

# **Overview Document on the Status of Early Warning Systems in Central Asian Countries**

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## I. Introduction

Natural and technological hazards remain among the most pressing challenges affecting the safety and sustainable development of states. Climate change, rapid urbanization, and industrial risks make early warning systems a critical tool in emergency management. The frequency and scale of natural disasters, such as floods, earthquakes, hurricanes, and droughts, continue to increase. At the same time, technological hazards—including industrial accidents, transport disasters, and hazardous substance leaks—pose serious threats to human life and health. These hazards significantly impact the economy, environment, and social stability, highlighting the necessity of timely early warning.

Effective early warning systems collect and analyze data using advanced technologies such as satellite monitoring, hydrometeorological networks, and seismic systems, enabling real-time assessment of potential threats. This data supports forecasting and risk evaluation, allowing authorities to anticipate event developments and potential impacts. A key function of these systems is notifying the public and operational services, achieved through multiple communication channels, including mobile applications, mass media, and sirens, ensuring rapid alerts for those in affected areas.

Timely warnings facilitate preparation, evacuation, and damage mitigation. International experience demonstrates the life-saving potential of early warning systems. Japan, for instance, has one of the world's most advanced earthquake and tsunami warning systems, which significantly reduces losses through prompt response. In Bangladesh, a robust cyclone warning system has dramatically decreased fatalities over recent decades.

In Central Asia, with its diverse natural landscapes and climatic zones, the development of early warning systems is particularly crucial for protecting populations, infrastructure, and ecosystems.

### *Vulnerability of Central Asian Countries*

Central Asia, comprising five states—Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan—is home to over 75 million people. The region is geographically diverse, encompassing extensive and relatively young mountain ranges such as the Tian Shan and Pamir, numerous permanent glaciers, large deserts and semi-deserts, vast steppe areas, thousands of small rivers, and several major rivers and lakes, including the Amu Darya and Syr Darya, the Caspian and Aral Seas, Balkhash, and Issyk-Kul. It also includes major reservoirs, densely populated valleys such as the Fergana Valley, and some of the most sparsely populated areas in the world.

Central Asia is exposed to almost all types of hazards (with limited exceptions such as tsunamis, tornadoes, volcanic eruptions, and a few others), including natural (geological, geophysical, meteorological, agrometeorological, hydrological), technological, environmental, and biological-social risks.

The region is particularly prone to extensive areas of high seismic activity, with potential earthquakes reaching magnitudes of 7–9 and above, as well as mudflows, floods, flash floods, landslides, snow avalanches, inundations, rising groundwater levels, strong and hurricane-force

winds, dust and sand storms, prolonged and heavy rains, hail, intense snowfall and blizzards, droughts, frost, rockfalls, steppe, forest and mountain fires, extreme temperatures, industrial and transport accidents, explosions, major fires, epidemics, and mass infectious diseases affecting humans and animals.

It is well established that economic losses do not always correlate directly with the number of disasters. For example, while the number of earthquakes in Central Asia is significantly lower than the number of floods, the economic damage caused by earthquakes is considerably higher than that resulting from floods.

## II. Assessment of the Current Status of Early Warning Systems in Central Asia

In Central Asia, monitoring and forecasting systems are well developed, covering a wide range of hazards. They employ equipment adapted to local conditions and rely on trained personnel. Scientific and technological methods are increasingly implemented, with access to regional data sources, and the systems comply with international standards for data collection and forecasting.

Institutional mechanisms and regulatory frameworks are operational; however, there is a need for standardized vertical operating procedures to clearly define roles and responsibilities and improve coordination. Existing mutual agreements provide a uniform warning language, but additional protocols are needed to streamline communication. Cooperation with international organizations is conducted through both multilateral and bilateral agreements.

