

ANALYSIS OF THE GEOGRAPHY AND IMPACTS OF FLOODS IN AZERBAIJAN

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Abstract

In the modern era, the sustainability of socio-economic development is directly related to environmental safety and effective management of natural disasters. The complex orographic structure of Azerbaijan makes a large part of the country's territory vulnerable to flood hazards. The presented research work analyzes the mechanisms of formation of flood events, the economic and geographical aspects of their damage to various sectors of the economy and population settlement. The research has determined that, along with natural and climatic factors, anthropogenic influences—deforestation, intensive exploitation of slopes and irregular settlement in river valleys—play a decisive role in increasing flood risk. In particular, in strategic economic regions such as Shaki-Zagatala, Guba-Khachmaz, Ganja-Dashkasan and Nakhchivan Autonomous Republic, the consequences caused by floods create serious obstacles to the sustainability of regional development. The scientific novelty of the work consists in studying flood events in their natural and anthropogenic interaction, and systematizing the regional differentiation of the economic damage they cause. At the end of the study, scientific and practical recommendations are put forward to optimize economic activity in risky areas, improve engineering protection systems, and ensure the safety of the population.

Keywords: *flood, orography, economic and geographical analysis, rainfall, river.*

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INTRODUCTION

A flood is a large volume of water, consisting of mud, water, and stones, that occurs suddenly and in a short time in mountainous areas, lasts for one or several hours, carries a large amount of solid and suspended sediment (up to 80%), and creates great danger and panic in the surrounding area with its violent and turbulent flows [1]. Floods differ from other natural disasters in terms of their speed (10-15 m/sec), duration (from 10 min to 10 hours and more), wave height (1.0-3.0 m), volume of solid materials washed and deposited from the area in a certain period of time (from 300 thousand m³ to

1.0 million m³ and more), and damage caused to population settlements and agricultural areas. Anthropogenic factors also play an important role in the occurrence of floods [1, 2].

Although the factors that cause floods in Azerbaijan are diverse, the main one is the relief conditions. The natural and geographical conditions of the Republic of Azerbaijan, especially the wide distribution of mountainous and foothill zones, dense river network and variability of climatic conditions, create conditions for frequent occurrence of flood events. These events, while being classified as natural disasters, also act as a critical factor limiting socio-economic development [3].

The study of the economic and geographical problems of flood events covers several important aspects [4, 5]. First, it is necessary to protect land resources and develop adaptation strategies to ensure the sustainability of agricultural production. Second, it is important to strengthen engineering measures and ensure the stability of infrastructure in order to increase the safety of settlements. Third, it is crucial to correctly direct the population settlement policy, plan new settlements in risk zones and optimize existing settlement structures.

The main goal is to analyse the impact of flood events on the economy and population settlement in the country from an economic and geographical perspective, determine the risk levels by regions and prepare scientifically based recommendations for reducing this risk.

The task was based on determining the scale and impact indicators of flood events in the regions, analyzing the impact on the productivity of agricultural areas and the use of land resources, studying changes in the location structure of settlements and population settlement conditions, comparatively assessing different risk levels in the regions, including preparing recommendations on engineering measures, adaptation strategies and settlement policies to prevent and reduce flood events.

From an economic and geographical point of view, the impact of flood events is manifested on a different scale across regions. In mountainous regions such as Shaki-Zagatala, Guba-Khachmaz and Mountainous Shirvan, as a result of the fragmentation of the relief and the intensity of precipitation, flood events take on a wider scale, the number of villages and the number of affected families is high. In these regions, the transformation of agricultural areas into floodplains leads to a decrease in productivity, weakening the economic sustainability of farms and worsening the social well-being of the population. On the other hand, in regions such as Lankaran-Astara and Nakhchivan, although the scale of flood events is relatively small, there are serious risks for the economy and settlement. This demonstrates that in addition to scale, the impact of floods is related to population density and economic structure.

Methods

The main material of the study is statistical indicators of flood events occurring in various economic regions of the Republic of Azerbaijan, the flooding of agricultural areas, the number of affected families and the scale of impact on settlements. This information was collected on the basis of reports of official state agencies, regional observations, records of hydro-meteorological services and information provided by local households. In addition, geographical maps, cartographic materials on relief and land cover, climatic indicators and hydrographic features of the river network are also included in the material base of the study.

The study applied economic-geographical analysis methods. The main methodological tools include statistical analysis, comparative-geographical approach, cartographic method, economic-geographical synthesis and analytical generalization.

Through statistical analysis, indicators on the scale of flood events, the size of flooded areas, and the number of affected families were studied in a comparative manner.

In the comparative-geographical approach, different indicators across economic regions were compared, and the relationships between the natural-geographical conditions of the regions and the scale of events were determined.

A visual map was prepared using a cartographic method based on 5-year precipitation data and the level of flood risk by area was shown.

Through economic-geographic synthesis, the impact of floods on the economy and population settlement was summarized and the mechanisms of impact on the socio-economic development of regions were identified.

Analytical generalization, risk levels for the regions were determined, and practical recommendations for agricultural and settlement policy were developed. Thus, the material and methodological part of the study forms the scientific basis of the research, provides a systematic approach to the study of floods from an economic-geographical perspective. This approach allows obtaining the necessary scientific results for the sustainable development of regions based on the integration of both natural-geographical conditions and socio-economic indicators.

Results and Discussion

Floods have typically spread and developed in mountainous areas of the United States, Japan, Italy, Central Asia, and the South Caucasus (Azerbaijan, Georgia, and Armenia). Since the Republic of Azerbaijan is a mountainous country due to its surface structure, almost 60% of its territory falls under flood risk areas [6]. After Azerbaijan gained independence, special attention was paid to preventing floods, which cause the most damage to the economy of the Republic than other disasters and always cause human casualties. However, the republic's financial difficulties are scientifically justified by the floods. The lack of study and implementation of comprehensive measures to combat them is the most important problem for Azerbaijan. Floods render lands, arable lands, forests, fruit and vineyard orchards unusable, destroy residential buildings, roads, engineering communication lines, various economic facilities, and cause human casualties. More than 100 urban and rural settlements located in 18 administrative regions of the republic (Shaki, Zagatala, Balakan, Gabala, Oguz, Goychay, Ordubad, etc.) are periodically or regularly exposed to floods [7, 8]. Floods in Azerbaijan cause recurrent damage to approximately 3.5 thousand hectares of arable land, more than 500 km of railways, and up to 2 thousand km of highways, as well as to over 300 km of electricity lines, 320 km of gas pipelines, 250 km of water supply networks, and other communication and social service infrastructures. Furthermore, nearly 1.0 million people live under constant flood risk, and the national economy suffers average annual losses estimated at 25–30 million manats as a result of this natural hazard [9].

