risk of manifestation of natural and technogenic catastrophes” in 1991 can be considered as the starting point of a new era of scientific research on natural hazards and risks. Under this programme, much of the previous experience was synthesised and an atlas of maps of dangerous natural hazards was compiled. This atlas became a base for the “Science Atlas” published by the Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters together with the Russian Academy of Sciences (Shoigu, 2005). In the following years, studies on natural hazards and risk were conducted under the umbrella of the “Federal target programmes” “Reduction of risks and abatement of consequences of emergency situations of natural and technogenic character in the Russian Federation for the period until 2010”, as well as “Reduction of risks and abatement of consequences of emergency situations of natural and technogenic character in Russian Federation until 2015”.

In the subsequent sections we briefly present the variety of natural hazards affecting the territory of Russia as well as the main historical developments in scientific research.

At the national level of the Russian Federation, Osipov et al. (2017) present the most dangerous natural hazards that may cause considerable economic loss as well as fatalities and injuries. The history of studies in the assessment of different natural risk indices with respect to different end-users is described, and conceptual instruments used in the assessment of these indices are discussed. Finally, the principle GIS-based methodical approaches used in the assessment and mapping of natural risks are provided. The article concludes with an outlook on future research needs related to nation-wide vulnerability assessments.

Approximately 20% of the territory of the Russian Federation is potentially affected by earthquakes with an intensity of VII and higher (MMSK-86 scale), including the Northern Caucasus, Altai, Sayany, the Baikal area, Yakutiya and the Russian Far East, including Kamchatka, Sakhalin Island and the Kuril Islands. Frolova et al. (2016a) address methodological procedures for risk assessment and databases used for risk computation at different scales ranging from national to local. Challenges involved in the application of simulation models and respective input data required for earthquakes loss estimation are discussed.

Timely and suitable action immediately after a strong earthquake can result in significant benefits in saving lives and reducing the overall and long-term impact of such events on the economy. Frolova et al. (2016b) describe how prompt and reliable information on losses may enhance emergency response and recovery. The authors analyse the factors which influence the reliability of earthquake impact simulation under emergency situations with a particular focus on an increase in reliability of loss assessment. The authors show how the reliability of loss assessment output of global models is directly dependent on the quality of input data and on the quality of simulation models. Main constraints on the accuracy and reliability of loss estimation result from input data on earthquake parameters, model assumptions and regional parameters used for intensity simulation, and model assumptions and parameters used for the simulation of damage to buildings and impact on population.

In the contribution of Kazeev and Postoev (2016) pure scientific and applied research on landslide hazard and risk is presented with a focus on both the territory of the Russian Federation and the former Soviet Union. This research includes a broad spectrum of studies on landslide processes based on monitoring data collected at specialized stations nationwide, as well as the data collected and analyzed by various government and academic research institutions. The contribution summarizes a vast body of knowledge encompassing an inventory of landslide cases, an overview of mechanisms of landslide development, monitoring and slope stability assessments.

Frolova et al. (2016c) present an evaluation of various aspects of hydrological hazards in the Russian Federation at different scales. With regard to floods, an interesting spatial pattern can be observed: While the number of floods has increased in the Asian part of the country, the number and intensity of floods have significantly decreased in the estuarine areas of the European part of Russia since the middle of the twentieth century, especially in the 2000s. It is discussed that these dynamics can be attributed to controlled flood runoff in the mouths of regulated rivers, with an effective system of flood and ice jam protection. Subsequently, a classification of flood risk is presented, taking into account more than 20 hydrological and social-economic parameters. Finally, hazard and vulnerability maps for the entire country were generated which can be used for water management plans.

The contribution by Shalikovskiy and Kurganovich (2016) proposes a hybrid approach to assess flood risk for the Russian territory combining quantitative and qualitative indicators. The article describes various methods to assess flood risk, such as likelihood and magnitude of flooding, average annual damage, maximum damage, etc. The authors present two types of flood risk maps, a first type intended to define the mathematical prediction of damage zones for reference buildings with the possibility of risk calculation for other buildings using multiple factors, and a second type of map which is designed for the purpose of land use regulation and was based on a priori statistical estimates of flood risk.

Hydrological hazards at river mouths of the Northern Dvina and the Pechora rives are presented in the contribution of Magritsky et al. (2016). The article is based on results of long-term monitoring, detailed studies and numerical simulation of hydrological hazards at the river mouths of the two major rivers in northern European Russia. Main hydrological hazards described include dangerous ice phenomena, inundations from both pure maximum stream flow and peak discharges with ice jams, surge-induced flooding, wind-induced down-surges, low-water periods and seawater intrusion into the delta arms. These hazards repeatedly caused significant socioeconomic loss and environmental damage to the adjacent riparian areas. Causes and characteristics of hydrological hazards have been evaluated. Furthermore, the impact of regional climate change and economic activities is discussed.

The contribution of Agafonova et al. (2016) deals with dangerous ice phenomena on the lowland rivers of European Russia. Based on computation and modelling, the authors present flood dynamics on the basis of observations of 300 hydrological stations for the period between 1936 and 2013. The dynamics of the ice phenomena are influenced by conventional natural (primary climatic) and anthropogenic factors. A diversity of natural conditions and the degree of climatic change within European Russia has allowed the authors to identify the main stages of the ice regime evolution with current climatic conditions.

Vinogradova and Vinogradov (2017) report on the experimental results of the artificially-triggered debris flows experiments in the Chemolgan river basin, Kazakhstan, 1972-1976. These experiments, organized by the Hydrometeorological Research Institute of Kazakhstan (KSRHI, present successor: Kazhydromet), were the first full-scale experiments with detailed recording of multiple debris flows characteristics in the channel bed of approximately 7 km length. While some of the results have already been available to the international scientific community, most of the material is still published in Russian. Given the fact that these experiments were conducted quite early in the history of quantitative scientific research, the results were influential in stimulating further works on erosional and depositional patterns of debris flows. The movie about this experiment is available as online supplement to this Special Issue on Springer's webpage.

Perov et al. (2017) report on regional characteristics of debris flow hazards in Russia. Spatial patterns of debris flow processes within the country are analyzed, and a map of debris flow hazards in Russia is presented based on a classification of debris flow hazard areas into two zones, six regions and 15 provinces. Furthermore, an inventory of remarkable debris flow events is presented, including parameters such as their magnitude and impact. Major events are reported from Kamchatka-Kuril, the North Caucasus and the Baikal province.

The contribution of Kazakova et al. (2016) deals with a large-scale assessment of snow avalanche and debris flow hazards in the Sakhalin region, Russian Federation. Their work explores the challenges of hazard assessment in exposed urban areas. More than 60 settlements are at risk by snow avalanches and more than 30 settlements by debris flow hazards. Data are provided for avalanche and debris flow events that occurred in the Sakhalin region between 1928 and 2015. In their paper, the method for the design of hazard maps is described, providing the starting point for any planning constraints in general settlement planning schemes.

The final contribution contained in this Special Issue is presented by Makitov et al. (2016) on research of hailstorm formation and its development over the central part of the Northern Caucasus. The authors report radar observations which provide the base for further computation and which were carried out continuously from the moment of the first radar echo registration until complete dissipation of the hailstorm. The distribution of the hailstorms first radar echo formation zones over the study area was compiled, and areas with the maximum frequency of the hailstorms first radar echo formation were defined. Hailstorm trajectories were analyzed, and the dynamic parameters of the hail core formation and development were evaluated. The paper ends with a comparison of hail storm characteristics in the Northern Caucasus with the hail storms of Mendoza, Argentina, and Alberta, Canada.

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