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CONCEPT FOR COMPREHENSIVE APPROACH OF TRANSBOUNDARY DISASTER RISK MANAGEMENT IN CENTRAL ASIA IN THE CONTEXT OF CLIMATE CHANGE

Almaty, 2024

CONTENTS

I. INTRODUCTION

The modern social development is increasingly faced with the problem of safety and increased vulnerabilities to the impacts of climate change. Natural and man-made disasters and accidents that have a complex impact on many spheres of national life, may threaten national security, have transboundary, interregional or global consequences, and directly or indirectly cause damage to one or more States, are becoming particularly acute.

In this regard, there is an urgent challenge to strengthen the coordination of authorized bodies of Central Asian countries responsible for transboundary disaster risk management. This entails the need to organize effective interaction between authorized bodies of neighboring countries in transboundary disaster risk management. Coordination of Central Asian countries in the field of disaster risk management is primarily determined by the fact that this area of cooperation is an increasingly important part of the system of modern international relations, taking into account the increasing risks related to climatic change.

The issues of disaster risk management efficiency are considered at various interstate meetings. However, the issue of how to organize cooperation management in cases when it is necessary to involve forecasting services, capacities and means of rescue formations of neighboring states to reduce transboundary disaster risk has not yet been resolved.

Interaction in transboundary disaster risk management consists in negotiating the procedure for mutual exchange of forecast data on natural and man-made disasters and early warning in case of emergency, agreeing on joint actions and the procedure for mutual assistance in carrying out tasks aimed at reducing transboundary disaster risk. To harmonize these factors, it is necessary to develop conceptual approaches based on international norms and practices.

Analyses of natural and man-made disaster risks and events in Central Asian countries show that many crisis situations do not respect borders and have the potential of reaching a transboundary level. The successes and failures of response to them directly depend on the completeness and skillful organization of joint interaction in prevention, preparedness and response.

At present, taking into account global climatic changes and, as a consequence, the increasing number of transboundary disasters, it becomes urgent to develop a unified integrated approach to disaster risk management in Central Asia in order to minimize the consequences of climate change for the population, territory and economic facilities.

1.1. Overview of the Concept's objectives and target audience

This paper considers possible vulnerabilities, risks and threats to socio-economic development and stability of the Central Asian region (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) arising from ongoing disaster hazards and man-made accidents associated with global climate change. It is proposed to develop the Concept of a comprehensive approach to transboundary disaster risk management in Central Asian countries to reduce the consequences of disaster hazards and man-made accidents caused by climate change.

The Disaster Risk Profile of Central Asian countries, taking into account climate change, was carried out with the support of the United Nations Office for Disaster Risk Reduction.[1]

[1] CA Risk Profile. CESDRR https://cesdrr.org/uploads/regforum/2022/Региональная%20характеристика%20риска%20бедствий.pdf

The concept of integrated transboundary disaster risk management has been developed for the national authorities of Central Asian countries in the fields of civil protection (defense), environmental protection, agriculture, water resources and economy.

1.2. Justifying the need for an integrated approach for climate change-informed transboundary disaster risk management

Transboundary disaster risks affecting the livelihoods of the population and economies of Central Asian countries are increasing faster than measures to reduce them. In order to increase the protection of Central Asian countries from the negative impact of disasters caused by global climate change, it is necessary to consolidate joint efforts to develop a single integrated approach to transboundary disaster risk management.

Integrated transboundary disaster risk management by Central Asian countries is a key element for preventing, preparing for and responding to natural and man-made hazards and accidents affecting transboundary disaster risk reduction.

Integrity in disaster risk management is a complex endeavor as it involves coordination of multiple actors at the national and transboundary levels. It is proposed to develop a methodology for integrated climate change-informed transboundary disaster risk management in order to assist Central Asian countries in this endeavor.

The application of integrated transboundary disaster risk management will support the realization of the Sustainable Development Goals, the Paris Agreement on climate change and the Sendai Framework for Disaster Risk Reduction for 2015-2030. The application of integrated transboundary disaster risk management will support the implementation of the Sustainable Development Goals, the Paris Agreement on Climate Change and the Sendai Framework for Disaster Risk Reduction 2015-2030r.

II. CONTEXT AND ANALYSIS

2.1. Description of the region and its vulnerability to transboundary disasters

More than 75 million people live in the Central Asian region, which consists of five states - Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan.

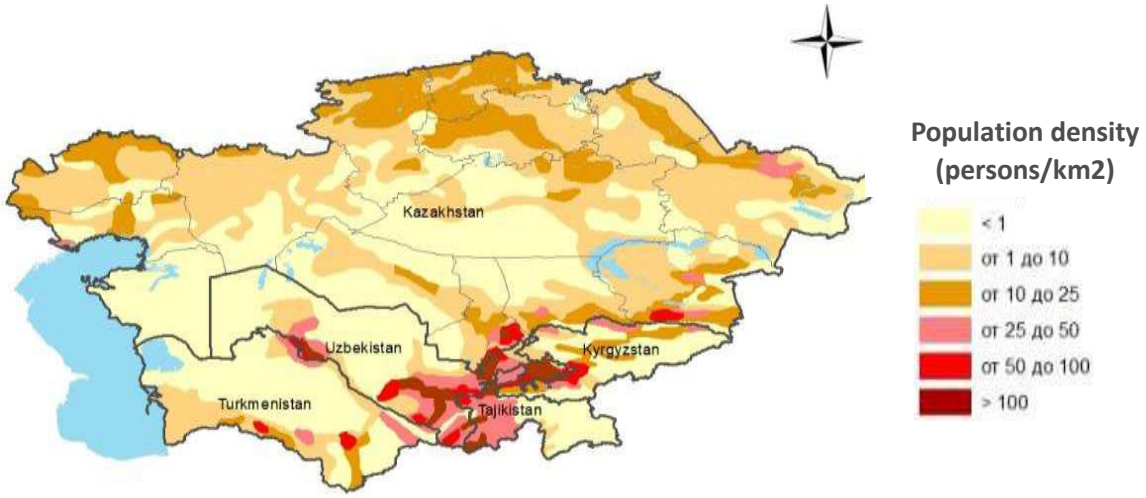

Figure 1 - Population density in Central Asia

Geographically, Central Asia is very diverse, encompassing vast, relatively young mountain systems such as the Tien Shan, Pamir, many eternal glaciers, large deserts and semi-deserts, and endless steppe zones; as well as thousands of small and dozens of large rivers and lakes, including the Amu Darya and Syr Darya, the Caspian and Aral Seas, Balkhash, Issyk Kul, large

reservoirs, very densely populated valleys such as the Fergana Valley, and some of the most sparsely populated areas in the world.

The geographical location of the region is determined by a sharply continental climate with a low amount of unevenly distributed precipitation. The Central Asia region is characterized by a large amplitude of daily and seasonal temperatures, with high solar radiation and relatively low humidity.

The Central Asian region is exposed to virtually all types of disaster risks (*with few exceptions, such as tsunamis, tornadoes, volcanic eruptions and some others*) of natural (*geological, geophysical, meteorological, agrometeorological, hydrological*), man-made, environmental, biological and social nature

The region is most characterized by vast areas with high seismic activity, with probable strong earthquakes of 7-8-9 and more points, mudflows, floods, floods, landslides, snow avalanches, waterlogging, groundwater table rise, strong, hurricane winds and even tornadoes, desertification, dust storms, sandstorms, long and heavy rainfall, hail, heavy snowfalls and blizzards, droughts, frosts, rockslides and rockfalls, steppe, forest and mountain fires, extreme temperatures, environmental, technogenic industrial and transport accidents, explosions, large fires, epidemics, mass infectious diseases of people and animals, diseases, weeds and pests of agricultural plants, as well as the presence of artificial reservoirs and bursting reservoirs, nuclear and chemical industry waste storage facilities, enterprises with toxic and potent poisonous substances, hazardous technological processes [2] .

It is well known that the amount of economic damage is not always consistent with the number of disasters. For example, the number of earthquakes that have occurred in Central Asia is much smaller than the number of floods, but the economic damage from earthquakes is much larger than that from floods. The quantitative risk assessment[3] conducted in this study confirmed the following risk patterns:

- **Kazakhstan**: earthquakes are the main risk factor, followed by floods;
- **Kyrgyzstan**: earthquakes are the main risk factor, followed by landslides and floods;
- **Tajikistan**: floods are the main risk factor, followed by earthquakes and landslides.
- **Turkmenistan**: earthquakes are the main risk factor, followed by landslides and floods;
- **Uzbekistan**: earthquakes are the main risk factor, followed by droughts.

Dramatic population growth and the development of irrigation in Central Asian countries over the last 40 years have significantly increased the demand for land and water in the region. At the same time, more than 46% of residents live in urban areas[4]

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The Republic of Kazakhstan, with an area of 2.74 million km^2 , is the largest country in Central Asia. The country is home to 20.1 million people and its GDP in 2023 was US$224.3 million (GFDRR).

[2] Analys of regional legislation in DRR https://cesdrr.org/uploads/dev/2022/05.12.22%20-%20ЦЧССРБ%20-%20Анализ%20региональной%20нормативной%20базы.pdf
[3] Analys of regional legislation in DRR https://cesdrr.org/uploads/dev/2022/05.12.22%20-%20ЦЧССРБ%20-%20Анализ%20региональной%20нормативной%20базы.pdf
[4] Analys of regional legislation in DRR https://cesdrr.org/uploads/dev/2022/05.12.22%20-%20ЦЧССРБ%20-%20Анализ%20региональной%20нормативной%20базы.pdf

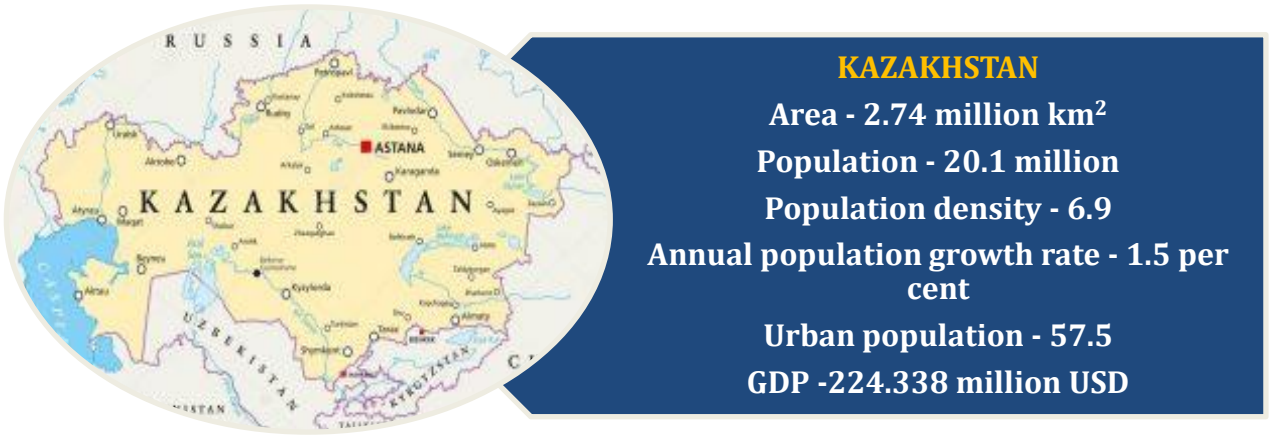


Figure 2 - Overview of statistical data of the Republic of Kazakhstan [5]

The country has a large altitude difference from 7010 m in the south-east to -132 m in the Caspian lowlands. Most of the territory is desert or semi-desert. However, Kazakhstan has an extensive river network. In fact, the predominant hazard for the country is floods. These river floods, caused mainly by rainfall and snowmelt, cause an average annual damage estimated at $726 million. Earthquakes cause 7 times less damage than floods, but have a high concentration in the south and southeast of the country (GFDRR).

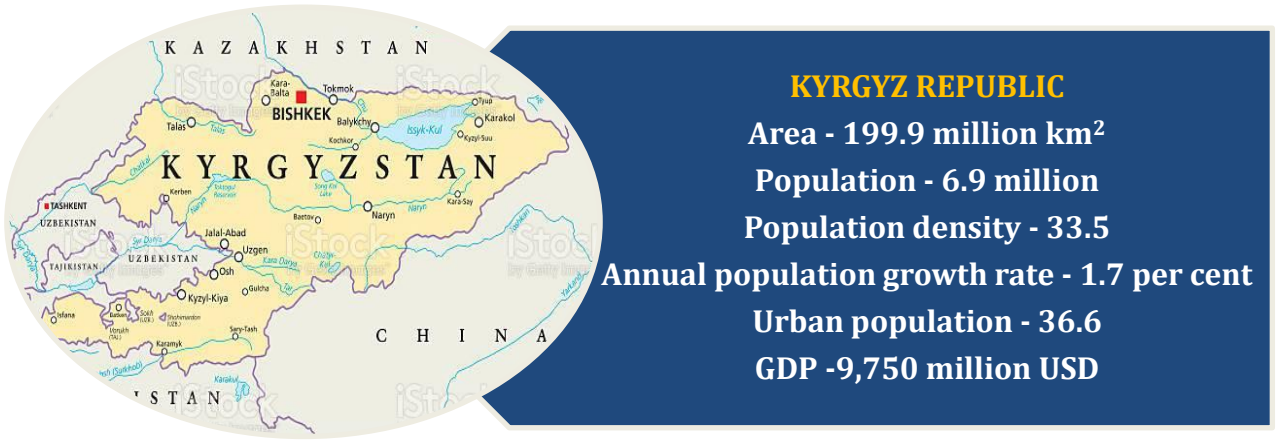


Figure 3 - Overview of statistical data of the Kyrgyz Republic [6]

The Kyrgyz Republic is a landlocked country. The population is 6.9 million and the GDP in 2023 was US$ 9,750 million.

Mountains cover most of the country's territory, with only about 6 percent in the lowlands, where most of the agricultural activities take place. According to the risk profile, the country is highly prone to earthquakes, floods and landslides. Floods are the most frequent hazard. However, economic losses from earthquakes are greater than those from floods, with average annual losses of approximately US$190 million (GFDRR).

[5] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf
[6] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

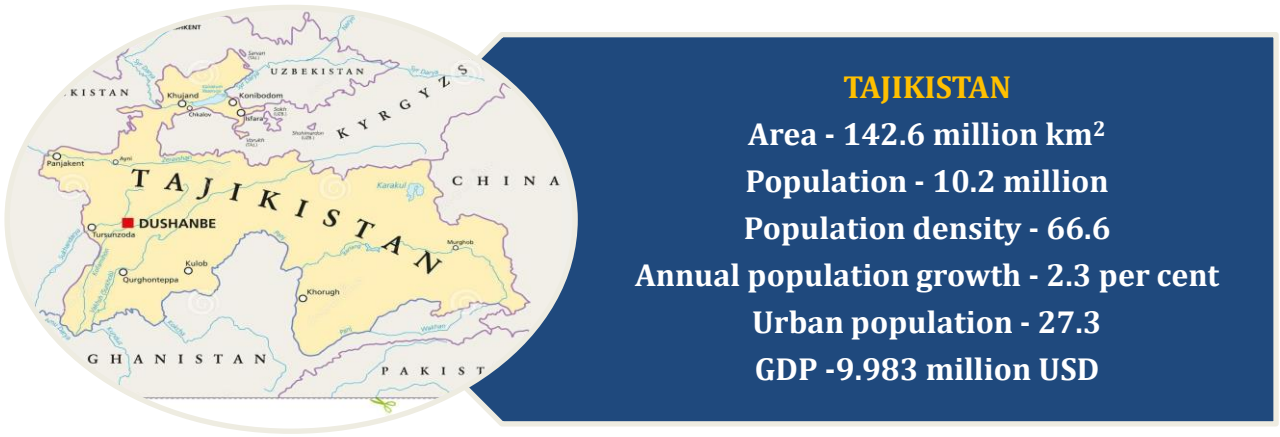


Figure 4 - Overview of statistical data of the Republic of Tajikistan [7]

The Republic of Tajikistan is a country of about 10.2 million people, with a GDP of US$ 9,983 million in 2023. Like the Kyrgyz Republic, 90 percent of the country is mountainous and it is located in a highly seismic region. However, due to its relatively lower percentage of urbanization, it is less prone to earthquakes.

