

Hydrological risks and their prevention in Kazakhstan

Introduction

The Republic of Kazakhstan is located in the temperate zone of the Eurasian continent within geographical coordinates: 40°35' - 55°30' north latitude and 46°30' - 87°20' east longitude. The territory of the republic is large - 2724.9 thousand km².¹ For this reason, the republic has a wide variety of natural conditions in the republic: mountains, plains, forests, steppes, deserts, etc., which predetermines the manifestation of numerous hydrological risks.

The causes of hydrological risks are extreme hydrological phenomena (EHP), the number of which reaches about 30 species. Conventionally, all the EHP can be divided into three groups: 1 - the EHP on land water bodies; 2 - the EHP on the marine water bodies and 3 - the EHP on the groundwater bodies. Of all the EHP in Kazakhstan, only a few of them have significant damage potential. These are: rain (thaw-rain) and thawed floods; spring floods on flat rivers; mud flow; wind surge in large reservoirs; ice-hazards on rivers; water shortage; high levels of surface and groundwater and avalanches. Dangerous EHP can develop over a wide range of scales: from local to global (catastrophic). An illustrative example of the catastrophic risks associated with the water factor is, for example, the year 1993, when in the spring, according to official data, 669 settlements were simultaneously subjected to floods and flooding. At the same time, residential houses with a total area of 635,000 m² were destroyed, and direct economic damage according to the data of the State Committee on Statistics in 1993 from floods was 57.7 billion rubles in Soviet prices,² in US dollars, was probably equivalent to a sum of no less than \$500 million.

Kazakhstan is characterized by 4 main types of water regime of rivers: The Kazakhstan type is widespread on the rivers of the steppe and semi-desert plain territories in the northwestern, northern and central parts of the republic. The features of this mode are an exceptionally sharp and high snow-melt flood wave (from 2-3 weeks to 1 month), when up to 90% of the total annual flow passes. And extremely low water period, when the flow is very small, until the rivers are completely dry. The Tien Shan type is characteristic of the rivers of South-Eastern and Southern Kazakhstan, whose sources lie in the zone of eternal snow and glaciers. On such rivers, the summer snow-melt flood is mainly due to the consistent melting of seasonal snow cover at various altitudes of mountainous areas and glaciers in the highlands. The Altai type is characteristic of the rivers of the mountainous regions of East Kazakhstan, whose basins are mainly located in the middle mountain zone. Such rivers are characterized by a stretched spring flood for 1-2 months, increased summer runoff with rain floods and low winter water period. The desert type is distributed on small temporary streams of arid central and western parts of the republic, where the runoff is observed only in short spring periods on the slopes of local territories, where it is developed into a network of drying streams of watercourses.

Causes of floods and flooding in Kazakhstan

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type river basins - the melting of seasonal snow cover on plains and low mountains, ice jams, liquid precipitation during snow-melt flood, as well as spring floods caused by the breakthroughs of ponds and reservoirs;

- In the Tien-Shan type river basins - intensive melting of seasonal snow cover in the mountains, heavy rainfall in the spring-summer period, mudflows, spring floods arising from the breakthroughs of mountainous, glacial lakes, and reservoirs;
- In the Altai type river basins - melting of seasonal snow cover, prolonged rains during the warm period of the year, ice-hazards phenomena on the rivers, breakthroughs of ponds and reservoirs;
- Desert-type basins also cause flood, but very rarely with heavy rains or rare anomalous melting of seasonal snow cover.

In Kazakhstan, dangerous floods and flooding of a natural character occur in the valleys of large, medium and small rivers of 25 km or more in length with snow-melt floods and spring floods, in the coastal zone of the Caspian Sea with wind surges of sea water, as well as in closed relief depressions with low filtration properties underlying soils.

The highest increases in water levels during snow-melt floods (5-10 or more m) are observed in the valleys of the largest lowland rivers of Kazakhstan: Ural, Tobol, Torgay, Esil, and Ertis and on their tributaries. On the middle rivers of the flat territory, the water level in the spring period rises to a lesser extent - up to 3-5 m. Still less, water levels rise in the valleys of the Mountain Rivers with the Tyan-Shan and Altai types of flow regime - up to 1-3 m, where there are relatively significant slopes.³ In the coastal zone of the Caspian Sea, the maximum water surges according to actual observations reach 2-3 m.³ Flooded areas are different - units, tens, hundreds and even thousands of km², which is determined by the terrain, river channel characteristics and hydrometeorological conditions, both previous and current. There are no official methods for assessing the economic, social and environmental damages associated with the harmful effects of water in Kazakhstan. Nonetheless, some disaster generalizations have been made.