Among flood phenomena, river floods represent the most decisive and influential component [10]. In the Republic of Azerbaijan, floods that occur almost every year in the rivers of Shaki-Zagatala, Guba-Khachmaz and Nakhchivan Autonomous Republic, and periodically in the mountain rivers flowing through the territories of the Ganja-Gazakh and Lankaran-Astara economic-geographical regions, cause severe damage to population settlements and various economic sectors, and sometimes result in human casualties. In this regard, the morphometric indicators of the relief of the indicated territories—relative height, vertical fragmentation and inclination—play an exceptional role in the formation of floods. The relief of the Republic of Azerbaijan starts from -27.5 meters below sea level and reaches the highest peak in the Greater Caucasus, Bazarduzu (4466 m), with a clearly defined vertical zonation. The area is sharply divided into north and south by denudation. The erosion relief form attracts attention. Various rock complexes have been formed here, differing in composition, structure and origin from the Paleozoic era to the modern era. These rocks change, break down, crumble and are carried by running waters from high relief areas to low relief areas as a result of the activity of various external

processes. In addition to these materials collected in alpine and subalpine meadows, the mainly mountainous relief of the area, its high fragmentation, and the lithological and chemical composition of the rocks also play an important role in the formation of floods. The flood rivers of the southern and north-eastern slopes of the Greater Caucasus mainly begin at 3000-3500 m above sea level, the rivers of the Lesser Caucasus and the Nakhchivan Autonomous Republic at 2500-3000 m, and the Talysh rivers at 1500-2300 m. Most of these rivers begin at bare peaks with no vegetation cover, high mountainous-rocky and steep slopes. Because the upper reaches of river tributaries are narrow and their slopes are extremely steep, large amounts of erosional materials accumulate at the bottom of such rivers [11]. The steep slopes of the middle mountainous zones, along with the debris and sediment materials that cause floods, also play an important role in the formation of floods, as do the tributaries and temporary stream valleys that join the main river and the sediments of the tributaries. For example, low terraces with a height of 20-25 m are widespread in the basins of each of the flood rivers flowing through the Shaki-Zagatala area. The terraces, floodplains and materials accumulated in the bed found in the Kishchay, Shinchay and other basins are the main source of flood nutrition. The structure of the river valleys, i.e. their narrowness or inclination, the filling of erosion, avalanche and landslide materials there, also play a major role in the formation of floods. Seismic processes, modern tectonic movements, faults and disruptions in the relief, and landslides also play an active role in the formation of floods. The formation and development of floods in rocks of different lithological composition are not the same. Thus, in rocks resistant to all types of denudation, the formation of floods is weak, while in areas where easily washed rocks are widespread, they are active. Since the tectonic structure of the territory of Azerbaijan is complex, the fact that the tectonic units of the Greater Caucasus are mainly sedimentary, and the Lesser Caucasus, Talysh and Nakhchivan are mainly composed of volcanic rocks also plays a different role in the formation of floods in river basins. The southern and northeastern slopes of the Greater Caucasus are steeper, and the area where denudation materials and sedimentary rocks accumulate more, so the initial conditions for the formation of floods are more favorable here [12, 13]. If we take into account that the area receiving the second highest rainfall in Azerbaijan after Lankaran-Astara is also the indicated area, then the reason why floods in these areas are intense and powerful becomes clear once again. In the Lesser Caucasus tectonic territorial units, except for the Nakhchivan Autonomous Republic, the rocks are mainly composed of volcanic rocks, so the erosion process is weak here and the precipitation is easily absorbed into the ground. Due to the relief of the Lesser Caucasus, it is less fragmented and has a lower slope than the Greater Caucasus. If the terrain in the Greater Caucasus covers areas with slopes from $30-40^{\circ}$ to $70-80^{\circ}$ in terms of flood formation, this indicator is reduced by half in the Lesser Caucasus tectonic zone. However, the ideas we have stated for the Nakhchivan Autonomous Republic do not justify themselves. This is because, despite the prevalence of volcanic rocks here, the terrain slopes up to $30-50^{\circ}$. On the other hand, since the continental climate prevails here, the erosion and fragmentation of rocks is more active. As the altitude increases, precipitation also increases, which plays an important role in flood formation. In Talysh, the terrain plays a secondary role compared to other mountainous areas [14]. Mountainous landscapes are also one of the reasons for the occurrence of floods. However, not all mountain landscapes can be considered favorable for the formation of floods. As a rule, floodplains do not form in constantly humid mountain-forest and subalpine landscape zones; even if the overall geomorphological and geological conditions create favorable conditions for the formation of floodplains, this process often does not occur. On the contrary, intensive atmospheric precipitation washes away weakly weathered materials from the slopes and channels of river valleys, causing little damage, or enriching these areas with vegetation. Since a lot of suspended materials accumulate in

floodplains on mountain slopes after long-term droughts, sudden heavy rains cause flood events that cause great losses. Thus, floods do not occur in all mountain landscapes and always at a certain time and place. In general, floods are more characteristic of transitional and continental sectors of mountain landscapes. One of the distinctive features of floods is that, despite occurring in the mountains, they cause great damage to the nature and economy of lowland areas. This is especially due to the use of various altitude zones for economic purposes. The partial or large-scale involvement of such areas in production causes severe damage to means of transport (bridges and roads), settlements, agriculture, and industrial facilities. Along with floods in mountain rivers, the fact that they cause floods in the areas where they enter the lowlands has a permanent negative impact on the territorial organization of the economy. Since the beds of mountain rivers are deep, no matter how strong the floods are, they do not go beyond the borders of the valleys and do not cause major disasters. When entering the lowlands, on the contrary, their consequences are accompanied by even greater disasters.

One of the main factors causing floods in Azerbaijan is the climate, and its two main factors - high-intensity solar radiation, which creates conditions for physical erosion; and a large daily amplitude of air and soil temperatures - actively participate in this. The occurrence and destructiveness of floods are related to the volume of materials brought by them, the amount and duration of precipitation. The period of greatest precipitation in the Greater and Lesser Caucasus of Azerbaijan mainly falls on the end of spring and summer, and in Talysh - on winter. In April-June, 250-300 mm of precipitation falls, and in July-September - 90-100 mm. Intensive precipitation that causes a flood often goes beyond the absolute maximum. Climatologists have determined that in Azerbaijan, torrential rains with an intensity of 0.4-2 mm per minute and 20 mm per day can cause floods. The southern slope of the Greater Caucasus Mountains stands out from other areas in terms of the intensity, frequency and amount of precipitation. The most torrential rains are observed here in spring and autumn. However, due to the massive deforestation and destruction of vegetation in the republic over the past 20 years, even heavy rains with an intensity lower than the above indicators can cause floods. As a result, if previously flood events on flood-prone rivers were repeated every 5-10 years, in recent years this process has intensified and is repeated every 3-5, and even every year in some rivers. Precipitations that cause floods often occur as a result of the entry of cold air masses with high humidity into the territory of the Republic of Azerbaijan. Cyclones that formed over the Balkan and Asia Minor peninsulas and passed to the countries of the South Caucasus, including Azerbaijan, have also recently become one of the factors that cause floods by causing heavy precipitation. In such cases, the air temperature drops by 10-15° compared to previous days, and the amount of humidity in the air increases. Such a situation is observed at the upper borders of forest areas and in meadows. When the amount of precipitation per day is 50-60 mm, and sometimes 80-100 mm, a strong flood occurs.