The population is mainly concentrated in the lowland areas of the country. That is, in the northern and southern parts of the country where agriculture is mainly practiced. Because of the topography, in addition to earthquakes, the country is prone to flash floods, as well as mudflows and landslides as rainfall and snowmelt occur (GFDRR).

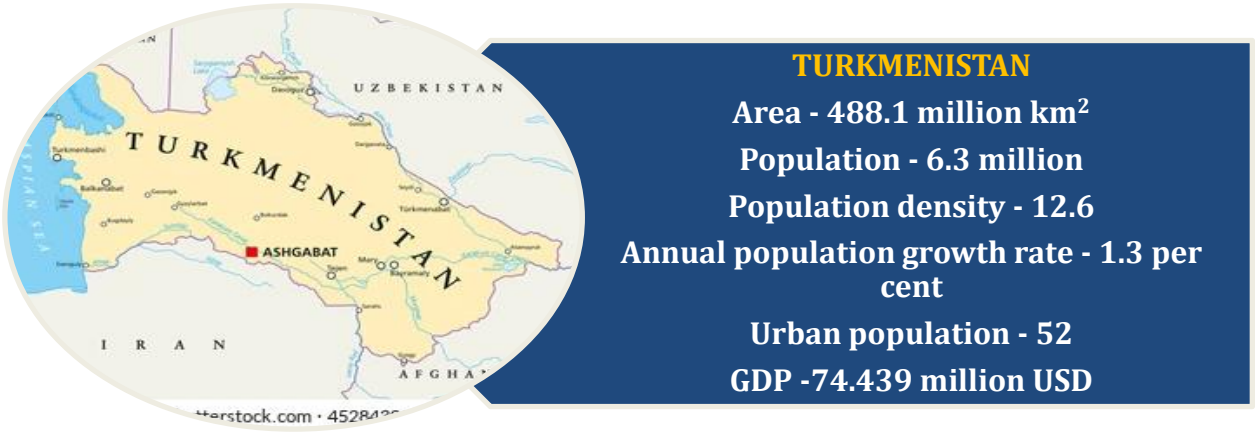


Figure 5 - Overview of statistical data of Turkmenistan

Turkmenistan, with a population of over 6.3 million people and a GDP of US$ 74.439 million in 2023. It is the second largest country in Central Asia, with about 50 per cent of the population living in rural areas.

[7] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

The country is exposed to various hazards, of which floods cause the most damage (average annual loss is about 90 million USD). The country is also in a zone of high seismicity. However, the risk of this hazard is less than from floods, for which the average annual loss is estimated at approximately US$34 million. According to the topography, landslides are also part of the country's hazards, with these landslides mainly located in the Akhal region, in the south of the country (GFDRR).

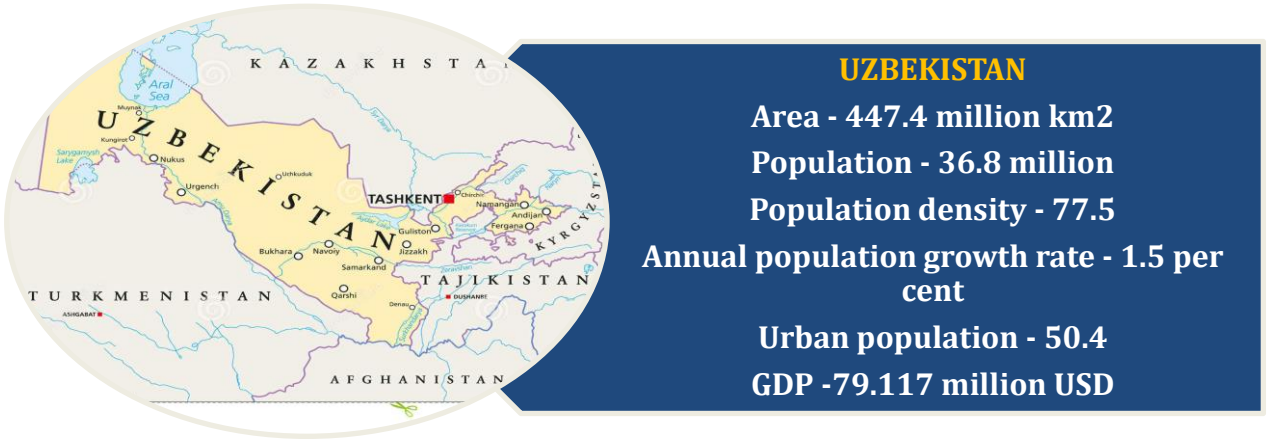


Figure 6 - Overview of statistical data of the Republic of Uzbekistan [8]

The Republic of Uzbekistan, with a population of over 36.8 million people and a GDP in 2023 of - 79.117 million USD, the largest share of which is agriculture.

By studying the history of Uzbekistan, it can be said that the country is prone to earthquakes, drought, floods, mudslides and landslides. It is worth noting that only about 15% of the country's territory is located in earthquake-prone areas. However, about 80% of the population lives in this region, i.e. in the eastern part of the country, where the capital Tashkent is located (GFDRR).

2.2. Analyzing previous disasters and effects on the region

Central Asia is prone to various natural and man-made disasters, including fires, earthquakes, floods and landslides. Climate change, population growth and urbanization have led to an increase in the frequency and severity of losses from man-made accidents and disasters in the last two decades[9].

[8] *Analysis of natural and manmade hazards in CA, CESDRR. https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf*
[9] Initiative on disaster risk management in CA, UNDRR https://www.unisdr.org/files/11641_RMSIFINALrussmall.pdf

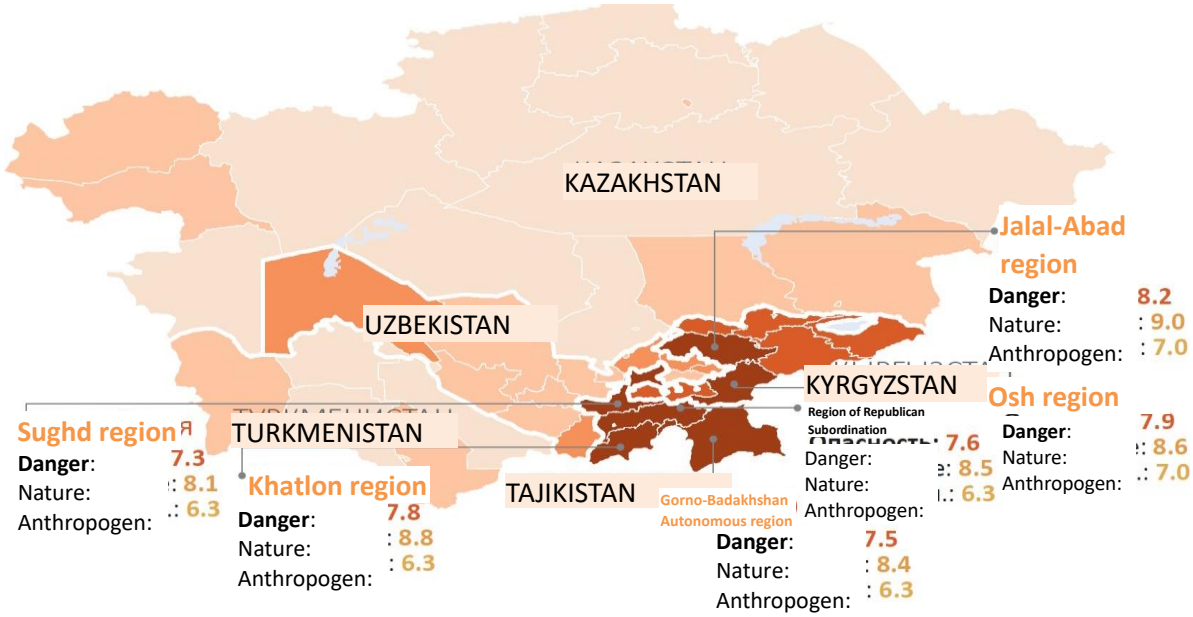


Figure 7 - Hazard and Exposure Map, national averages for Central Asian countries [10]

Earthquakes and floods pose the greatest risk to the CA region in terms of potential loss of life and economic damage.

A significant area of Central Asia, including almost all major cities, is in a high seismic risk zone.

Over the last 100 years, strong earthquakes have occurred in every country of Central Asia, killing hundreds of thousands of people and causing billions of dollars in damages (Central Asian Bureau for Analytical Reporting).

Table 1- Strong earthquakes in Central Asia[11]

Date	Name	Number of people affected	Economic loss (millions of US dollars)
03.01.1911г.	Kemin earthquake, Kazakhstan, Kyrgyzstan	450	20
05.10.1948г.	Ashgabat earthquake, Turkmenistan	176000	6000
26.04.1966г.	Tashkent earthquake, Uzbekistan	100000	300
13.10.1985г.	Earthquake in Tajikistan	8080	200
19.08.1992г.	Jalalabad earthquake, Kyrgyzstan	86806	130

Even in the absence of strong earthquakes in the region, up to 200 people die annually from seismic events. This speaks of the stable seismic hazards that are present in the daily life of every resident of Central Asia.

The Central Asia region loses about half a billion dollars annually from earthquakes alone.

[10] Subregional Risk Index INFORM for Central Asia 2021

[11] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

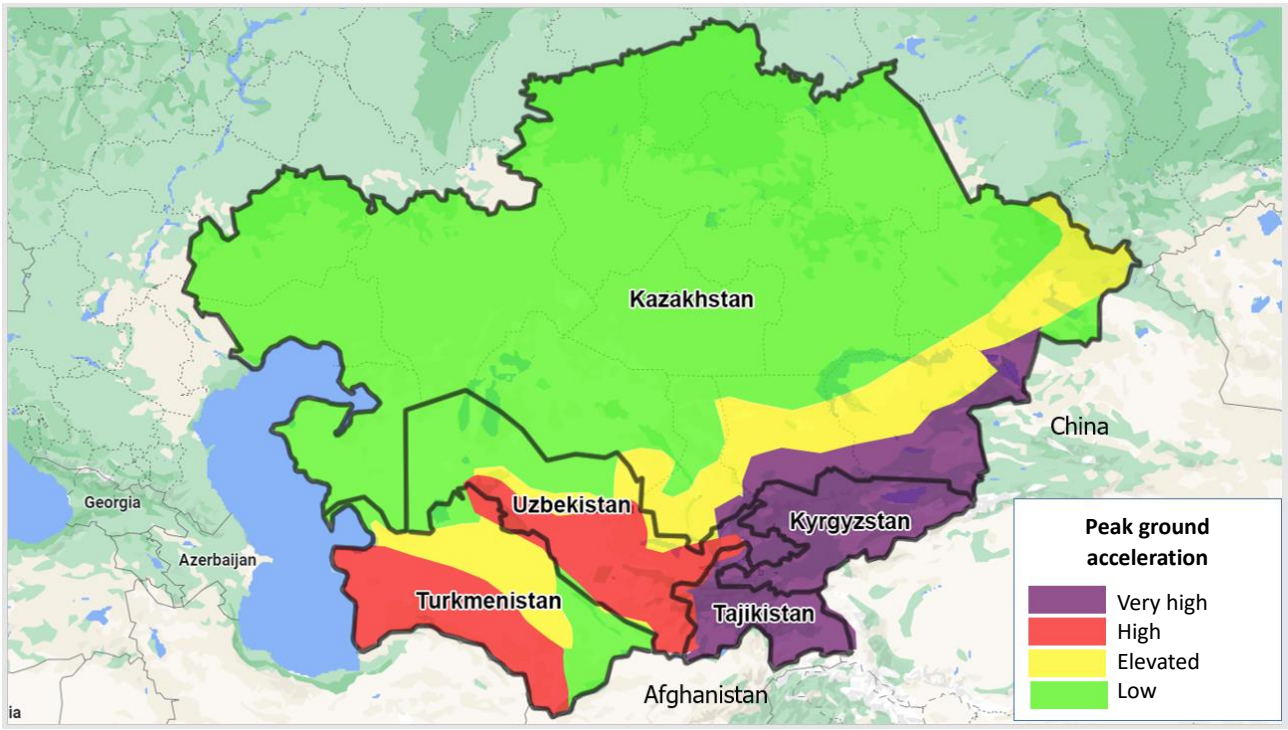


Figure 8 - Seismic hazard map of Central Asia [12]

Catastrophic earthquakes in Central Asia can lead to transboundary disasters, as seismic manifestations in the region occur from south to north. In addition, strong earthquakes can trigger avalanches, landslides, and the bursting of high-altitude lakes.

The greatest threat in the region is the risk of a rupture of Lake Sarez in Tajikistan (*lake volume of more than 17 billion m³*) as a result of a strong earthquake, and this could have catastrophic consequences for several countries in the region. For example, if the natural dam Usoy, which holds back Lake Sarez, fails, billions of cubic meters of water could be released, causing devastating floods downstream of the Murghab River. Flooding would affect the territories of Tajikistan, Afghanistan, Turkmenistan and Uzbekistan, damaging population, infrastructure, agriculture and industrial facilities.

There are more than 100 sites in Central Asia with mining wastes, which contain radionuclides, salts of heavy metals (*cadmium, lead, zinc*), as well as toxic substances (*cyanides, acids, silicates, nitrates, sulphates, etc*.)[13]

. There is a constant threat of possible environmental disasters due to the destruction of storage facilities located in areas with high seismicity and landslide activity. At the same time, in a number of cases negative impacts of potentially hazardous sources may lead to transboundary environmental pollution.

In this regard, the speed of transmission of transboundary emergency warnings between Central Asian countries is of particular importance.

Large rivers located in the Central Asian region such as the Amu Darya, Syr Darya, Chu, Talas, Tarim and others, as well as the hydraulic structures located on them, can lead to catastrophic transboundary floods. An example of this is the breach of the dam of the Sardoba reservoir in

[12] CESDRR Presentation https://cesdrr.org/uploads/docs/2024/15.10.24%20-%20Презентация.pdf
[13] Fergana inform portal https://fergana.agency/articles/103296/?utm_source=chatgpt.com

Uzbekistan on 1.05.2020, which led to flooding of vast transboundary territories of Uzbekistan and Kazakhstan[14].

The analysis has shown that in the period from 1997 to 2021, more than 167.4 thousand disasters of natural and man-made nature occurred in CA countries (*Academy of Civil Protection of the Ministry for Emergency Situations of the Republic of Kazakhstan, 2023*).

The dynamics of man-made accidents and disasters in CA countries, from 1997 to 2021, is presented in Figure 9.