For example, in 2014, based on the data of the Committee for Emergency Situations of the Ministry of Internal Affairs of the Republic of Kazakhstan, the authors carried out studies of the exposure of the Republic of Kazakhstan to natural emergencies for the period 2004–2013 and determined that 93 different EHP occurred in the republic during this period, leading to 58 floods, 9 spring floods, 5 flooding areas, 15 wind surges, 3 mudflows, one ice-hazards, one dangerous slope runoff, and one high groundwater level rise. The general consequences of these events were: 45 dead and 13,055 affected people, as well as direct economic damage - 41.36 billion tenge (or \$275.7 million).⁴ Probably, the magnitude of this damage is significantly underestimated in comparison with its real value, since only in 1993, flood damage was twice as high (see above). On the environmental damage caused by floods, there is no possibility to assert, because in Kazakhstan, no one has dealt with special studies of this problem.

In general, it can be concluded that the negative economic effect from floods in Kazakhstan is some fraction of one percent of the republic's average annual GDP. Climate is the most important factor determining the spatial and temporal patterns in the formation and flow regime on the territory of the republic, including the occurrence of EHP. The climate in Kazakhstan, as well as on the entire planet, is changing. According to the RGP "Kazgidromet" over the past 75 years, on average in Kazakhstan there is an increase in temperature by 0.280 and a decrease in the amount of precipitation by 0.2 mm every 10 years.⁵ In this connection, insignificant flow variations of various directions occur on the flat rivers of the republic.⁶ Against this background, there is an opinion among specialists about the possible activation of EHP, including floods.⁷ The test of this assumption in the RGP "Kazhydromet" of the year involved some experts. So, Dolgikh S.A. was found that for the periods of 1960-1990 and 1991-2012 in Kazakhstan there are the following EHP ratios: spring floods - 50/89; high snow-melt flood on rivers - 65/50; ice-hazards - 11/20; mudflows - 11/18. Similar comparisons were made by Kozhakhmetov P.Zh., who for the periods 1967-1990 and 1991-2015 several other EHP ratios was defined. For mountain rivers: spring floods - 54/96, mudflows - 11/20, ice-hazards - 8/17. For lowland rivers: high snow-melt water - 49/39, ice-hazards - 3/7.

The results of these comparisons show that in the last half-century period, the frequency of spring floods, mudflows, ice-hazards has increased, and the frequency of high floods has decreased. However, these conclusions should be considered as preliminary ones. In Kazakhstan, the prevention of hydrological risks is carried out on the basis of the legislation of the Republic of Kazakhstan in the areas of land and water relations, ecology, civil protection, on local government bodies, etc. In Kazakhstan in the field of prevention and mitigation of the consequences of hydrological risks, there are a number of shortcomings and gaps. Many settlements and objects are located in flooded areas and poorly protected by engineering and protective structures; the network of hydrometeorological monitoring and forecasting of EHP requires significant expansion and automation; the

population of the republic practically does not take part in self-defense from EHP and is poorly trained in the rules of behavior before, during and after an emergency. Early warning of possible EHP is practically not implemented and is not sufficiently taken into account in strategic plans and programs for the development of territories at various levels of government, etc.

In 2015, in order to reduce disaster risks in Kazakhstan with the assistance of UNDP, the updated "Plan of preparedness of the Republic of Kazakhstan for natural emergencies"⁴ and methodological foundations were developed and introduced into the state system of civil protection of the republic: "National Situational Safety Analysis of the Republic of Kazakhstan from natural and man-made disasters".⁸ Currently, the Committee on Emergency Situations of the Ministry of Internal Affairs of the Republic of Kazakhstan is also working to attract international progressive experience in the fields of innovative technologies for flood protection engineering and disaster risk management with the participation of the Center for Emergency Situations and Disaster Risk Reduction in Almaty as part of the Sendai Framework for Risk Reduction disaster for the years 2015-2030.

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Conflicts of interest

The author declares that there is no conflict of interest.

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