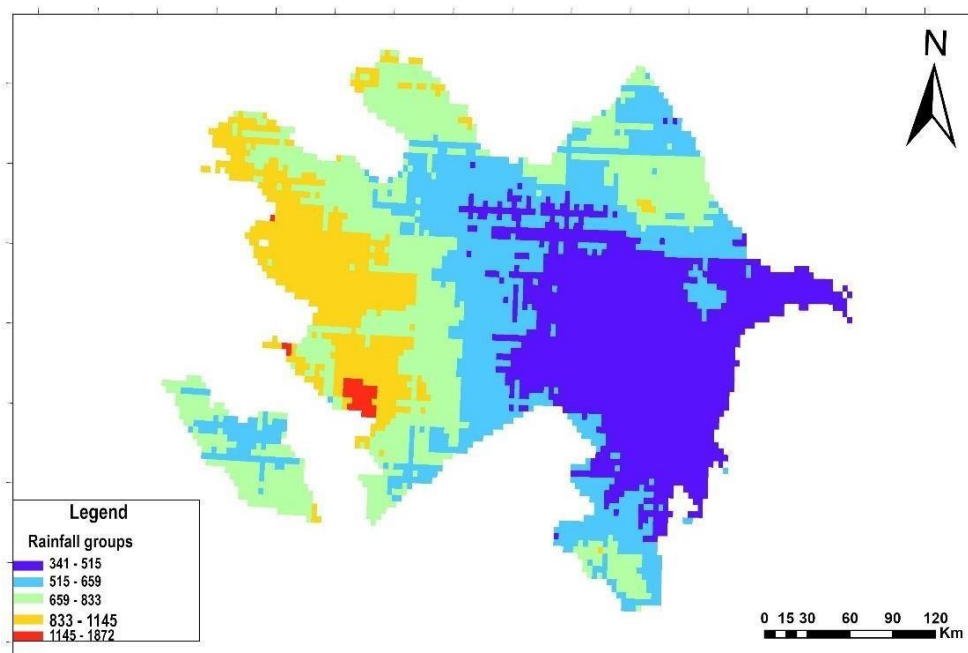


Figure 1. Azerbaijan average annual precipitation map (2020-2025)

Source: CHRS Data Portal

One of the main factors causing floods is heavy snowfall in mountainous areas in winter, followed by rapid melting as a result of sudden increases in temperatures in late spring and early summer. Snowfall plays a key role in the formation of rivers with high water storage capacity. These rivers are included in the group of rivers with spring-summer floods.

One of the factors causing floods in the republic is its hydrological conditions. Hydrological conditions include the water content of rivers, bottom and suspended sediments, surface runoff, river food sources, rainfall, etc. Flood-prone rivers of Azerbaijan discharge 35-50 % of their annual water volume in the spring months, and 15-40 % in the summer. This is the result of feeding with snow waters. Studies show that permanent snow cover begins at an altitude of 1200-1400 m. However, depending on the orientation of the mountain slopes and humidity conditions, each mountainous region is characterized by its own characteristics of snow cover distribution. In Azerbaijan, the most snow falls on the southern slope of the Greater Caucasus, where the maximum snow thickness varies between 90-120 cm. Since winter in the Lesser Caucasus is relatively mild and with little precipitation, the maximum height of the snow cover falling here is 50-70 cm. In the middle and high mountainous areas of the Greater and Lesser Caucasus, the duration of snow cover is 1-3 months, and in Talysh it is 1-3 weeks, and sometimes even a week [15]. The duration of snow cover and its melting properties in the republic often lead to the formation of strong flood flows in the spring-summer season, when snow melts, coinciding with heavy rains. The snow feeding of rivers and their role in the formation of floods differs in different regions of Azerbaijan in terms of quantity. Thus, in rivers with high catchment areas, snow feeding is 20-40% for rivers flowing from the Shaki-Zagatala and Mountainous Shirvan territories and 20-45% for the rivers of Guba-Khachmaz. In the lower catchment river basins of the indicated areas, snow feeding rarely reaches 25%.

In the high catchment areas of the Lesser Caucasus, snow water feeding accounts for 25-40%. Rain water feeding is the mainstay in rivers with low catchments. In the Greater and Lesser Caucasus, in Talysh, rainwater creates strong floods when it overlaps with the snowmelt. In Talysh, floods occur only

once every 5-10 years due to rainwater. This situation is also characteristic of the southern and northeastern slopes of the Greater Caucasus in Azerbaijan [16].

One of the factors causing floods is the decrease in the resistance of the soil and vegetation of the area. In this regard, the massive deforestation of forests in the mountainous areas of Azerbaijan, the excessive loading of alpine and subalpine meadows with livestock, and the intensity of physical erosion as a result of the exposure of bedrock in the rocky part of the high mountain zone play an important role in the formation of floods. Since the slopes are steep and more inclined, the erosion materials are blown away by their own weight, forming rockfalls and debris. Deep ravines, surface washouts, and trails form on the soils of the alpine zone. Since the grass layer is poorly developed on such soils, the mountain meadow zone covers bare areas in many places. The presence of glaciers and snow cover here creates conditions for the development of glacial erosion. In fact, the snow and glacier areas here are considered the source of floods, and floods are formed from here.

The terrain of the mountain forest areas is complex, cut by steep slopes and deep ravines. Due to the high deforestation in the areas bordering the forest massif and the meadow zone, the forest boundary has become very low. On average, 1.5-2% of the forest-covered area in the republic is massively cut down and destroyed by people every year. Over the past 30 years alone, 7,000 hectares of the republic's total forest area have been destroyed. Since the soils of the areas cleared of forests are quite soft, they are also actively washed away by flood waters. Over the past 30 years, mass deforestation and the denudation of 20-30% of the forest-covered areas, the loading of pastures and hayfields above the norm (3-4 times), and the involvement of floodplain river basins for cultivation play a special role in the formation and intensification of floods in the republic [17, 18].

Over the past hundred years, 1484 floods have occurred in the rivers of the Republic of Azerbaijan, causing an average of 2.0-2.5 billion manats of damage to the country's economy. 561 settlements and 15 cities with a population of 1.2 million across the republic - Shaki, Zagatala, Gakh, Balakan, Nakhchivan, Ordubad, Julfa, Guba, Gusar, Shabran, Goychay, Agsu, Masalli, Lankaran and Astara - are exposed to floods. The impact of the flood event on settlements and population in the economic and geographical regions of the republic is clearly reflected in the table below. Currently, there are 171 in Shaki-Zagatala with a population of 400 thousand people, 23 in Nakhchivan AR with a population of 48.2 thousand people, 154 in Guba-Khachmaz with a population of 212 thousand people, 70 in Mountainous Shirvan with a population of 171.2 thousand people, 50 in Ganja-Dashkasan with a population of 102.2 thousand people, 64 in Gazakh-Tovuz with a population of 120.4 thousand people, in Lankaran-Astara, 29 settlements with a population of 95.8 thousand people are affected by floods [9]. The most active seasons for the occurrence of flood processes in Azerbaijan are April-May, July-August and September-October. Of the floods occurring in the territory of the republic, 67.8% or 458 occurred in the Greater Caucasus, 17.6% or 119 in the Nakhchivan Autonomous Republic, 12.1% or 82 in the Lesser Caucasus, and 2.5% or 17 in Lankaran-Astara [9].