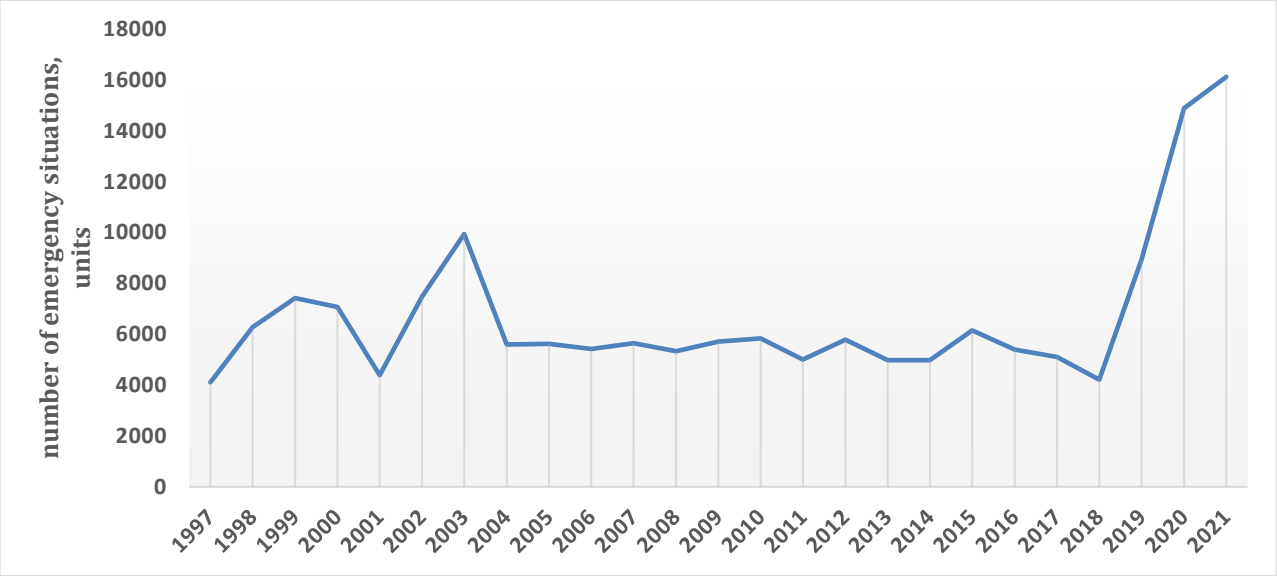


Figure 9 - Disaster dynamics in Central Asian countries, from 1997 to 2021

Figure 10 shows the dynamics of natural and man-made disasters and accidents in the context of CA countries.

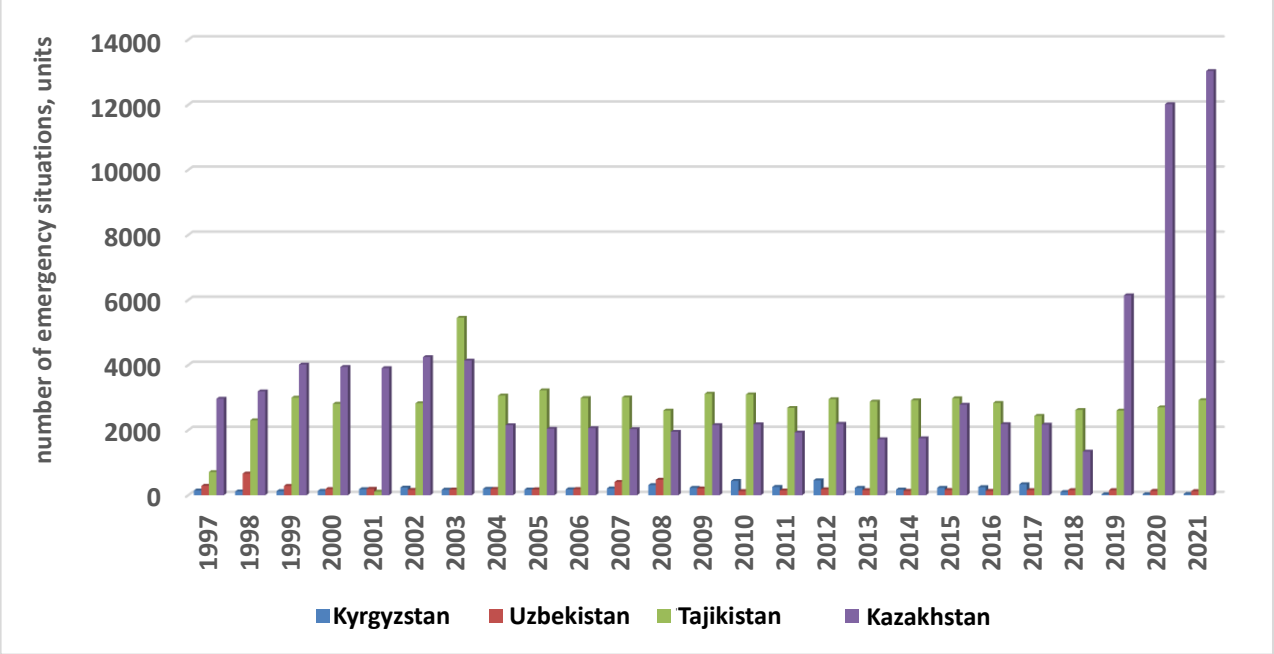


Figure 10 - Disaster dynamics by Central Asian countries, from 1997 to 2021

[14] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

Figure 10 shows that the largest number of natural and man-made disasters and accidents occurring in the CA countries are in the Republic of Kazakhstan and the Republic of Tajikistan.

The dynamics of the number of victims of natural and man-made disasters and accidents in the Central Asian countries (*Kazakhstan, Kyrgyzstan, Tajikistan*) in the period from 2000 to 2021 is presented in Figure 11.

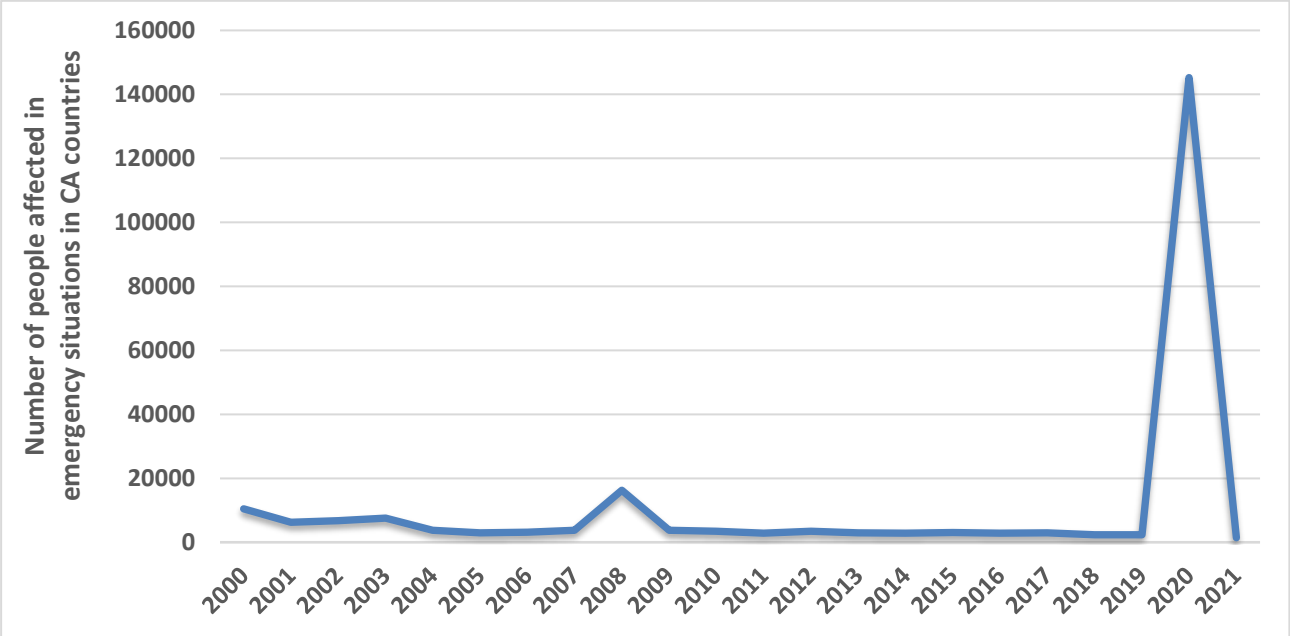


Figure 11 - Dynamics of the number of people affected by disasters in Central Asian countries, from 2000 to 2021

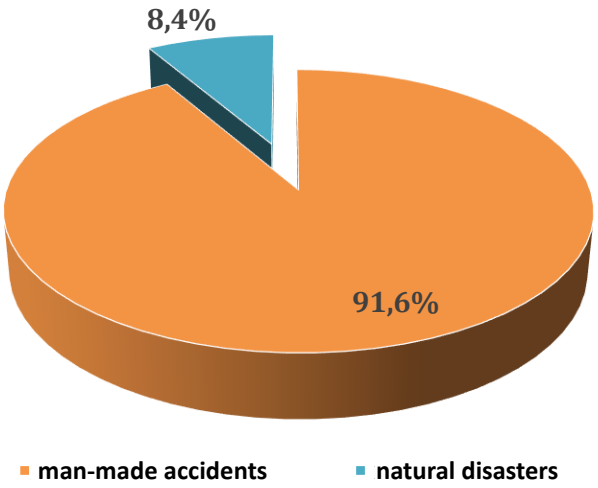
Figure 11 indicates that between 2000 and 2021, more than 240,600 CA residents became affected by natural and man-made disasters and accidents.

The highest number of victims occurs in 2020. This circumstance is associated with the coronavirus pandemic (COVID-19).

Of all disasters occurring in the region, up to 91.6 per cent are man-made accidents, i.e. human-induced (*Figure 12*) [15]

[15] *Analysis of natural and manmade hazards in CA, CESDRR. https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf*

Figure 12 - Correlation of man-made accidents and disasters in Central Asian countries in the period



from 1997 to 2021

The ratio of man-made accidents and disasters, by Central Asian countries, is presented in Figures 13-16.

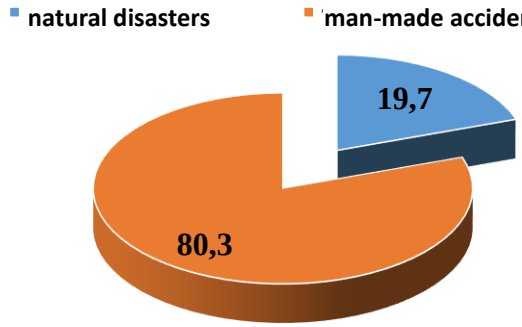


Figure 13- Correlation of man-made accidents and disasters in the Republic of Kazakhstan

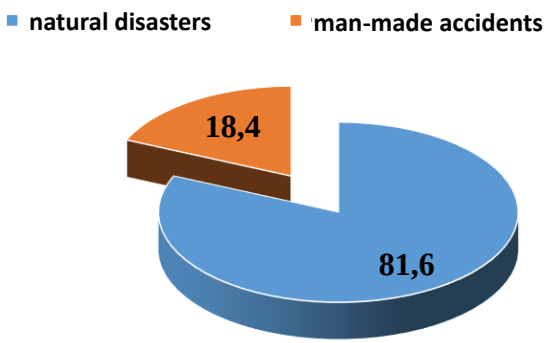


Figure 14 - Correlation of man-made accidents and disasters in the Kyrgyz Republic

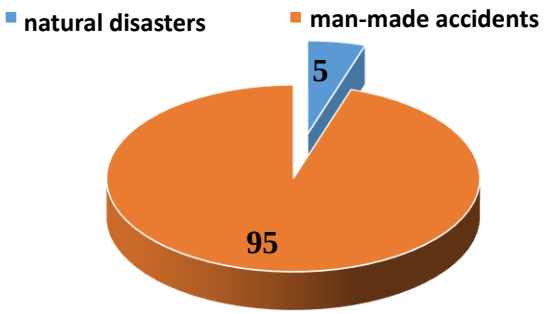


Figure 15 - Correlation of man-made accidents and disasters in the Republic of Tajikistan

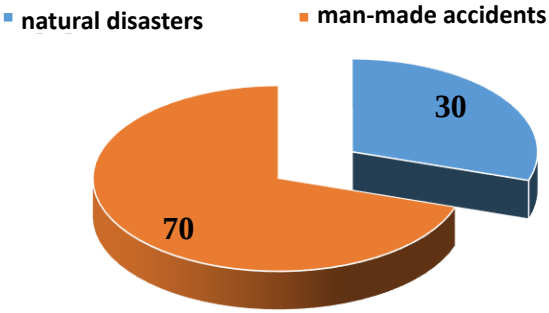


Figure 16 - Correlation of man-made accidents and disasters in the Republic of Uzbekistan

Figures 13-16 show that man-made accidents account for the largest number of disasters in CA countries, with the exception of the Kyrgyz Republic, where more than 81 per cent of disasters are caused by natural hazards[16].

The dynamics of man-made accidents is presented in Figure 17.

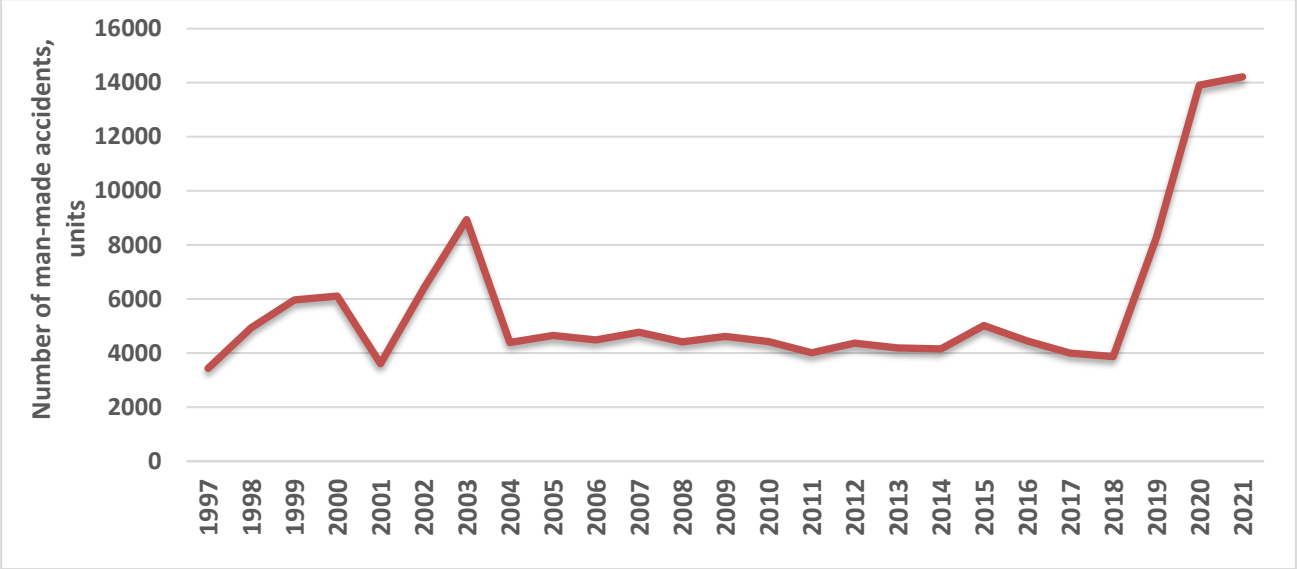


Figure 17 - Dynamics of man-made accidents in Central Asian countries, from 1997 to 2021

Figure 17 indicates that on average about 5.6 thousand man-made accidents occur annually in the CA countries.

Figure 18 shows the dynamics of man-made accidents in the context of CA countries in the period from 1997 to 2021.

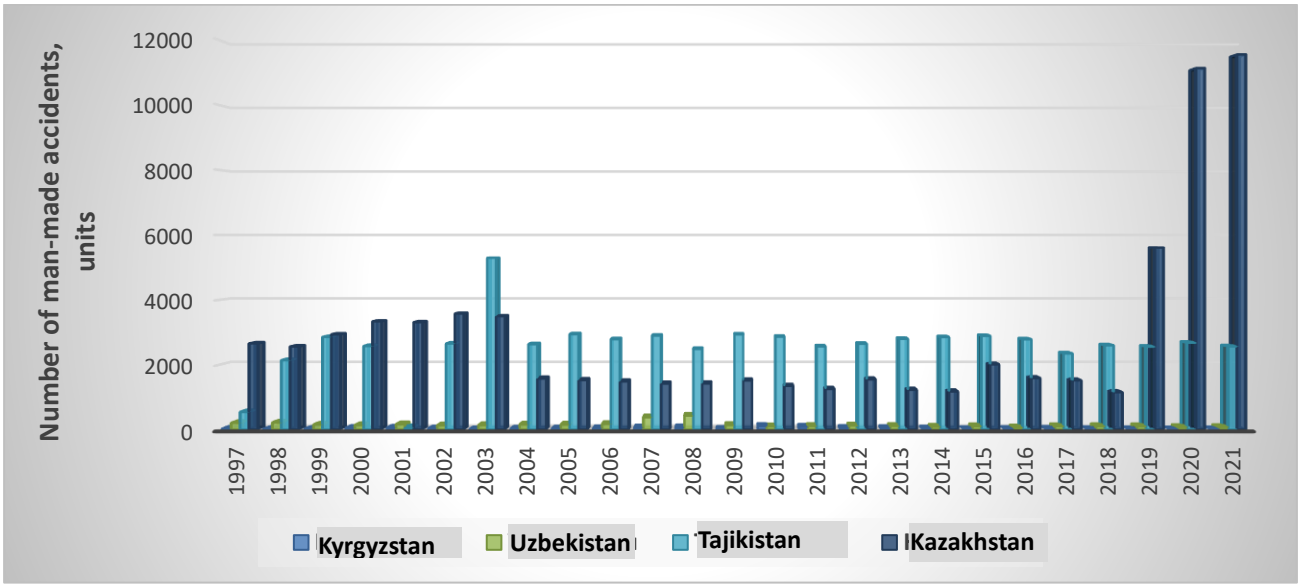


Figure 18 - Dynamics of technogenic accidents in the context of Central Asian countries, in the period from 1997 to 2021

Figure 18 shows that in recent years there has been an increase in man-made accidents in the Republic of Kazakhstan.