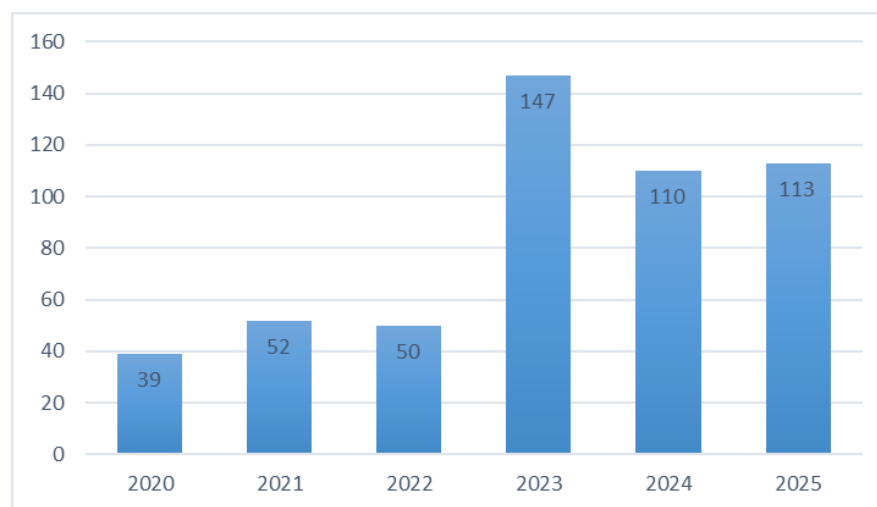


Figure 2. Recurrence of flood events by year in 2020-2025

Analysis of the figure shows that while 39 events were recorded in 2020, this figure increased to 52 in 2021, 50 in 2022, and 147 in 2023. The recording of 110 and 113 events in 2024 and 2025, respectively, indicates that flood processes have become particularly intense in recent years and cover a wide area. The temporal distribution clearly shows that flood events are concentrated mainly in the spring and summer months. The majority of the dates fall in the months of April-June and July-August, which is explained by the intensification of torrential rainfall and the melting of snow reserves in high mountainous areas. At the same time, the repeated occurrence of events in a number of rivers in September-October also indicates that the flood risk is significant in the autumn season. Therefore, the danger is not limited to the spring-summer season and remains relevant during the wet periods of the year.

Between 1996 and 2025, heavy rainfall, floods and mudflows were recurring, severe hydrometeorological processes in various regions of the republic. These processes were examined not merely as temporary water surges but as phenomena that generate substantial material and economic consequences. The principal sectors affected include agriculture, transportation and engineering infrastructure, housing, irrigation systems, and public services.

Specifically, floods have caused complete and partial destruction of agricultural products, soil erosion and loss of topsoil, failure of roads, bridges and engineering structures, damage to household and farm facilities, disruption of irrigation systems, and failure of electricity and communication lines.

Analysis of materials for 1996–2025 shows that floods, in addition to being an extraordinary hydrometeorological risk for Azerbaijan, should be characterized as a more persistent economic and social problem.

If we look at the statistics of flood events in the Republic, in 1996-2006, their recurrence was recorded approximately 10-15 times per year, while in 2007-2019 this figure increased to 20-25, and in 2020-2025, it reached an average of 68, with a total of 404. In fact, this analysis shows that flood events have increased approximately 3 times in the Republic in the last 5 years.

Table 1.

General indicators of the impact of the flood event on settlements and population in the regions of Azerbaijan

No.	Economic regions	Number of villages affected by floods	Floodplain area/ha	Number of families affected by floods
1	Shaki-Zagatala	171	9522	54569
2	Guba-Khachmaz	154	4982	14808
3	Mountainous Shirvan	70	1749	9546
4	Ganja-Dashkasan	50	1198.2	4532
5	Gazakh-Tovuz	64	1504.8	7867
6	Lankaran-Astara	29	800	3628
7	Nakhchivan	34	531	3309
Total Republic-wide		561	20286	98259

The impact of flood events on the regions in Azerbaijan has serious socio-economic consequences on a nationwide scale. In total, 561 villages were affected by floods, 20.3 thousand hectares of land were flooded, and 98.3 thousand families suffered damage. These figures show that flood events significantly affect agricultural production, the sustainability of infrastructure, and the daily lives of the population.

The most affected region is the Shaki-Zagatala economic region. Here, 171 villages were affected by floods, 9.5 thousand hectares of land were flooded, and 54.6 thousand families suffered damage. These indicators are the highest in the country both in terms of the number of villages and the damage to the population. The mountainous terrain of the region and the dense river network increase the risk of floods, and as a result, the scale of the impact is wider. The Guba-Khachmaz economic region is also distinguished by high indicators, where 154 villages, up to 5 thousand hectares of land and 14.8 thousand families suffered damage from floods. Although the number of villages in this region is large, the number of families affected by floods is smaller than in Shaki-Zagatala.

Among the regions with medium-scale impacts, the regions of Mountainous-Shirvan, Gazakh-Tovuz and Ganja-Dashkasan should be noted. Although 70 villages and 1.8 thousand hectares of land in Mountainous-Shirvan were affected by floods, the number of affected families is 9.6 thousand, which is a high indicator compared to the size of the area. In Gazakh-Tovuz, 64 villages, 1.5 thousand hectares of land and 7.9 thousand families, and in Ganja-Dashkasan, 50 villages, 1.2 thousand hectares of land and 4, thousand families are at risk of flooding.

Relatively less affected regions include Lankaran-Astara and Nakhchivan Autonomous Republic. In Lankaran-Astara, 29 villages, 800 hectares of land and 3,628 families are at risk of flooding, and in Nakhchivan, 34 villages, 531 hectares of land and 3,309 families are at risk of flooding. Although the scale of the flood event in these regions is smaller, there are risks for agriculture and social life.

Overall, the analysis shows that flood events pose serious obstacles to the socio-economic development of regions in Azerbaijan. In the most affected regions, agricultural production, infrastructure and living conditions of the population suffer the most. These indicators necessitate strengthening flood engineering measures in the regions, developing adaptation strategies in agriculture and improving population safety plans.

These statistical indicators on floods show that over the past 20 years, the frequency of floods in the republic has increased 3 times, and the area of floodplains and their distribution areas have increased 1.5-2 times. If until 1990, floods caused an average of 17-20 million manats of damage to the republic's economy per year, now this figure is 25-30 million manats.

Recently, strong floods have been repeated almost every year in all mountainous and foothill areas of

Azerbaijan, especially in the rivers of the southern and northeastern slopes of the Greater Caucasus and the Nakhchivan Autonomous Republic, and periodically in the rivers of the Lesser Caucasus and the Talysh Mountains. More than 150 rivers with floods have been registered in the republic, of which 67 are considered more dangerous. In particular, floods occur periodically in 16 rivers in Shaki-Zagatala, 4 in Mountainous Shirvan, 12 in Guba-Khachmaz, 12 in Nakhchivan Autonomous Republic, 2 in Ganja-Dashkasan, 4 in Gazakh-Tovuz, 2 in East Zangezur, 6 in Karabakh, 2 in Absheron-Khizi and 5 in Lankaran-Astara. Due to increasing human interference with the environment, if floods in the republic used to occur every 5-10 years, in recent years this process has intensified and is repeated every 3-5 years, and even every year in some rivers.

It is mainly concentrated on the southern slope of the Greater Caucasus (Balakan-Zagatala-Gakh-Shaki-Gabala), on the northeastern slope of the Lesser Caucasus (Ganja-Dashkasan-Gadabay-Tovuz) and partly in the Shamakhi-Ismayilli zone. This is directly related to the intensity of heavy rainfall in these areas, the morphometric characteristics of river basins and the lithological composition of rocks. Up to 20% of floods occurring in the country occur at altitudes of 1000 m above sea level, 60% at 1500-2000 m, and 20% at 2500-3500 m, while the damage to the economy and population is greatest at altitudes of 500-1000 m [6].

The area most affected by floods in the country is agriculture. The total land fund of the republic is 8641.5 thousand ha, of which 6.2% (5.4 thousand km²) is located in floodplain areas. More than 2.6 million hectares of the total land fund of the republic have been washed away as a result of floods and have lost 60-70% of their productivity. In Shaki-Zagatala this indicator is 597 thousand, in Ganja-Dashkasan 212 thousand, in Gazakh-Tovuz 315 thousand, In the Nakhchivan Autonomous Republic, it is 402 thousand, in Guba-Khachmaz - 356 thousand, in Shamakhi-Ismayilli - 312 thousand, and in Lankaran-Astara - 192 thousand hectares. Although these are indicated as arable land in the reports of the indicated economic and geographical regions, in reality they are used only as pastures. It takes many years and a large amount of funds to restore and restore such land areas to their previous state.

The most damaged area by the flood is crop production. Crop production accounts for 18.8% of Azerbaijan's agricultural lands and 62.4% of the average annual income from this sector in the republic (1726.4 million manat) [19]. Considering the hydrometeorological data for 2020-2025, we see that during the floods in different regions, 470.8 thousand ha of grain, 920 ha of tobacco, 87 thousand ha of vegetables, 52 thousand ha of orchards, 23 thousand ha of vineyards, 47 thousand ha of pastures and hayfields were significantly damaged in the republic, and in general, 32 million manats of direct damage was caused to the crop production sector [9].

Among the agricultural sectors affected by floods, livestock farming is the most affected. 37.6% of the income from this sector (1038.6 million manat) falls on livestock farming. The subalpine and alpine meadows, winter pastures, perennial forage crops and favorable natural and climatic conditions of the Republic of Azerbaijan create great opportunities for the comprehensive development of this sector. Our research shows that every year, as a result of natural disasters, livestock farming suffers an average of 1.5-2 million manat in damage, which is approximately 0.2% of the income from livestock farming. When analyzing the research period (2020-2025), we determined that 3470 hectares of pastures and grazing land became completely unusable as a result of floods. The damage to livestock farming is particularly evident in the destruction of small and large cattle (in terms of head count).

One of the areas regularly exposed to floods in the republic is the road system. Floods on the international western (Baku-Agstafa-Tbilisi), southern (Baku-Astara), southwestern (Baku-Alat-Julfa) and northern (Baku-Khachmaz-Derbend) highways lead to major disruptions and economic losses. If we look at individual regions of the republic, 6 km of republican highways and 14 km of local roads in

Absheron, 22 km and 254 km in Shaki-Zagatala, respectively, 14 km and 36 km in Ganja-Gazakh, 2 km and 8 km in Lankaran-Astara, 24 km and 120 km in Nakhchivan Autonomous Republic are under flood threat. Including 74 km of local roads in Mountainous Shirvan, 12 km in Eastern Zangezur, and 134 km in Karabakh, they are periodically damaged by floods [20]. In particular, the total length of highways in the Shaki-Zagatala economic-geographic region is 1801 km, of which 704 km or 39.1% fall on flood-prone areas. Also, the Shaki-Balaken, Shaki-Gakh, Oghuz-Gakh, Oghuz-Shaki, Zagatala-Birinci Tala, Gabala-Vandam highways and up to 300 km of dirt roads connecting up to 70 rural settlements are subject to flooding [20]. The First Shamakhi-Ismayilli-Shaki-Balaken highway, which passes through the Mountainous-Shirvan and Shaki-Zagatala economic-geographic regions and continues to the Georgian border, suffers more damage from floods. This road passes at a considerable distance from a number of regional centers belonging to the Shaki-Zagatala economic-geographic region, and operates mainly through bridges built over rivers where floods occur intermittently. In these areas, the flow of stones and gravel destroys the roads and makes them unusable. Although bridges were built over the Kishchay, Talachay, Balakenchay, and Kurmukchay rivers, which the aforementioned highway crosses, the roads on the Shinchay and Mukhaxchay rivers were mainly built along the river valleys. Since the First Road mentioned above is more exposed to flood danger, it has been converted from a road of republican importance to a road of local importance. Therefore, the Second Khaldan-Zagatala-Balaken highway was built parallel to the First Highway. Compared to the First Highway, the Second Road is less exposed to flood danger. Although floods do not destroy the mentioned roads and bridges, they cover the roads with silt, and as a result, they have a negative impact on the normal movement of automobile transport. This highway of republican importance passes 44 km from Oguz and 16 km from Shaki and Gakh. Since more than 80% of local roads are dirt roads between settlements, they are more susceptible to floods. Since the Shaki-Zagatala economic-geographic region is a classic flood region, the roads between villages here are more exposed to natural disasters.

In the Nakhchivan Autonomous Republic, there are Ordubad-Julfa, Nakhchivan-Shahbuz, Shahbuz-Bichenek highways and Local roads connecting 21 rural settlements are subject to flooding. In the territory of the Mountainous Shirvan economic-geographic region, the highways of republican importance are Agsu-Goychay, Agsu-Ismayilli, Ismayilli-Basqal; in the Gazakh-Tovuz economic-geographic region, Ganja-Dashkasan-Khoshbulag, Shamkir-Tovuz and Lankaran-Lerik in the Lankaran-Astara economic-geographic region are damaged by floods. Motorways connecting 70 villages in the Shaki-Zagatala economic-geographic region, 60 in the Guba-Khachmaz economic-geographic region, 32 in the Gazakh-Tovuz economic-geographic region, 26 in the Nakhchivan AR, 24 in the Mountainous-Shirvan economic-geographic region and 18 in the Lankaran-Astara economic-geographic region are operating under the threat of floods.

When a flood occurs, it destroys road embankments and bridges, disrupting the connections between administrative districts, settlements and the capital of the republic for a long time. This, in turn, leads to disruption of the rhythmic activity of production and non-production sectors. Therefore, when new roads are built, they are built in the floodplain. Rivers should be diverted from their basins, bridges should be built, and highways passing through river valleys and floodplains should be protected from floods. Protective structures and concrete barriers should be built to prevent collapse.