[16] *Analysis of natural and manmade hazards in CA, CESDRR. https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf*

The dynamics of the number of victims of technogenic accidents in CA countries (*Kazakhstan, Kyrgyzstan, Tajikistan*) in the period from 2000 to 2021 is presented in Figure 19.

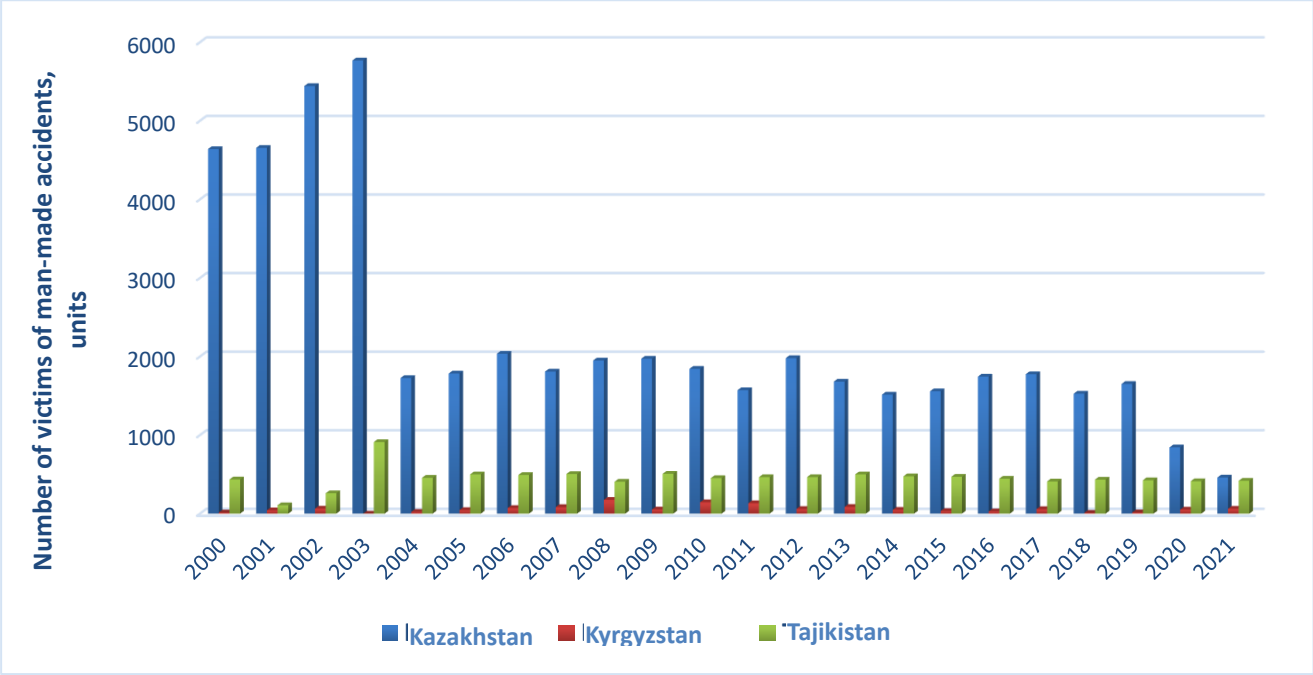


Figure 19 - Dynamics of victims of man-made accidents in Central Asian countries, from 2000 to 2021

Figure 19 indicates that during the period under review, the largest number of people affected by man-made accidents in Central Asia is in the Republic of Kazakhstan.[17]

Figure 20 shows the dynamics of disasters in CA countries.

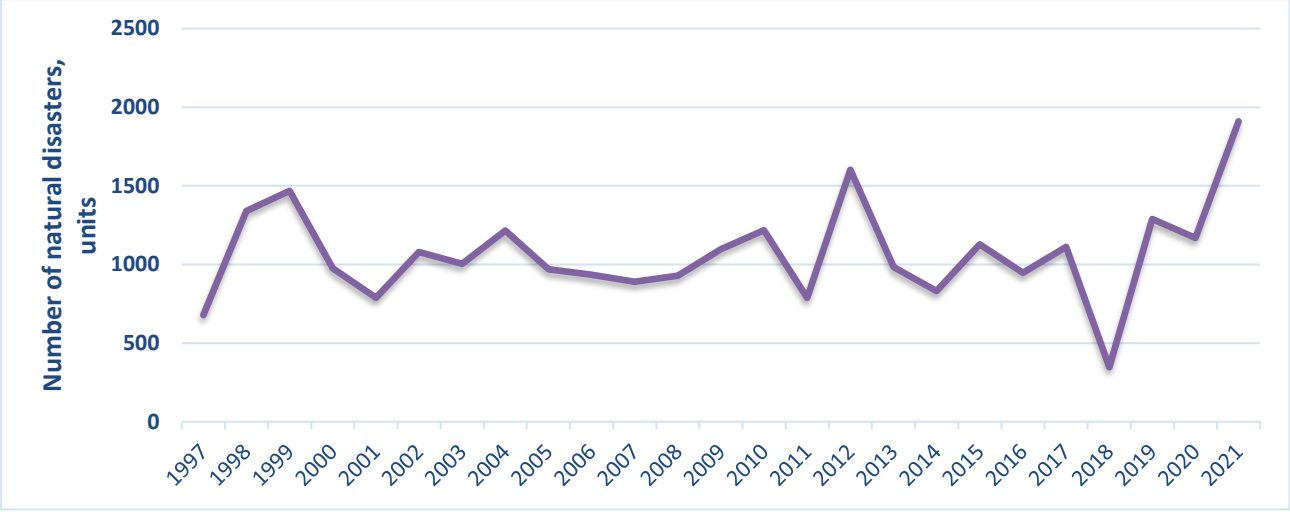


Figure 20 - Dynamics of disasters in Central Asian countries, from 1997 to 2021

Figure 20 shows that there is a tendency of increasing disasters in CA countries in recent years. This circumstance is related to climate change occurring all over the world, including in Central Asia.

Figure 21 shows the dynamics of disasters in the context of CA countries.

[17] *Analysis of natural and manmade hazards in CA, CESDRR. https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf*

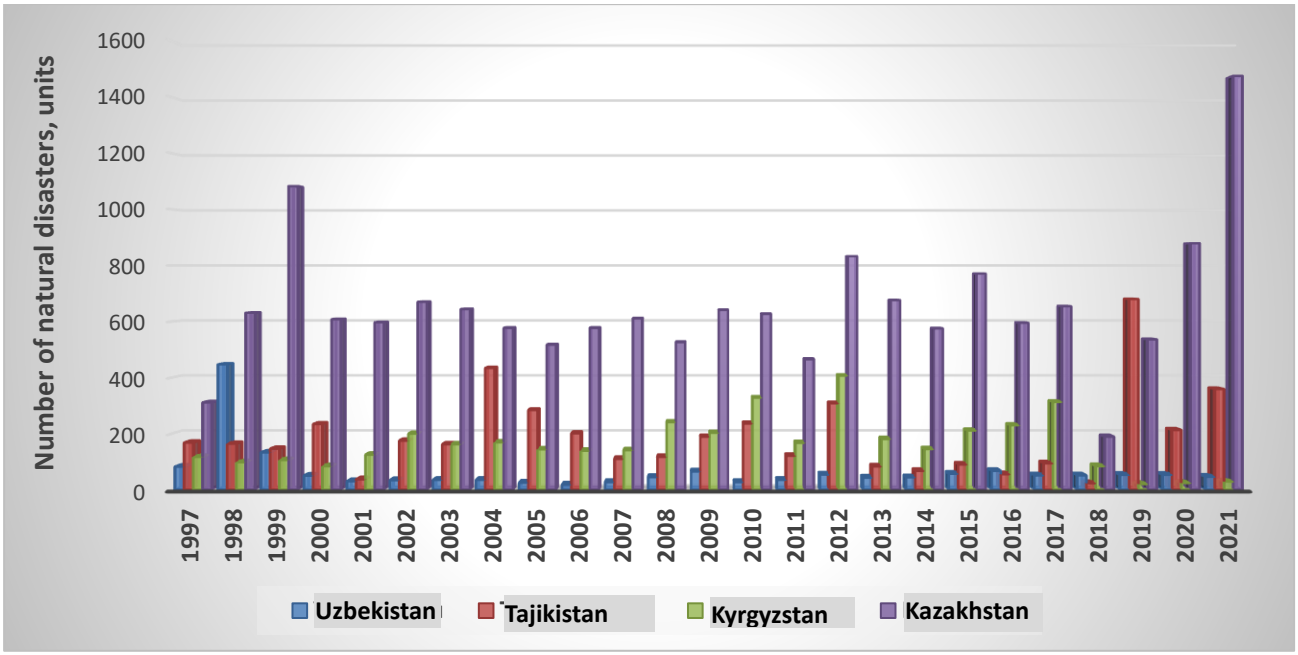


Figure 21 - Dynamics of disasters in the context of Central Asian countries, from 1997 to 2021

Figure 21 indicates that disasters in CA countries during the period under review occurred in waves. The largest number of disasters occurred in the Republic of Kazakhstan.

Disaster hazards and man-made accidents can simultaneously affect different countries, for example, seismic events in the Fergana Valley (*Namangan province of Uzbekistan*) affect the territory of Uzbekistan, Kyrgyzstan and Tajikistan. The cross-border nature of disasters in Central Asia requires an integrated approach at the regional level to support, plan and coordinate disaster risk management strategies.

Disasters account for about 75 per cent of casualties in Central Asian countries (*Figure 22*)

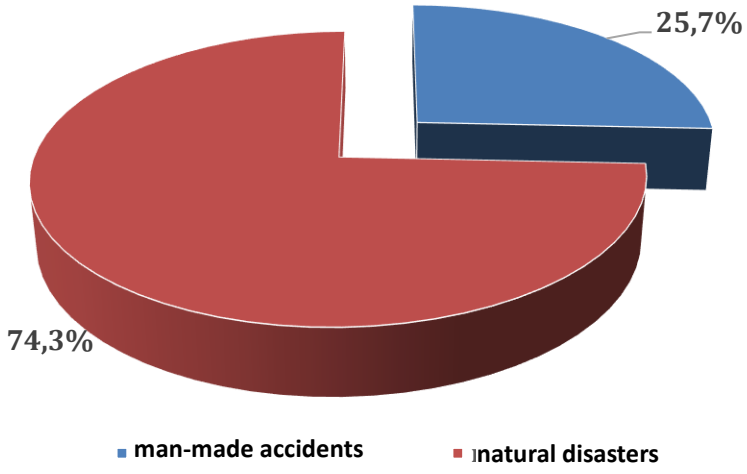


Figure 22 - Ratio of victims of man-made accidents and disasters in the countries of Central Asia, in the period from 2000 to 2021

The dynamics of the number of victims of disasters in Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan) in the period from 2000 to 2021 is presented in Figure 23.

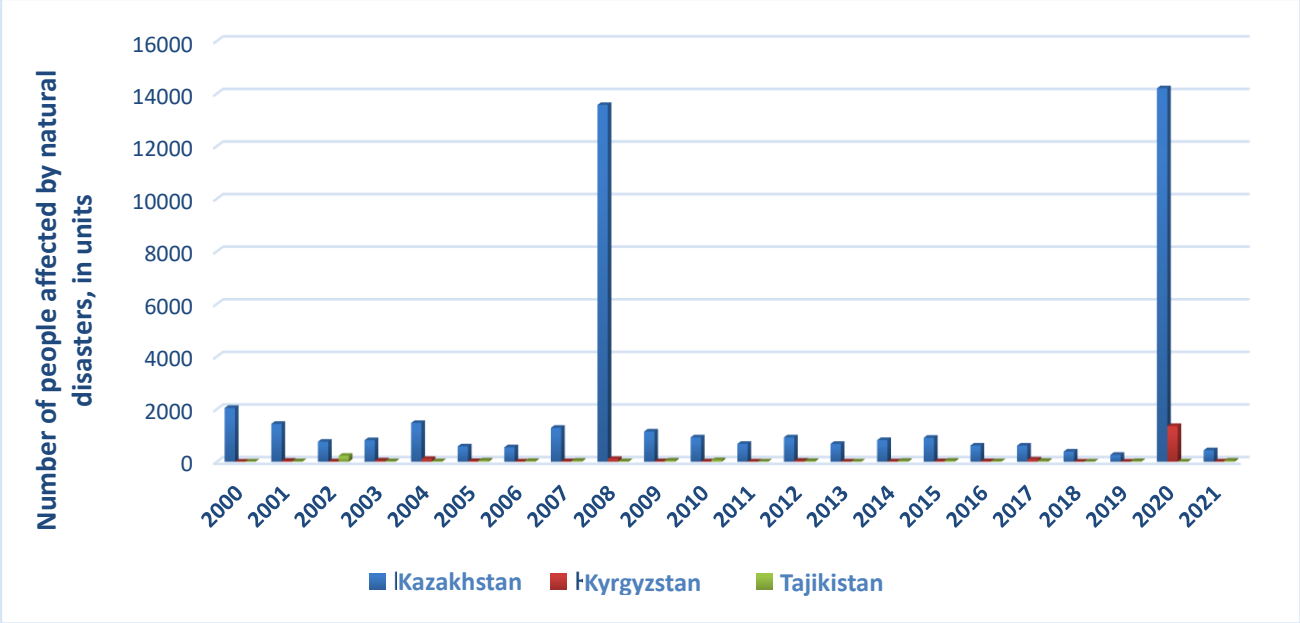


Figure 23 - Dynamics of people affected by disasters in Central Asian countries, from 2000 to 2021

Figure 23 shows that during the period under review, the highest number of people affected by disasters in CA countries is in the Republic of Kazakhstan.[18]

2.3. Analyzing the exposure of Central Asian countries to disasters

Climate change as well as natural and geographical features of the CA region lead to an increase in the frequency and intensity of climate-related disasters, including - floods, landslides, mudslides, snow avalanches.