Constructing bridges over rivers in each season and utilizing them within the construction industry can provide substantial benefits. Moreover, in areas where bridges are built over rivers prone to flooding, there is a significant need for the establishment of protective embankments along both banks at a distance of 150–200 meters.

One of the areas exposed to floods is railway transport. The Baku-Agstafa-Tbilisi, Baku-Khachmaz-Derbend and Baku-Astara main railways are very rarely affected by natural disasters. The Baku-Alat-Julfa line, on the other hand, suffers from constant flooding. In particular, the Ordubad-Sharur and Kerchivan-Salammalik sections of this main railway are damaged by constant flooding. The Nakhchivan Autonomous Republic natural disasters, especially floods, have always created major problems in the rhythmic development of the railway, its normal freight and passenger transportation. Although floods do not destroy these roads and bridges, they cover them with silt, thus negatively affecting the normal movement of railway transport. They disrupt the rhythmic activity of railway transport, sometimes railway trains do not operate for several days or hours. There are major interruptions and problems in the timely delivery of important cargo of various purposes to the home. Meanwhile, the damage caused by permanent flooding of the Baku-Alat-Julfa railway line of international and republican importance is noteworthy. In particular, the Ordubad-Sharur (Ordubad-Julfa, Julfa-Babek, Givrag-Sharur) and Kerchivan-Sallammelik sections of this highway are damaged by permanent flooding. Compared to automobile transport, the flooding of the area was mainly taken into account in the construction of the railway line. Therefore, this area suffers very little damage.

One of the areas exposed to floods is pipeline transport. Pipeline transport in the country is represented by oil and gas. According to the 2013 statistics, the length of the main pipelines in the republic is 4091 km, of which 1418 km (34.7%) are oil pipelines, and 2673 km (65.3%) are gas pipelines. The international Baku-Tbilisi-Ceyhan (1730 km), Baku-Tbilisi-Supsa (920 km) highways pass through Girdimanchay, Agsuchay, Turyanchay, Garachay and Yevlakh, then through Kurekchay, Ganjachay, Shamkirchay, Zayamchay and Tovuzchay to enter the territory of Georgia. These highways cross the Kura River twice in Azerbaijan. The specified highways pass through flood-prone areas and are protected by temporary protective dams. The Baku- Novorossiysk (1346 km) main oil pipeline also crosses the flood-prone Valvelachai, Gudyalchay and Gusarchay basins. Locally important pipelines pass mainly through the Absheron and Aran economic-geographic regions and are far from flood-prone areas. These lines connect oil fields with oil refineries in the country.

The Astara-Hajigabul and Baku-Agstafa-Tbilisi main gas pipelines, as well as the Baku, Shamkir, Siyazan, Zagatala, Shirvan, Mingachevir, Ganja, Sumgayit and Lankaran gas supply nodes, pass through various river basins and are often subject to flooding. Since pipelines in the republic are mainly laid parallel to roads and railways, complex protection measures are necessary to protect the transport system from flooding.

One of the important objects damaged by floods in the republic is bridges and hydrotechnical structures. The length of bridges of republican importance is 25.7 km, of which 6.4 km, the length of bridges of local importance is 14.3 km, of which 6.8 km are permanently damaged by floods. Most of the bridges in other regions, except for the Aran and Absheron economic-geographical regions, are exposed to floods. Therefore, both passive and active methods should be used to protect the transport system in the republic from floods.

One of the important areas damaged by floods in the republic is its communication system. The country's communication system is more vulnerable to natural disasters, covering gas and water pipelines, telephone and television lines, bridges and hydrotechnical facilities, water distribution locks and other networks. One of the areas that floods in Azerbaijan constantly damage and render useless is the republic's water and sewage network. The total length of water pipelines in the republic is 3515 km, of which an average of 250-300 km is exposed to floods every year. Including 30 km in Guba-Khachmaz, 27 km in Mountainous Shirvan, 110 km in Shaki-Zagatala, 47 km in Ganja-Dashkasan, 36

km in Gazakh-Tovuz, 24 km in Nakhchivan AR and 47 km in Lankaran-Astara water pipelines are constantly exposed to floods.

One of the areas exposed to floods is irrigation canals. The total length of irrigation canals in the republic is 72 thousand km, of which an average of 8-10 km are destroyed and become unusable as a result of floods every year. In particular, 24 km in Lankaran-Astara, 34 km in Guba-Khachmaz, 36 km in Shaki-Zagatala, 56 km in Ganja-Dashkasan, 47 km in Gazakh-Tovuz, 46 km in Mountainous Shirvan and 18 km in Absheron irrigation canals become unusable as a result of floods, and a large amount of funds are allocated every year for the restoration of this system. Also, 128 of the 1645 pumping stations registered in the republic and 1206 of the 35.4 thousand hydrotechnical installations are located in flood-prone areas [20]. In particular, water pipelines, water distribution sluices, irrigation systems, communication lines and the Samur-Absheron canal of cities in the Shaki-Zagatala, Nakhchivan Autonomous Republic, Guba-Khachmaz and Lankaran-Astara regions are periodically damaged by floods. The centralized water pipeline systems of the republic are more exposed to natural disasters. 3687 km of centralized water pipelines are used in 481 settlements of the republic, of which 700-800 km are damaged by floods every year. Accordingly, the areas where 224 km of water pipelines pass in Shaki-Zagatala, 72 km in Guba-Khachmaz, 14 km in Lankaran-Astara, and 94 km in Nakhchivan Autonomous Republic are constantly at risk of floods. Such disasters occurring in areas traversed by communication systems disrupt the normal functioning and daily activities of the population while simultaneously exacerbating unsanitary conditions due to the absence of an integrated sewage network.

The economic and geographical impact of the flood event on the country's economic system and population settlement requires the development of a complex geographical forecast system for natural disasters in the long-term socio-economic development strategy of the Republic of Azerbaijan, its regions and districts. In this context, economic and geographical zoning of a flood event (microzonation) can help predict and neutralize a natural disaster in the life and economic activities of the population by anticipating it in a certain spatial-temporal interval. The main goal of economic and geographical zoning of a flood is to help develop an effective management mechanism so that this problem does not create difficulties in the territorial organization of production and population settlement. When conducting zoning, we paid special attention to the studies of many researchers who have conducted research in this area. We used indicators of direct damage caused by floods to residential areas and agricultural areas, paying special attention to physical and geographical indicators such as the extent of the flood and its destructive activity. In the meantime, the following 7 regions have been distinguished in the Republic of Azerbaijan depending on the damage caused by floods to agricultural areas and settlements:

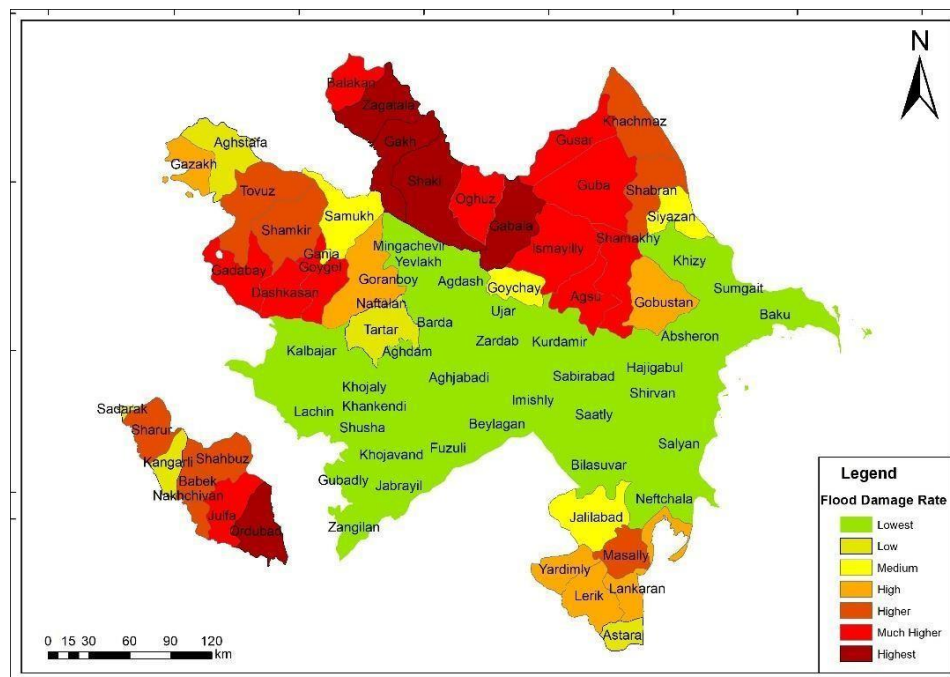


Figure 3. Flood damage risk zones of Azerbaijan

- In the region where flood damage is more severe - it can be said that 6-8 flood events are observed every year. This region includes 151 settlements with a population of 66.8 thousand people. Including, in the Shaki region, 29 settlements with a population of 13 thousand people, 18.8 thousand ha of arable land, 9.2 thousand ha of summer pastures and 11.8 thousand ha of forested areas; in the Zagatala region, 40 settlements with a population of 10.8 thousand people, 26 thousand ha of arable land, 25.6 thousand ha of summer pastures and 51.3 thousand ha of forest; in the Gakh region, 29 settlements with a population of 23.8 thousand people, about 20 thousand ha of arable land, 39 thousand ha of summer pastures and 43.8 thousand ha of forest; In the Gabala region, 33 settlements with a population of 7,000 people, 26,700 ha of arable land, 47,400 ha of summer pastures and 50,300 ha of forest land; in the Ordubad region, 20 settlements with a population of 12,200 people, 18,000 ha of arable land and 5,400 ha of summer pastures are periodically affected by floods. In total, 26 flood events were recorded in this region in 1990-2014, of which 4 were relatively weak and caused little damage, and 22 were strong and caused large losses, causing an average of more than 20 million manats of damage to the country's economy every year.

- In the region where flood damage is strongly observed - 6-7 flood events occur per year and unites 11 regions (Balakan, Oghuz, Guba, Gusar, Ismayilli, Agsu, Shamakhi, Goygol, Julfa, Gadabay, Dashkesan). This region includes 247 settlements with a population of 230.6 thousand people. The territory of the region mainly covers areas from 300 m to 3000 m and higher above sea level, altitudinal zones from semi-desert to mountain-tundra. The total seismicity of the region is mainly 8-9 points, and the annual amount of precipitation can vary from 400-600 mm to 1200-1400 mm. Over the past 20 years, 14 flood events have been observed in the region, 4 of which were relatively weak and 8 were strong. In this region, 218.1 thousand hectares of arable land and 176.8 thousand hectares of meadows and summer pastures are regularly damaged by floods, resulting in 10-15 million manats of damage to the republic's economy every year.

- *The region where the most damage caused by the flood was observed* - includes 105 settlements with a population of 130.2 thousand people and covers the territories of Shabran, Khachmaz, Tovuz, Shamkir, Shahbuz, Babek, Masalli and Sharur districts.

- *The region with the highest flood damage* is the one that includes 46 settlements with a population of 121.7 thousand people and covers the territories of Gobustan, Goranboy, Gazakh, Lankaran, Yardimli, Lerik regions. 52.4 thousand ha of arable land and 112.6 thousand ha of pasture and pasture land in the region are affected by floods. During the study period, 8 flood events were recorded in the region, and the country's economy suffered an average of 5-10 million manats of damage annually.

- *The region with moderate flood damage* - includes 42 settlements with a population of 80 thousand people, covering the territories of Siyazan, Goychay, Jalilabad, Hajigabul, Samukh regions. During the study period four flood events were recorded in the region, and strong floods occur every 10-15 years in the mentioned regions.

- *The region where flood damage is less observed* – covers the Sadarak, Tartar, Astara, Kangarli regions with a population of 75 thousand people. Here, strong floods occur every 15-20 years. The average flood damage to this region is 0.5-1.0 million manat.

- *The region where flood damage was less observed* – Baku, Absheron-Khizi, Central Aran, Mil-Mugan, Shirvan-Salyan, and Karabakh and East Zangezur regions. In this region, the recurrence of a strong flood event is very rare, occurring once every 20-30 years.

CONCLUSIONS

Thus, the economic and socio-geographical problems caused by the impact of floods on the economy in Azerbaijan were studied and the following results were obtained:

Thus, the economic and socio-geographical problems formed as a result of the impact of floods on the economy of Azerbaijan were investigated and a number of results were obtained. Natural and anthropogenic factors causing floods in the territory of the republic, as well as flood sources, were identified. The impact of floods on the organization of agricultural territories and population settlement was studied for the first time from an economic and socio-geographical perspective through a historical, statistical, systematic approach, regionalization and cartographic methods. In addition, insurance activity in Azerbaijan was analyzed from an economic and geographical perspective in the context of the damage caused by floods to the population and agricultural sectors. To protect the economic system of the republic from floods, a complex of both passive and active methods should be used. Passive methods include forest-melioration and agro-melioration measures. This includes regulating cattle grazing on mountain slopes, protecting forest, grass and shrub cover, establishing forest belts along river beds and highways, proper observance of agrotechnical rules in agriculture, terracing of slopes and other measures.

Pastures in the high mountainous areas have a great influence on the development of flood events. Erosion is more common in areas without forests. Therefore, forests are of great importance in preventing erosion processes and floods. It can be concluded that mountain forests have a water and soil protective role. Thus, within the framework of measures to reduce and eliminate flood flows, the mountain forests of the Southern slope of the Greater Caucasus and the Nakhchivanchay basin should be declared national parks and reserves, and it is important to regulate livestock grazing to increase the productivity of pastures.

The above-mentioned measures should be implemented first in overused summer pastures, in flood-prone basins of the Talachay, Kurmukchay, Shinchay, Kishchay, Turyanchay, Nakhchivanchay and Ordubad rivers. The placement of industrial facilities, construction of roads and other facilities should be carried out under strict control.