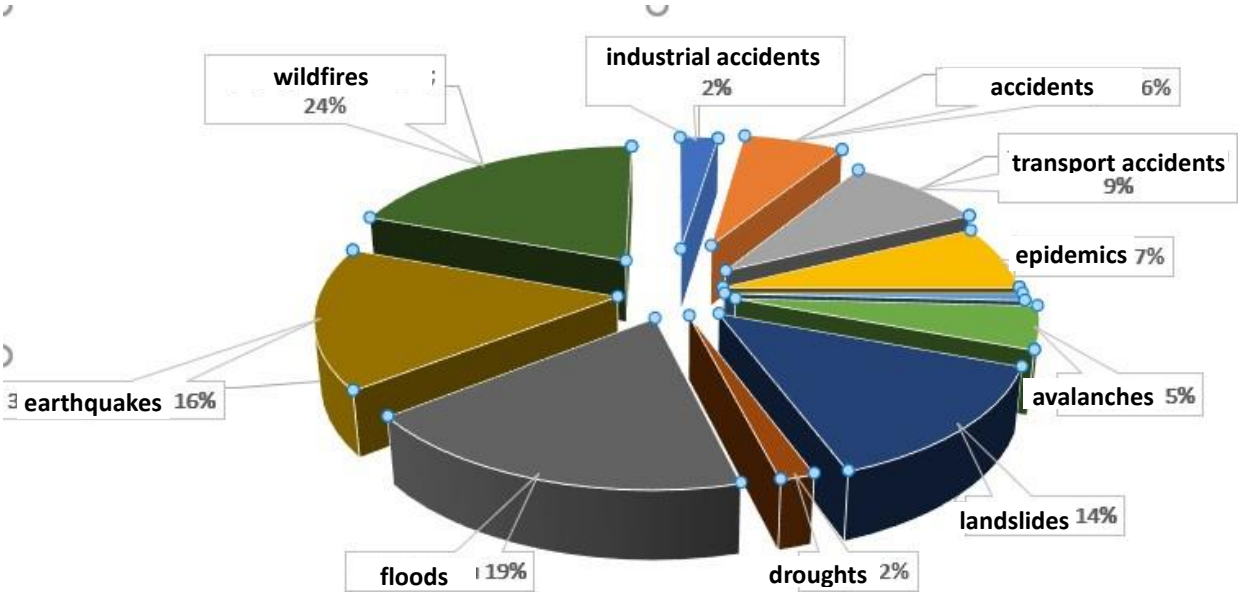


Figure 24 - Percentage distribution of registered disasters in the Central Asia region[19]

[18] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf
[19] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

The dynamics in the breakdown of disasters occurring in CA countries in the period from 2019 to 2021 is presented in Figure 25.

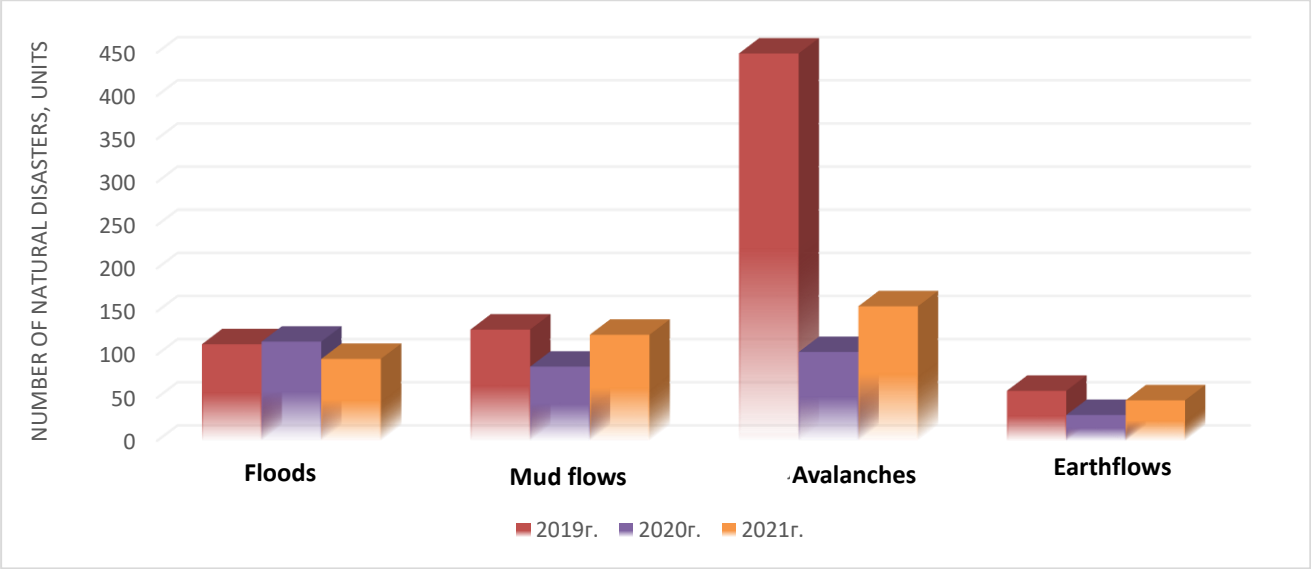


Figure 25 - Dynamics by type of disasters that occurred in Central Asian countries in the period from 2019 to 2021

Figure 25 shows that in the period from 2019 to 2021 in CA countries there were landslides - 135; rainfall melt floods - 319; mudflows - 338; avalanches - 708 (*Academy of Civil Protection of MES RK, 2023*).

The dynamics of rainfall melt floods that occurred in CA countries in the period from 2019 to 2021 is presented in Figure 26.

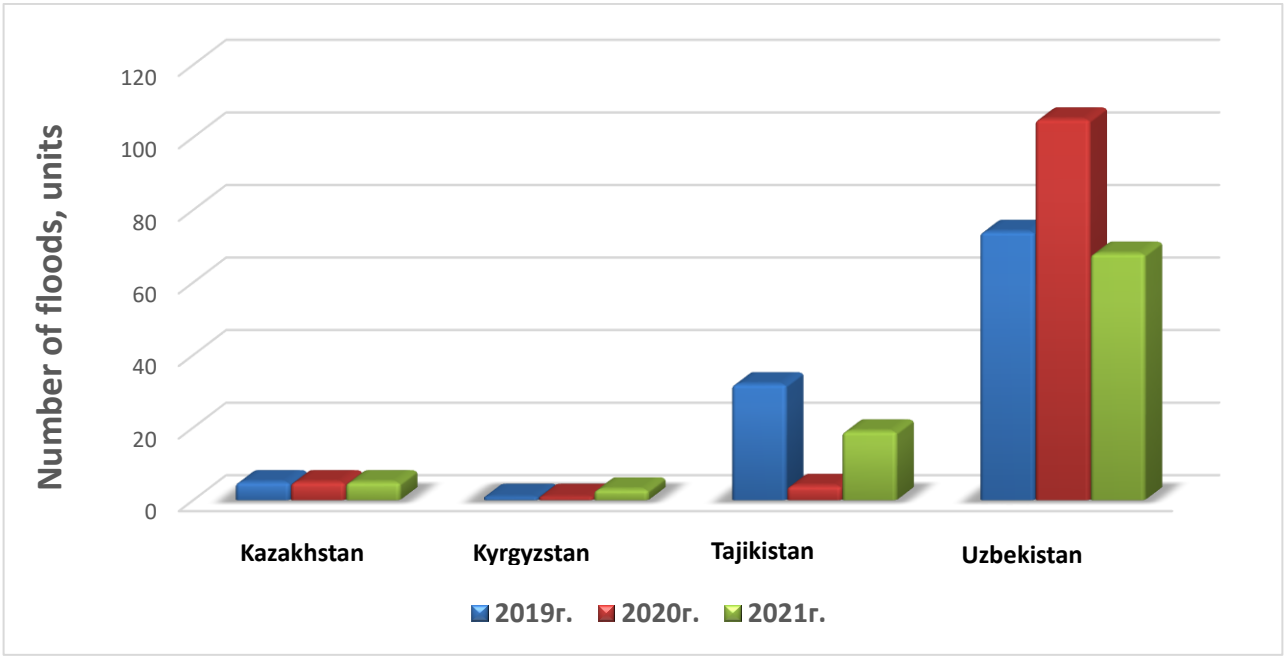


Figure 26 - Dynamics of rainfall melt floods that occurred in Central Asian countries, in the period from 2019 to 2021

Figure 26 indicates that there has been an increase in the number of rainfall melt floods in the Central Asian countries in recent years[20].

The dynamics of mudflow events that occurred in Central Asian countries in the period from 2019 to 2021 is presented in Figure 27.

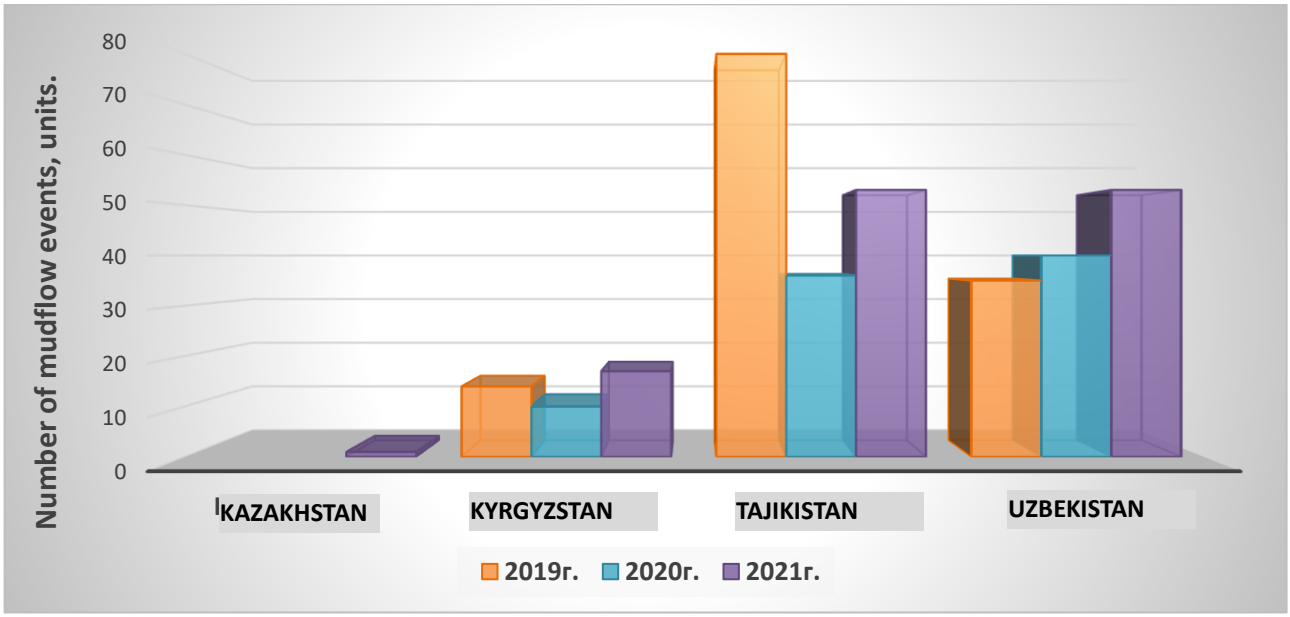
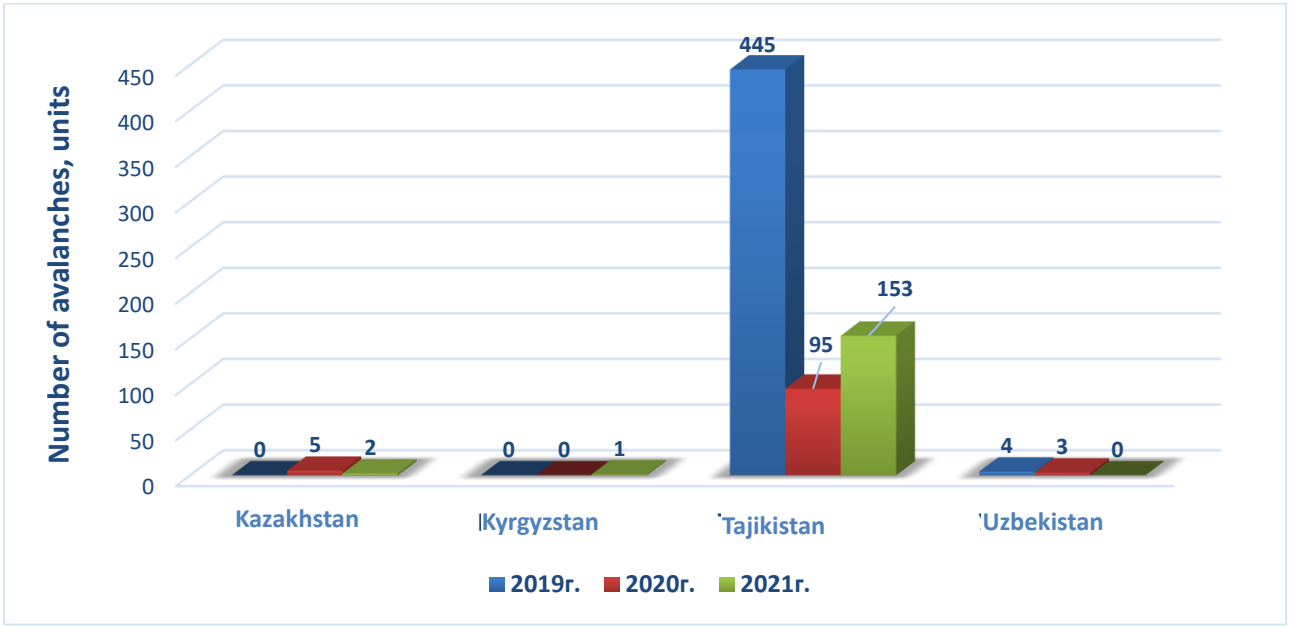


Figure 27 - Dynamics of mudflow events that occurred in Central Asian countries, in the period from 2019 to 2021

Figure 27 shows that the largest number of mudflow events during the period under review occurred in the Republic of Tajikistan and the Republic of Uzbekistan.

The dynamics of avalanches occurring in CA countries between 2019 and 2021 are presented in Figure 28.



[20] *Analysis of natural and manmade hazards in CA, CESDRR.* https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf

Figure 28 - Dynamics of avalanches that occurred in Central Asian countries, in the period from 2019 to 2021

Figure 28 shows that the largest number of avalanches in the period under consideration occurred in the Republic of Tajikistan.

The dynamics of landslide processes in CA countries in the period from 2019 to 2021 is presented in Figure 29.

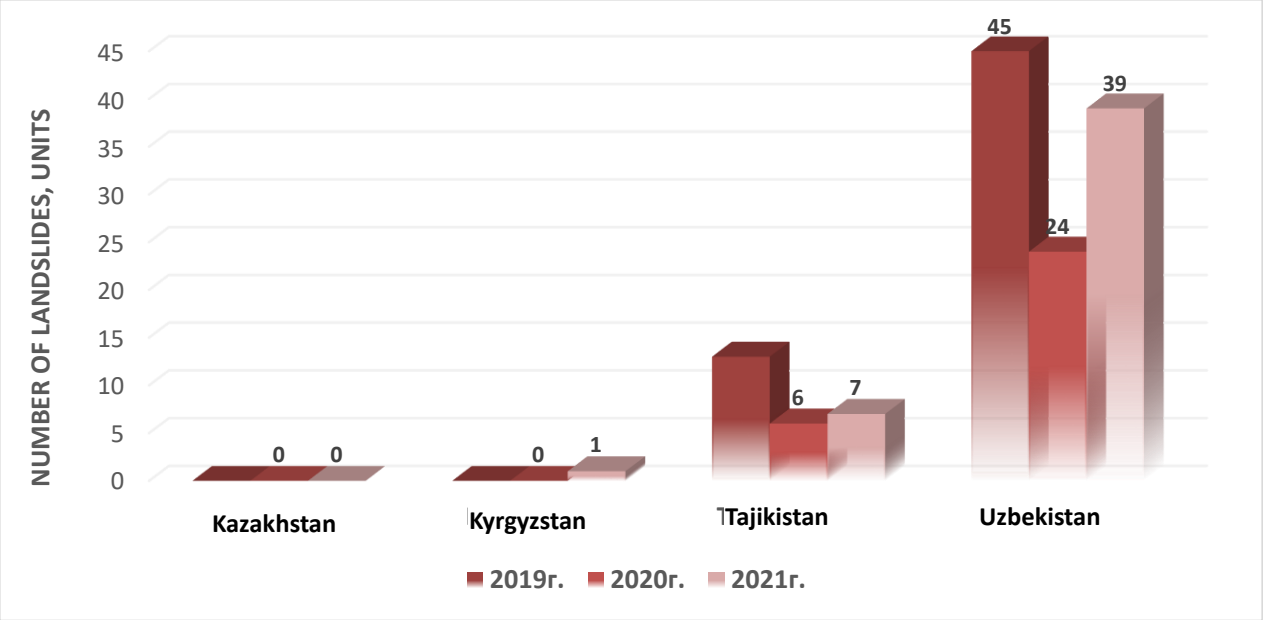


Figure 29 - Dynamics of landslides that occurred in Central Asian countries, in the period from 2019 to 2021[21]

Figure 29 indicates that the largest number of landslides during the period under review occurred in the Republic of Uzbekistan.