The centuries-old experience of combating flood flows in the mountainous countries of the world - the Balkans, the Carpathians, the Apennines, the Alps, the Pyrenees, the Cordilleras, the Andes, and the CIS should be used. It is also of great importance to carry out complex measures against flood flows, consisting of both forest-melioration and hydrotechnical works. Strengthening slopes that are dangerous for floods and erosion and raising the border of forests higher (2600 m higher), planting drought-resistant and cold-resistant tree species and shrubs should be taken into account. Also, the measures to combat the flood in the floodplain should be carried out in 2 zones - in the alluvial cone and river valleys, mainly aimed at reducing the power of the flood. The strong flow that brings the flood mass from the mountain must first be weakened in the floodplains and then in the confluence.

One of the active and important and reliable measures directed against floods is the implementation of engineering and installation works. The experience of constructing and commissioning hydrotechnical facilities in the coastal zones of flood-prone rivers shows that these measures are highly effective in weakening flood flows. In engineering and installation works carried out against floods, complex measures should be implemented, such as intercepting flood flows above the protected object, releasing and removing flood flows from the risky object, protecting the river bed from washing out and facilities from the impact of the flow. In this regard, carrying out bank strengthening works against floods in 22 flood-prone river basins of the Republic is one of the main provisions envisaged in the State Program. However, the results of our research show that the number of flood-prone rivers in the territory of the Republic of Azerbaijan exceeds 60. Therefore, it is important to carry out engineering and installation works along 555 km as well as across at least 30,000 km. Reinforced concrete structures should be used more widely in the fight against flood flows. Thus, reinforced concrete structures are useful in combating flood flows of any strength. However, the size of the flood flows, i.e. the specific gravity and impact force, should be taken into account here. In order to protect highways from flood flows, as well as to ensure uninterrupted movement on mountain roads throughout the year, these or other structures should be used, taking into account the physical and geographical conditions of the area. It should be noted that extensive experience has been gained in the Republic of Azerbaijan and on the railways of the South Caucasus against floods.

These measures can also be used on highways in mountainous regions. In order to protect highways from the destructive effects of flood flows, it is important to build a large number of bridges of great length.

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REFERENCES:

- [1] Javadinejad, S. (2022). Causes and consequences of floods: Flash floods, urban floods, river floods and coastal floods. *Resources Environment and Information Engineering*, 4(1), 173–183.
<https://doi.org/10.25082/REIE.2022.01.002>
- [2] Hoang Duc, V., & Liou, Y.-A. (2024). Assessing the influence of human activities on flash flood susceptibility in mountainous regions of Vietnam. *Ecological Indicators*, 158, 111417.
<https://doi.org/10.1016/j.ecolind.2023.111417>

- [3] Mammedov, R. (2006). Transboundary floods in Azerbaijan. In J. Marsalek, G. Stancalie, & G. Balint (Eds.), *Transboundary floods: Reducing risks through flood management* (NATO Science Series IV: Earth and Environmental Sciences, Vol. 72). Springer. https://doi.org/10.1007/1-4020-4902-1_21
- [4] Mtibaa, S., Maeno, K., Islam, K., & Motoshita, M. (2025). Potential risk by riverine floods in the global economy: Sector-wise assessment of direct and indirect impacts through international trade. *Journal of Environmental Management*, 393, 127041. <https://doi.org/10.1016/j.jenvman.2025.127041>
- [5] Svetlana, D., Radovan, D. V., & Ján, D. (2015). The economic impact of floods and their importance in different regions of the world with emphasis on Europe. *Procedia Economics and Finance*, 34, 649–655. [https://doi.org/10.1016/S2212-5671\(15\)01681-0](https://doi.org/10.1016/S2212-5671(15)01681-0)
- [6] Mahmudov, R. N. (2008). *Catalog of flood-prone rivers of Azerbaijan*. Ziya Publishing House.
- [7] International Federation of Red Cross and Red Crescent Societies. (2024). *Azerbaijan: Floods - DREF operation No. MDRAZ002 final report*. ReliefWeb. <https://reliefweb.int/report/azerbaijan/azerbaijan-floods-dref-operation-n°-mdraz002-final-report>
- [8] Gasimova, E. E. (2014). The damages caused to automobile roads by natural disasters and the measures of protection in Azerbaijan Republic. *International Journal of Business, Humanities and Technology*, 4(1), 136–139. https://ijbht.thebrpi.org/journals/Vol_4_No_1_January_2014/15.pdf
- [9] Ministry of Emergency Situations of the Republic of Azerbaijan. (2025). *Floods in Azerbaijan (2007–2025 data)*.
- [10] Uyan, Y., & Çakır, Ö. (2025). Statistical Analysis of Flood Disasters in the World. *Journal of Emergency Aid and Disaster Science*, 5(1), 12–19. <https://izlik.org/JA55XN55GL>
- [11] Gudratzade, S. V. (2021). Current state of water objects in Azerbaijan and their protection. *Bulletin of Science and Practice*, 7(10). <https://doi.org/10.33619/2414-2948/71/04>
- Mammadova, J. S. (2020). Factors influencing the formation of geosystems of the southern slope of the Greater Caucasus in the Republic of Azerbaijan and assessment of landscape-environmental capacity. *RUDN Journal of Ecology and Life Safety*, 28(3), 237–251. <https://doi.org/10.22363/2313-2310-2020-28-3-237-251>
- [12] Tarikhazer, S. A., Karimova, E. J., & Kuchinskaya, I. Y. (2023). Quantitative assessment of mudflow risk in the Greater Caucasus of Azerbaijan (on the example of the northeastern slope). *Journal of Geology, Geography and Geoecology*, 31(4), 722–735. <https://doi.org/10.15421/112268>
- [13] Alizade, E. K. (1998). Morphostructural structure of mountain systems of Azerbaijan and neighboring (adjacent) territories (based on materials of decoding of the KS). “Science”.
- [14] Huseynov, N., & Huseynov, J. (2025). *Climate of Azerbaijan: Atmospheric precipitation regime*. Optimist LLC.
- [15] Artunov, N. (2023). Flood risk mapping: Using remote sensing technique to identify the influence of floods on territorial planning (A case study of Shaki District, Azerbaijan). *Ekonomichna ta Sotsialna Geografiya*, 89, 53–61. <https://doi.org/10.17721/2413-7154/2023.89.53-61>
- [16] Mammadov, Q., & Khalilov, M. (2022). *Forests of Azerbaijan (Current state, anthropogenic transformation, and restoration)*. Region Press.
- [17] Global Forest Watch. (2026). *Forest change data for Azerbaijan*. World Resources Institute. Retrieved March 30, 2026, from <https://www.globalforestwatch.org>
- [18] Statistical Committee of the Republic of Azerbaijan. (2025). *The agriculture of Azerbaijan – 2025*. https://www.stat.gov.az/menu/6/statistical_yearbooks/source/agriculture_2025.pdf
- [19] Pashayev, N. A. (2018). *Economic-geographical assessment of the impact of natural disasters on the economy in the Republic of Azerbaijan*. European Publishing House.