III. IDENTIFICATION AND FORECASTING OF CLIMATIC FACTORS CONTRIBUTING TO DISASTER RISK

In recent years, the increasing severity and frequency of extreme event due to global climate change has resulted in loss of life, economic losses, destruction of infrastructure, disruption of supply chains and degradation of vital natural and ecological systems.

According to the United Nations, in 2022 alone, disasters worldwide caused nearly 31,000 deaths and $223.8 billion in economic losses, affecting more than 185 million people[22].

Climate modelling projections suggest that by the end of the century, temperatures will increase by 2.5-6.5 °C across CA compared to the 1961-1990 baseline period (CAREC 2020). Meanwhile, future precipitation is likely to be unevenly distributed across the region, with the northeast becoming wetter and the southwest becoming drier. This is the trend observed over the last 40-50 years (CAREC, 2020).

Central Asia faces serious challenges in coping with the adverse effects of climate change. In particular, the impact of climate change on water-related disasters in the region has been recognized as one of the key threats. For example, temperatures have increased by 1 degree in

[21] *Analysis of natural and manmade hazards in CA, CESDRR. https://cesdrr.org/uploads/dev/2022/1.06.2022%20Анализ%20ЧС%20в%20ЦА.pdf*
[22] UN website article. https://news.un.org/ru/story/2022/08/1430712

Kyrgyzstan, 1.6 degrees in Turkmenistan, 1.4 degrees in Kazakhstan and Uzbekistan, and Tajikistan has become hotter by 0.7 degrees over the past 45 years.

According to these projections, Central Asia is projected to experience more frequent periods of heat waves, fire weather and droughts, especially in areas with arid and semi-arid climates (IPCC, 2022).

Abnormal droughts, which typically occur at a frequency of once every 100 years, are projected to occur 4-10 times more frequently in the region, depending on the degree of global warming (Naumann et al. 2018).

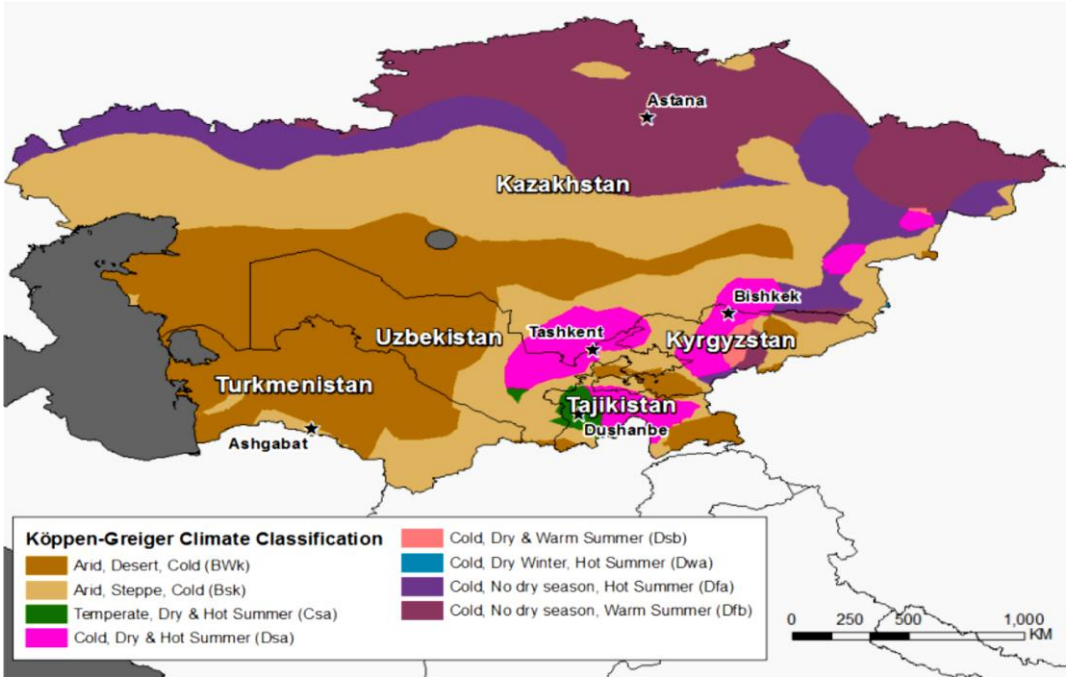


Figure 30 - Climatic classification of Central Asia[23]

These projections also predict increasing water scarcity, with major river basins such as the Amu Darya and Syr Darya experiencing declining river flows (*International Alert, 2021*). The annual river flow of the Amu Darya is predicted to decrease by 26-35 percent by 2050 (*Government of the Republic of Tajikistan, 2022*).

[23] https://carececo.org/main/ckh/publications/illyustrirovannyy-obzor-izmenenie-klimata-v-tsentralnoy-azii/

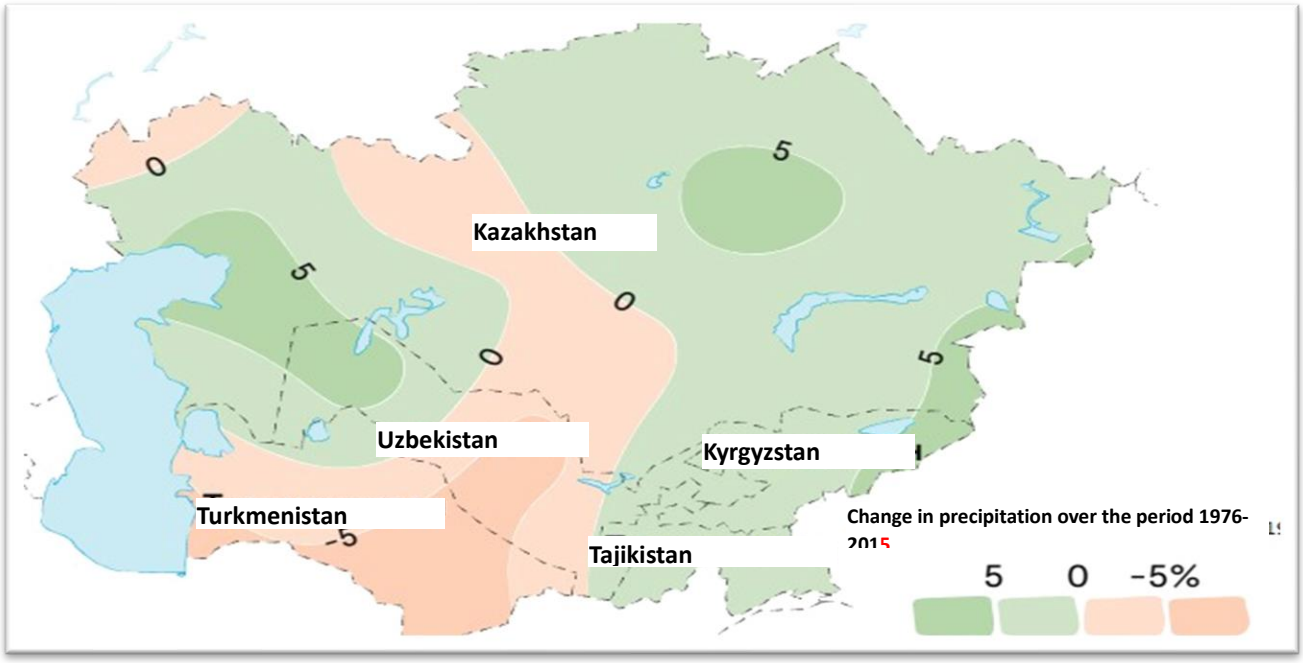


Figure 31 - Precipitation change in Central Asia

Similar trends are likely to be evident for other rivers in the region: in Turkmenistan, the two largest rivers after the Amu Darya, the Murghab and the Tejen, are projected to experience a decline in flow volumes as a result of higher temperatures and lower precipitation (Ministry of Nature Protection of Turkmenistan 2015).

The effects of these trends are particularly evident in mountainous regions.

In high mountain areas throughout Central Asia, both snow cover and snow volume will decline during the 21st century, along with likely reductions in glacier mass and permafrost thawing (*IPCC 2021*).

In Uzbekistan, several river basins, such as the Pskem, Surkhandarya, Kashkadarya and Chatkal rivers, are likely to experience a steady decrease in glaciated area between now and 2050 (*UzHydromet, 2016*). At the same time, increased temperature and precipitation may lead to an increase in glacial lake outburst floods and landslides over moraine dammed lakes (*IPCC, 2021*).

Due to its continental climate, the region is also prone to periodic cold waves and blizzards during winter. For example, in early 2023, unfavorable winter weather conditions in Central Asia, including the lowest temperatures ever recorded in the region, had very serious impacts on the countries' infrastructure and economy (*in the form of gas, electricity and water supply disruptions, accidents at critical life-support facilities, blocked main roads by snow drifts*), as well as on people's livelihoods and health (*as some households have resorted to burning waste as fuel for their cookers, resulting in severe air pollution*).

It is generally accepted that climate change exacerbates extreme weather events (Buchholz, 2023), but the impact of climate change on increasing the intensity of extreme cold weather events is controversial (Brown, 2022).

Global climate change can affect security and stability in Central Asia in a variety of ways.

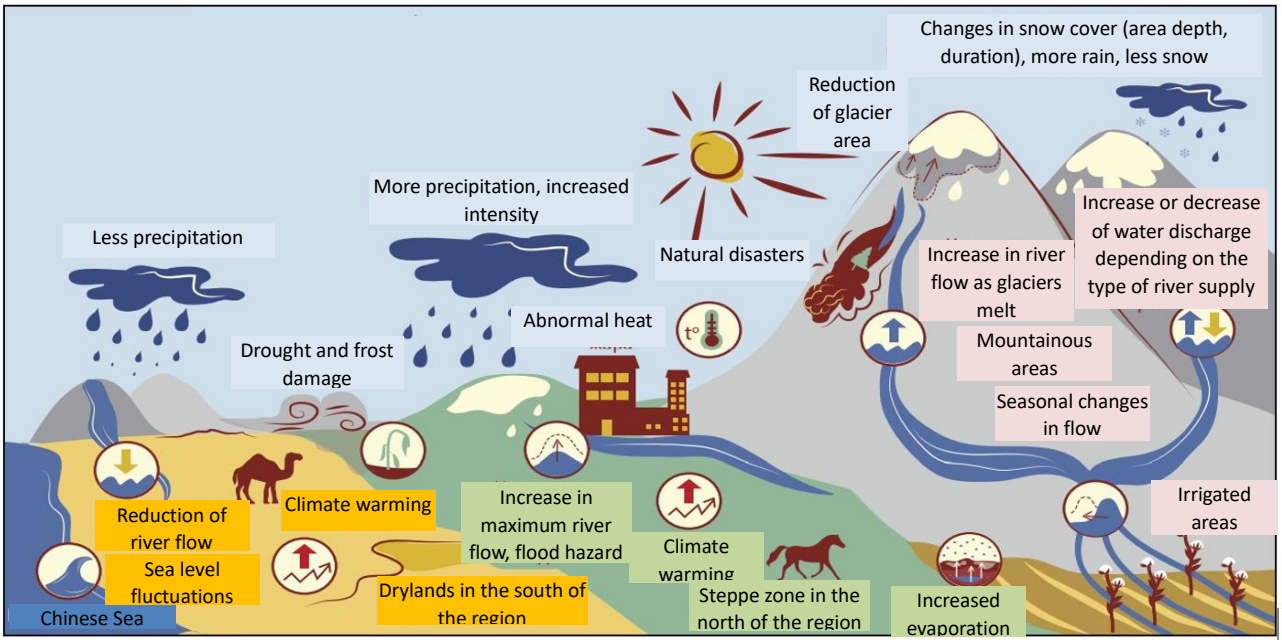


Figure 32 - Climate change trends and projections in Central Asia[24]

Consider likely scenarios of climate impacts on disaster risk in CA.

Agricultural sector

The impact on ecosystems is a particular challenge for local people whose livelihoods depend directly on agriculture and natural resources. The habitat of the Italian locust (Calliptamus italicus) is expected to expand in CA, while in Kazakhstan, drought is already causing a slowdown in tree growth and reforestation, as well as increased tree mortality rates (*IPCC, 2022*).

Changes in river flow regimes could affect irrigation systems in the region (*IPCC, 2022*), jeopardizing food security in lowland areas highly dependent on irrigation (*Novikov and Kelly, 2017*).

In addition, the projected increase in heat stress is expected to reduce the area of arable land in Central Asia, which, coupled with worsening water scarcity, will negatively affect agricultural productivity in the region.

However, the impact of these factors varies in the countries of the Central Asian region depending on the type of farming (large or small), as well as on the agricultural and water management technologies used (*IPCC, 2022*).

Energy sector

Security threats may also arise from climate change impacts on the energy sector. Shifts in glacial and river flow regimes could affect hydropower operations (IPCC, 2022). For example, projections show that with 2°C warming, small hydropower potential is expected to decrease by 13 per cent by 2050, in Turkmenistan and 19 per cent, in Kyrgyzstan (Reyer et al. 2017). Of Tajikistan's 300 small hydropower plants, less than 20 per cent continue to operate (UNECE, n.d.). The hydropower sector is also highly vulnerable to floods, and most hydropower structures in the region require maintenance to ensure their safe operation (OSCE 2022). This makes the mountainous regions of Kyrgyzstan and Tajikistan particularly vulnerable to climate

[24] https://carececo.org/main/ckh/publications/illyustrirovannyy-obzor-izmenenie-klimata-v-tsentralnoy-azii/

change, given their dependence on hydropower for their energy needs (Adler et al. 2022; Novikov and Kelly 2017).

Countries dependent on hydropower are increasingly turning to coal as a short-term solution to energy security. Kyrgyzstan, for example, relies on coal to cope with the increasing load on the grid during the winter months when reservoir levels are low and electricity demand is high (*OSCE, 2022*). In Kazakhstan, coal accounts for 50 per cent of primary energy consumption and 70 per cent of electricity generation (*IEA, 2020*). However, the continued use of coal has serious negative environmental and health impacts and, if this practice continues in the long term, may increasingly hinder the realization of current climate goals and sustainable development plans (*OSCE, 2022*).

As for the Caspian littoral regions of Kazakhstan and Turkmenistan, the oil and gas infrastructure located there remains vulnerable to sea-level fluctuations, storm surges and other extreme events (*Novikov and Kelly 2017; Tehran Convention Secretariat 2021*), with potential implications for energy security as well as for the revenues of countries dependent on these resources.

Health Sector

The health impacts of climate change are also a growing concern. Increasing frequency and intensity of natural hazards such as heat waves, floods and droughts across Asia may increase the incidence of vector and waterborne diseases, malnutrition, mental disorders and allergic diseases (*IPCC, 2022*).

In Central Asian areas with substandard water supply and sanitation systems, heavy rainfall can increase the risk of transmission of waterborne diseases such as typhoid, salmonellosis and dysentery (*Novikov and Kelly, 2017*).

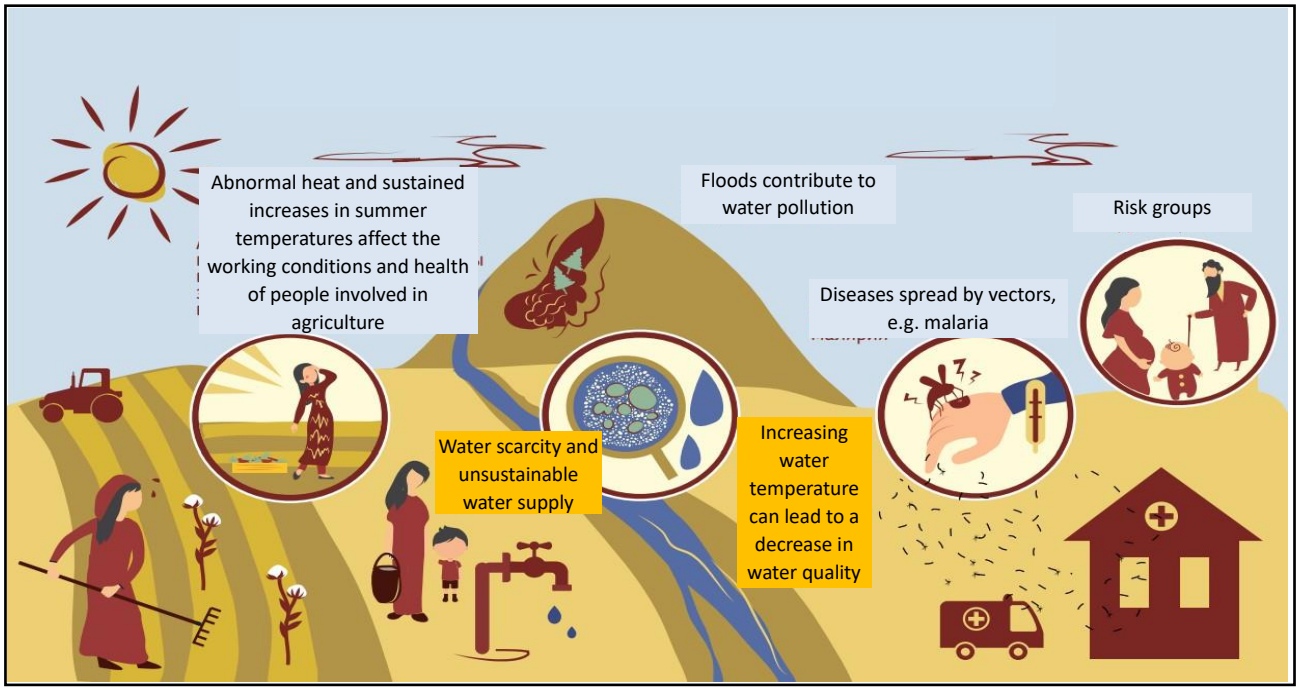


Figure 33 - Climate change and human health hazards[25]

[25] https://carececo.org/main/ckh/publications/illyustrirovannyy-obzor-izmenenie-klimata-v-tsentralnoy-azii/

In addition, the effects of heat waves and warmer temperatures may result in increased heat-related deaths and deaths from cardiovascular, respiratory, diabetic and infectious diseases, as well as increased infant mortality rates (*PCC, 2022*).

In the region, urban populations and agricultural workers are particularly vulnerable to such conditions (*Novikov and Kelly 2017*). In addition, dust storms, the frequency of which is likely to increase as the aridity of the climate increases, may enhance the exposure of Central Asian populations to dust and exacerbate respiratory problems as well as skin and eye diseases (*Reyer et al. 2017*).

Population mobility

Various forms of population mobility, including short-term displacement due to climate-related disasters, as well as seasonal and long-term migration, are increasingly affected by climate change.

The projected increase in the frequency of extreme weather events may lead to even more short-term displacements in CA, especially in mountainous areas, due to rapidly occurring weather and climate-related disasters such as floods, mudslides and landslides (*Blondin n.d.*). For example, in May 2020, the collapse of the dam wall of the Sardoba reservoir on the Uzbek side of the Syr Darya River caused severe flooding that killed six people and displaced more than 100,000 people in the border areas of Kazakhstan and Uzbekistan (*IDMC 2021; Radio Free Europe/Radio Liberty 2021; Xiao et al. 2022*).

Seasonal and long-term migration is already a common phenomenon in Central Asia and is of great socio-economic importance for migrants' places of origin due to remittances. Among the various drivers of migration, ecosystem degradation and loss of livelihoods due to the impacts of climate change, especially in the agricultural sector, is an important push factor (*Novikov and Kelly 2017; Reyer et al. 2017*). For example, in the past, drought and water scarcity have repeatedly caused cyclical migratory movements of people in the Aral Sea region in the 1990s and early 2000s (*Novikov and Kelly, 2017*).

Through exacerbating the degradation of vulnerable ecosystems in the Aral and Caspian Seas, the Tien Shan and Pamir Mountains, and the Amu Darya and Syr Darya river basins, climate change is likely to accelerate migration flows and affect drivers of migration in the region (*IOM, 2021*). It is estimated that by 2050, 2.4 million people may have to migrate out of Central Asia due to climate change impacts (*ICMPD, 2022*). This trend takes different forms for different population groups in the region.

In rural mountainous areas, for example, there tends to be massive labour migration of men and able-bodied youth, which increases the burden on the most vulnerable groups, including women, children and the elderly, who often remain in the country and are therefore disproportionately exposed to climate risks (*Novikov and Kelly, 2017*).

Human security

Disasterhazards such as floods, hurricanes (blizzards and dust storms) and forest fires pose a direct threat to the safety of individuals and the general population, the severity of which depends on their preparedness and access to post-disaster assistance and services. Mountain villagers are particularly vulnerable to landslides, mudslides and avalanches, the risk of which is increased by rising temperatures and melting glaciers (*CAREC 2020*), as well as by the relatively higher levels of poverty and isolation of mountain communities compared to those in the plains (*Novikov and Kelly 2017*).

Transboundary natural resources

There have already been several instances of tensions in CA over disputes over transboundary natural resources, primarily water and related infrastructure development such as dams.

Tensions have also arisen due to competition over access to land and water resources, especially in border areas such as the Ferghana Valley where borders are not fully delimited (*Climate Diplomacy, n.d.*). This situation, combined with the effects of climate change, may further limit the availability and accessibility of these resources (*Mirimanova et al. 2018*).

IV. TRANSBOUNDARY CO-OPERATION IN DISASTER RISK MANAGEMENT

The governments of Central Asian countries are taking steps to strengthen regional co-operation in various areas related to disaster risk reduction and man-made accidents.

Various multilateral interstate agreements on co-operation in the field of natural and man-made disaster risk management and elimination of consequences of natural and man-made accidents are the basis for the development of co-operation of the Central Asian countries on transboundary issues in this area (*Table 2*).

Table 2 - List of multilateral international agreements in the field of natural and man-made disaster risk management

No.	Document name	Date and place of signature
1	Agreement between the governments of the CIS member states on co-operation in the field of prevention and elimination of the consequences of natural and man-made emergencies	22.01.1993, Minsk
2	Decision of the Council of Heads of Government of the Commonwealth of Independent States on the Commonwealth of Independent States Forces Corps to eliminate the consequences of natural and man-made emergencies	9.12.1994, Moscow
3	Agreement between the governments of the CIS member states on co-operation and interaction in the field of earthquake research and seismic hazard forecasting	24.09.1993, Moscow
4	Agreement between the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan on co-operation in the field of prevention and elimination of emergency situations	17.09.1998, Cholpon-Ata
5	Agreement between CIS member States on the use and development of the transport communications network for the needs of the economy, military and humanitarian transport of CIS member States.	31.01.2001, Minsk
6	Decision of the Council of Heads of Government of the CIS member States on the procedure for organising the consequences of natural and man-made emergencies	29.11.2001, Moscow
7	Agreement between the governments of CIS member states on mutual assistance in cases of accidents and other emergencies at electric power facilities of CIS member states	30.05.2002, Moscow
8	Agreement between CIS member states on the exchange of information on natural and man-made emergencies, on information co-operation in dealing with the consequences and providing assistance to the affected population	18.09.2003, Yalta
9	Decision on the establishment of a Reserve Fund of the CIS member States to provide assistance to States affected by natural and man-made emergencies	16.04.2004, Cholpon-Ata
10	Agreement on co-operation of the CIS member states in the field of prevention and elimination of emergency situations	16.10.2015, Cholpong-Ata village. Burabai

11	Protocol on Amendments and Additions to the Agreement on Cooperation in the Field of Prevention and Elimination of Consequences of Natural and Technogenic Emergencies of 22 January 1993	30.10.2015, Dushanbe
12	Agreement between the Governments of the member States of the Shanghai Cooperation Organisation on cooperation in the provision of assistance in the elimination of emergency situations	26.10.2005, Moscow
13	Protocol to the Agreement between the Governments of the Member States of the Shanghai Cooperation Organisation on Cooperation in Emergency Response Assistance of 26 October 2005	05.12.2012, Bishkek
14	Agreement on Cooperation in the Field of Industrial Safety at Hazardous Production Facilities	28.09.2001, Moscow
15	Agreement on the Collective Security Treaty Organisation Collective Rapid Reaction Force	14.06.2009, Moscow
16	Strategy for development of cooperation of countries of Central Asia in disaster risk reduction for 2022 – 2030	05.11.2021 Tashkent
17	Decision on the Statement by the Heads of States members of the Commonwealth of Independent States on cooperation in the climate sphere	11.10.2022, Astana
18	Astana Declaration of the Council of Heads of States members of the Shanghai Cooperation Organisation	04.07.2024, Astana
19	Agreement between the Governments of the Shanghai Cooperation Organisation member States on cooperation in the field of environmental protection	04.07.2024, Astana

It is important to note that there are a number of bilateral agreements aimed at ensuring cooperation in disaster risk reduction, preparedness and response, taking into account that none of the regional agreements covers all CA countries. Table 3 below lists some of the bilateral agreements that are binding on the countries of the CA region, but the list is not exhaustive and is still expanding.

Table 3 - List of bilateral international agreements in the field of natural and man-made disaster risk management

No.	Document name	Date and place of signature
1	Agreement between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic on cooperation in the field of civil defense (protection), prevention and elimination of emergency situations	16.06.2009, Astana
2	Agreement between the Government of the Republic of Kazakhstan and the Government of the Kyrgyz Republic on the establishment of the Centre for Emergency Situations and Disaster Risk Reduction	17.05.2013, Almaty
3	Agreement between the Government of the Republic of Kazakhstan and the Government of the Republic of Tajikistan on cooperation in the field of civil defense, prevention and elimination of emergency situations	06.09.2014, Almaty
4	Agreement between the Government of the Kyrgyz Republic and the Government of the Republic of Tajikistan on cooperation in the field of civil defense (protection), prevention and elimination of emergency situations	27.05.2013, Bishkek
5	Agreement between the Government of the Republic of Tajikistan and the Government of the Republic of Uzbekistan on joint measures and co-operation on timely notification in the event of a breach of Lake Sarez	30.05.2000, Tashkent
6	Agreement between the Government of Turkmenistan and the Government of Uzbekistan on cooperation in the prevention and elimination of emergency situations	25.11.2013, Tashkent

7	Agreement between the Government of the Kyrgyz Republic and the Government of the Republic of Tajikistan on cooperation in the field of civil defense (protection), prevention and elimination of emergency situations	27.05.2013, Bishkek
8	Agreement between the Government of the Republic of Tajikistan and the Government of Turkmenistan on cooperation in the field of civil defense, prevention and elimination of the consequences of emergency situations	02.11.2017, Dushanbe

Since the Central Asian region is prone to transboundary disasters, multilateral and bilateral international agreements in the field of disaster risk management do not address the issues of early warning of disasters and hazards between the Central Asian countries, rapid response to them and international assistance. This fact predetermines the need to adopt international Agreements of Central Asian countries on prevention, early warning of disasters, response to disasters, regulation of international assistance provision.

During the 4th Consultative Meeting of CA Heads of State in July 2022, all five countries adopted the 'Roadmap for the Development of Regional Cooperation (*2022-2024*)'. This document envisages the creation of a number of interagency cooperation mechanisms focused on environmental protection, energy, education and culture.

In addition, the meeting adopted the Central Asian Regional Green Agenda Programme, which aims to strengthen cooperation on green economic growth and sustainable development through joint projects, technology transfer and knowledge sharing (*Kyrgyz Ministry of Foreign Affairs, 2022*).

The Central Asian governments, together with international partners, are also implementing a number of regional-level projects and initiatives aimed at addressing various climate change issues and strengthening regional co-operation in addressing these issues.

The Centre for Emergency Situations and Disaster Risk Reduction is actively working in the Central Asian region. In a short period of its existence, the Centre has managed to establish a regional platform for high-level disaster risk reduction - Regional Forum - Meeting of Heads of Emergency Agencies of Central Asian countries, whose members are the first heads of authorized bodies in the field of civil protection. It is important to note that the Centre has managed to ensure the sustainability of this platform, and currently this platform supports active dialogue between the governments of the countries in the field of disaster risk reduction at the regional level.

The Regional Forum adopted important strategic documents aimed at strengthening regional and international cooperation in the field of disaster risk reduction, as well as strengthening the capacity of emergency response services of the authorized bodies of the Central Asian countries. One of the most significant documents is the Strategy for Development of Cooperation of Central Asian Countries in the Field of Disaster Risk Reduction for 2022-2030.

This strategic document reflects the key problem areas in the region, identifies trends in disaster risk management and provides directions for effective regional cooperation in this area.

The document also formulates specific tasks to be undertaken to achieve the set goals:

- *Strengthening the institutional framework for regional and cross-border cooperation between countries in disaster risk reduction (DRR).*
- *Development of a common information space for disaster and emergency risk assessment and forecasting.*
- *Support the development of human resources in the region in the area of DRR.*

- *Supporting the development of National Disaster Risk Reduction Platforms in CA countries to develop and implement disaster risk reduction strategies at the national and local levels.*
- *Support and attract investment in DRR, involving the private sector, international and regional organizations and partners.*

In addition, for the practical implementation of these tasks at the regional level, a Roadmap for the implementation of the Strategy for 2023-2024 was adopted. In 2024, the Center is developing a draft Roadmap for 2025-2026, which will be submitted for consideration to the heads of emergency authorities of the CA countries. This document aims to move from the stage of risk awareness to concrete and effective measures that contribute to improving emergency preparedness and strengthening sustainable development.

Moreover, the United States Agency for International Development (*USAID*) is implementing a number of initiatives and projects in Central Asia aimed at solving environmental and water problems. For example, its Aral Sea ecosystem restoration activities (*2021-2024*) aim to improve soil and vegetation conditions in parts of the Aral Sea through afforestation activities, which will increase landscape resilience and human resilience (*USAID, 2021*).

The analysis of cross-border cooperation between CA countries concludes that despite the fact that there are a number of agreements between the bordering CA states in the field of disaster risk management and man-made accidents, information on the threat and occurrence of disasters is being exchanged, joint exercises and trainings are being held. At the same time, there continues to be a problem of joint response to transboundary disasters, consisting in the lack of clarity of organizational interaction, the exchange of forecast information, etc., which does not allow for the ability to quickly respond and take joint actions to reduce the risk of disasters.

The development of a more detailed methodology for integrated risk management of transboundary disasters in CA, taking into account the current climate change, would help to address this problem.

V. GOALS, OBJECTIVES AND PRINCIPLES OF RISK MANAGEMENT

5.1. Identify the main goals and objectives of disaster risk management

The objective of disaster risk management is to assess the integrated safety profile of the Central Asian area exposed to natural and man-made disaster risks and to develop proposals for their reduction and prevention on the basis of available and newly received stock and operational data on disasters and the results of their research.

Disaster risk management has several primary objectives that help ensure the safety and sustainability of CA countries. The main objectives of disaster risk management are:

1. **Monitoring and forecasting risks and threats:** includes a set of observations of the state of the environment (atmosphere, hydrosphere, other geospheres, soil and vegetation cover, wildlife, technosphere objects), as well as a proactive reflection of the likelihood of an emergency and the development of an emergency based on an analysis of the possible causes of its occurrence, the source in the past and present.
2. **Addressing Risk Drivers:** by proactively identifying and addressing risk drivers, it is possible to minimize the likelihood of disasters.
3. **Crisis management:** developing strategies and action plans to minimize the impact of disasters.

4. **Disaster risk financing:** This approach complements other elements of an integrated disaster risk management strategy - from investment in risk reduction to improved disaster preparedness and sustainable recovery and reconstruction.

Financial protection involves advance planning that helps to better manage the cost of disasters, ensure predictable and timely access to necessary resources, and ultimately mitigate the long-term financial impact of disasters.

The objectives of disaster risk management in Central Asia are:

- Collection, processing and archiving of information on natural and man-made disasters;
- Physical and statistical analysis of collected disaster information;
- Classification of disasters by sources of occurrence and extent of their negative impact;
- Assessment of hazards and risks of disasters, as well as vulnerabilities of the population, facilities and territories;
- Development of the most probable and extreme scenarios of occurrence, development and negative impact of single and multiple disasters;
- Ranking priority disasters by significance and justifying cross-border risk profiles;
- Developing systemic proposals for disaster risk reduction.

5.2. Highlighting the principles that underpin the concept

The basic principles underlying the concept of integrated disaster risk management are:

1. **Governance:** This governance principle covers organizational, legal and policy frameworks. Involves the development of strategies, policies and plans that will effectively manage transboundary disaster risks in response to global climate change.
2. **Risk identification, assessment and monitoring:** This principle focuses on the ongoing analysis and risk assessment of natural and man-made transboundary risks. Potential threats are identified in advance, the likelihood of their implementation and the impact on the population and economic facilities are assessed, as well as monitoring the situation for the purpose of prompt response.
3. **Understanding risk:** The Principle provides for the creation of a knowledge base on natural and man-made transboundary risks and their management mechanisms. Education and training play a key role in raising awareness of transboundary disaster risk management.
4. **Risk mitigation:** This principle aims to reduce vulnerability and eliminate factors contributing to cross-border risks. Including measures for acceptance, refusal and transfer of risk.

VI. MECHANISMS FOR INTEGRATED RISK MANAGEMENT

Analyzing existing risk management mechanisms in the region

Central Asian governments play a key role in disaster risk management and recovery. Given the real risks of large-scale and transboundary disasters, the negative consequences of which cannot always be eliminated only by the forces and means of one country, and the need for concerted and coordinated action to prevent and eliminate them, governments of Central Asian states are striving to unite their efforts in the field of disaster risk reduction, further strengthening bilateral, multilateral regional cooperation and global partnership.

Central Asian countries have now stepped-up coordination of joint actions to create sustainable mechanisms for the implementation of bilateral and multilateral interstate and/or interdepartmental agreements, the Sustainable Development Goals until 2030, the priorities of the Sendai Framework Program on DRR for 2015-2030, the UN Framework Convention on Climate Change, the Paris Climate Agreement and other international policy documents.

The dialogue among national Governments on disaster risk reduction at the regional level has now been strengthened through the implementation of the Framework for Strengthening Regional Cooperation in Disaster Risk Reduction and through the establishment of a permanent regional advisory platform in the format of the Regional Forum - Meeting of the Heads of Emergency Agencies of CA Countries.

Based on the decisions of the Regional Forums - Meetings of the Heads of Emergency Authorities of CA countries, interstate (intergovernmental) disaster councils, joint bilateral and multilateral colleges of emergency departments, the activities of technical working groups and expert specialists have been created and are being carried out, and within the framework of the formed Regional Scientific and Technical Council, measures are being taken to strengthen regional scientific and technical cooperation.

At the regional level, joint actions have also been intensified to enhance the capacity of emergency agencies in the region to reduce disaster risk, to learn and share experiences, to introduce innovative information and communication technologies, and to improve coordination, collaboration and emergency response mechanisms.

Currently, in order to prevent new and reduce existing disaster risks, the emergency departments of the Central Asian countries are taking joint coordinated identification measures, assessment, mapping and modelling of disaster risks, improvement of monitoring and forecasting systems, early warning and alert, response, regional and national capacity-building for the implementation of the Sendai Framework on DRR for 2015-2030 years, and climate change adaptation and mitigation measures.

The strategic documents of Central Asian countries in the field of disaster risk reduction indicate that the development and improvement of regional cooperation to implement joint coordinated actions to reduce their risk remains relevant.

Despite the fact that there are interstate agreements between the bordering States of the region in the field of ensuring security against natural and man-made disasters, exchange of information on the threat and occurrence of disasters, joint exercises and training, Challenges continue to exist in the joint response to transboundary disasters, with lack of clarity in organizational interaction, information exchange, etc., which makes it impossible to quickly respond and take joint actions.

The provisions of most of the existing normative and legal instruments do not fully provide for the implementation of the mechanism of international cooperation on the prevention and elimination of transboundary disasters, as defined by these agreements and treaties.

Central Asian countries, in order to create at the regional level an effective mechanism for the implementation of bilateral and multilateral interstate and intergovernmental international agreements/treaties that have entered into force, strengthening the readiness of emergency rescue units to carry out emergency rescue operations on their territory in the event of disasters, determination of emergency rescue units of constant readiness sent to the affected country for emergency rescue and urgent work in the emergency zone, **a Regional Register of forces and means of CA countries for emergency rescue operations on their territory in the event of disasters has been formed**. At the same time, there is no effective mechanism for

the prompt involvement of forces and means of neighboring CA countries to eliminate the consequences of natural and man-made disasters.

In Central Asian countries, on the basis of the adoption of regulatory legal acts, country systems for monitoring and forecasting natural and man-made disasters, integrated systems for informing and alerting the population, unified state duty dispatch services, Crisis Management Centers, early warning systems through television, radio, Internet, print media and SMS messages and so on. However, there is currently no single integrated system for monitoring and forecasting transboundary disasters and early warning of the population.

VII. DEVELOPING AN INTEGRATED APPROACH TO RISK MANAGEMENT

Recognizing the importance of regional-level activities on transboundary disaster risk management, for a region with a high level of agricultural activity and a large percentage of the rural population, there is a great need for regional integration actions to build the foundations for the regional meteorological database formation, hydrological, geophysical, geodynamic and other indicators for regional monitoring, forecasting and early warning, or counteracting the occurrence of natural hazards and man-made disasters.

A number of main directions and objectives working towards the creation of a regional process for integrated risk management of transboundary disasters taking into account climate change may be considered:

Direction 1: Strengthening monitoring and forecasting capacity, disaster risk assessment:

- **Existence of an integrated automated system for monitoring and forecasting the risk of transboundary disasters:** in order to organize conditions that allow monitoring, assessment and forecasting of transboundary disasters, the creation of a single automated geographic information platform (digital atlas) for collecting and processing forecast information is required;
- **Scientific and methodological manuals and tools for cross-border disaster risk profiling:** strengthen the legal, institutional and technical framework for monitoring, assessment and planning of cross-border disaster risk reduction actions, especially taking into account the tasks and needs of decision-makers;
- **Enhanced cooperation between the expert community, policy bodies and predictive information providers:** to improve monitoring, assessment and forecasting of transboundary disasters, to facilitate the flow of information between potential information providers, the analytical and expert community, and key beneficiaries.

Direction 2: Transboundary disaster risk reduction, development of disaster risk management plans:

- **Integrating innovative solutions into interstate and national plans to reduce the risk of transboundary disasters:** building countries' resilience to disasters by integrating innovative solutions;
- **Building resilience to climate change:** Exploring, adapting and disseminating best practices in transboundary disaster risk management;
- **Increased awareness of, response to and planning for transboundary disasters:** provision of reliable and adapted knowledge and data, including ways to assess the impact, damage, loss and vulnerability of a sector of the economy in disaster-prone areas.

Direction 3: Capacity building and awareness raising:

- **Establishment of a regional early warning system for cross-border threats:** support for the initiative of the Center for Emergency Situations and DRR to create a Regional Early Warning and Mutual Information System for Threats and Emergencies, approved by all heads of emergency authorities of CA countries;
- **Capacity-building of national institutions and decision-makers in monitoring, forecasting, assessing and understanding, direct and indirect, the impact of transboundary disasters on the socio-economic development of countries in the region:** Ensure, in close cooperation with international development partners, that the national institutions and line ministries responsible for developing national plans and projects on climate change adaptation and mitigation of transboundary disasters are fully enhanced in knowledge and experience, with a focus on building a proactive mindset of disaster prevention;
- **Support for women and other particularly vulnerable groups:** there is great potential in CA to raise general awareness of climate change and cross-border disaster risk reduction through capacity-building activities for local communities and especially women.

Direction 4: Regional Integration

- **Institutional reform:** development, where necessary, and further building, where it already exists, policy support and regulatory frameworks for regional cooperation on monitoring, forecasting, assessment and sharing of transboundary natural and man-made disasters;
- **Regional Database of Transboundary Natural Hazards and Man-made Disasters:** will enable national disaster risk reduction authorities to work with the most validated and verified data, on the historical basis of which it will be possible to generate trends and forecasts corresponding to the climate and exposure of the region.

VIII. COOPERATION AND COORDINATION

Developing a model for cross-border collaboration on disaster risk reduction

The existing model of protecting Central Asian countries from transboundary disasters does not ensure the protection of the population and territory from crisis situations, since their main task is to localize and eliminate a disaster that has already arisen. At the same time, the objects of protection carry social, economic and environmental consequences.

In this regard, it is proposed to improve the system for managing the risks of transboundary disasters from the rapid response system to the early identification of possible threats and hazards, in order to carry out appropriate measures to minimize them (Figure 34).

Integrated risk management for transboundary disasters includes:

1. *Selection of approach, planning and execution of natural and man-made disaster risk management operations;*
2. *Determining what risks (natural, man-made) can affect and documenting their characteristics;*
3. *Prioritization of risks for further analysis or processing by assessing and summarizing the probability of their occurrence and impact;*
4. *Quantitative analysis of potential impact of identified risks;*
5. *Analysis of consequences in case of implementation of identified risks;*

6. *Development of engineering, organizational and other measures to reduce the risk of disasters and increase the resilience of the population;*
7. *Monitoring identified risks, tracking residual risks, identifying new ones, executing disaster risk management plans.*

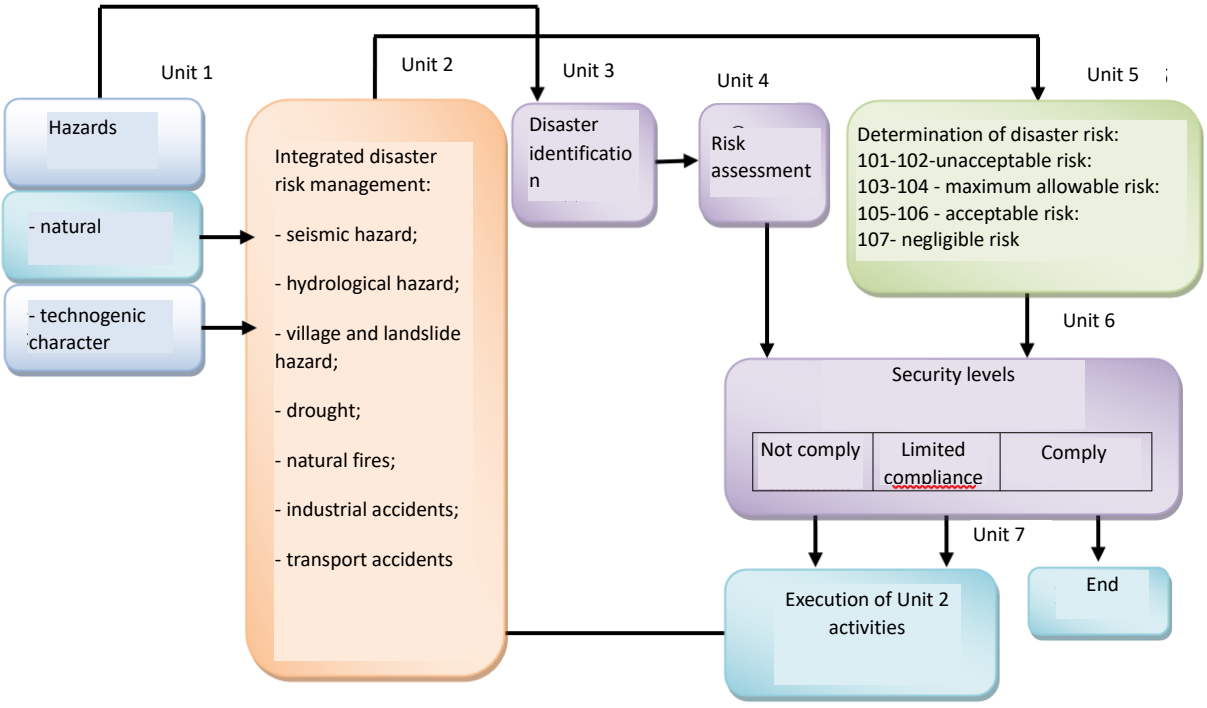


Figure 34 - Integrated Transboundary Disaster Risk Management Flow Chart[26]

With an integrated approach, all kinds of risks are taken into account:

1. *Natural, exposure of the territory to disasters (earthquakes, floods, mudslides, landslides, karsts, soil subsidence, etc.);*
2. *Man-made, possible accidents and catastrophes (fires, explosions, accidents on life support systems, radiation, chemical and biological contamination, etc.);*
3. *Environmental disasters.*

Integrated risk management of transboundary disasters allows to combine all possible levels of security (*fire, industrial, environmental, energy, economic*), thereby providing reliable and highly effective protection, allowing you to reduce the financial costs of countering various threats and dangers.

The structure of the integrated disaster risk management system includes the following main elements:

- *determination of acceptable risk levels based on economic and social factors, construction of mechanisms for interstate safety regulation;*

[26] Civil Defense Academy of the Ministry form Emergency Situations of Kazakhstan, 2021

- *environmental monitoring, risk analysis and forecasting of natural and man-made disasters;*
- *making decisions on the appropriateness of protection measures;*
- *prudent allocation of funds for preventive risk reduction and disaster reduction;*
- *Implementing preventive measures to reduce the risk of disasters and their consequences;*
- *emergency rescue and recovery operations in case of disasters.*

IX. FUNDING AND RESOURCES

. Developing a methodology to allocate disaster risk reduction investments based on priorities and needs

The economy of Central Asia is very vulnerable to natural and man-made disasters. The World Bank estimates the potential losses of Central Asian countries from disasters at between 5% and 70% of GDP.

Most Central Asian countries have specialized, export-dependent economies vulnerable to global climate change, which exacerbates the funding gap for implementing a set of disaster risk reduction measures.

Central Asian countries currently do not have a dedicated budget for climate change adaptation and mitigation activities. However, national budgets and strategic documents of CA countries indirectly contribute to the restoration of ecosystems, the promotion of natural resource management and the transition to a green economy, which in turn contributes to disaster risk reduction.

Therefore, the development of a methodology for allocating disaster risk reduction investments based on priorities and needs is relevant.

The methodology for allocating investments should be aimed at strengthening financial sustainability and accelerating disaster risk reduction in CA, taking into account the priorities and needs of the population.

The investment allocation methodology will enable early planning and management of disaster costs, ensure predictable and timely access to necessary resources, and ultimately mitigate the long-term financial impact of disasters.

X. CONCLUSION

Experts from the UN Framework Convention on Climate Change (UNFCCC) noted that global climate change will negatively affect all sectors of the economy around the world.

For Central Asian countries, climate change primarily means an increase in the frequency of transboundary natural and man-made disasters.

Climate and socio-economic risks become cross-border security risks if there is no clear concept and algorithm of interaction between the countries of the region to maintain an acceptable level of vital activity, at the cross-border level.

Disasters such as earthquake, floods, drought, etc. have no borders, and affect the safety and health of the population, the socio-economic development of the Central Asian countries.

There are no national boundaries for disasters and therefore an integrated regional approach is appropriate when developing risk management strategies. In order to reduce the risk of disasters, the Concept of an Integrated Approach for Managing the Risk of Transboundary Disasters in Response to Climate Change has been developed.

The Concept seeks to develop conceptual approaches based on international norms and practices for reducing the risk of transboundary disasters related to climate change.