### 2.1. Early Warning System in the Republic of Kazakhstan

#### *Legislation*

The emergency alert system in the Republic of Kazakhstan is governed by a set of legal and regulatory acts that ensure its effective functioning. The cornerstone document is the **Law of the Republic of Kazakhstan “On Civil Protection”** (dated April 11, 2014, No. 188-V), which establishes the principles, objectives, and tasks of civil protection, including the prevention and response to emergencies. This law emphasizes public information and alerting, as well as coordination among governmental agencies during emergencies. It serves as the primary legal framework regulating emergency prevention, evacuation organization, and dissemination of safety information to the population.

Additionally, the system’s activities are regulated by the **Order of the Minister of Internal Affairs of the Republic of Kazakhstan** (dated December 26, 2014, No. 945) **“On Approving the Rules for Organizing the Civil Protection Alert System and Population Notification of Emergencies in Peace and Wartime.”** This order sets out procedures for establishing, developing, and operating the alert system, including technical requirements for equipment and communication channels, as well as coordination between national and local management levels.

The emergency alert system employs multiple communication channels, including sirens, mass media (television and radio), mobile communication networks, and specialized automated alert

complexes. Particular emphasis is placed on timely delivery of information and accessibility for all population groups, including people with disabilities.

The regulatory framework also mandates regular drills and exercises to test the readiness of the alert system. These activities help identify and correct deficiencies, enhance personnel preparedness, and improve inter-agency coordination.

The alert system is closely integrated with other civil protection components, including monitoring and forecasting of emergencies and the management of response resources. As part of international cooperation, Kazakhstan participates in information exchange with neighboring countries regarding transboundary emergencies, which is crucial for regional safety.

Thus, the legal and regulatory framework governing Kazakhstan's emergency alert system represents a comprehensive set of interrelated acts designed to protect the population, minimize the consequences of emergencies, and enhance the readiness of government agencies and services for rapid response.

### *Existing Monitoring and Early Warning Systems*

Currently, hydrological observations in Kazakhstan are conducted at **367** hydrological posts, providing continuous monitoring across **208** watercourses, **27** lakes, and reservoirs throughout the country.

Meteorological monitoring in the Republic of Kazakhstan is carried out at:

- **347** meteorological stations;
- **43** stations conducting actinometric observations;
- **9** aerological stations;
- **5** stations performing ozonometric observations.

### **Dynamics of Moraine Lake Growth (2018–2022)**

For debris-flow monitoring in the mountainous regions of Kazakhstan, which contain 970 moraine-glacial lakes posing potential risks to downstream populations, an automated debris-flow monitoring system (ADM) was implemented in 2021 under the “Digital Kazakhstan” state program and the “Smart City” initiative, with the support of the Almaty City Akimat. The system covers the river basins of Kishi and Ulken Almaty, Kargaly, and Aksai.

The ADM system comprises **31** monitoring stations, categorized into **four** types according to their locations:

- *Lake monitoring stations;*
- *Source-area monitoring stations;*





To visualize data from debris-flow monitoring stations, automated workstations (AWS) equipped with computers and specialized software were established at two locations: the Almaty City Operational and Technical Management branch of the State Enterprise “Kazseleziashchita” and the Almaty City Emergency Department.

Threshold values for monitored parameters have been set at all stations to ensure timely activation of alarm and emergency modes. When these thresholds are exceeded, the sensors trigger automatic activation of alerting systems (visual and audible signals) at the dispatch center.

The implemented automated debris-flow monitoring system enables real-time remote monitoring and assessment of moraine-dammed lakes’ breach risks, overall debris-flow hazards, and hydrometeorological conditions, significantly reducing the risk of emergencies caused by debris flows.

However, similar automated monitoring systems for debris-flow, landslide, and avalanche-prone areas are currently absent in other mountainous regions of Kazakhstan. Seismic monitoring and forecasting are conducted by LLP “National Scientific Center for Seismic Observation and Research,” which operates 98 seismic stations, many of which are technologically outdated.

At present, the monitoring and forecasting of hazardous natural phenomena in Kazakhstan are conducted by the following scientific and research-production organizations:

- LLP “National Scientific Center for Seismic Observation and Research” under MES RK and the RSE on the Right of Economic Management “Institute of Geophysical Research” of the Ministry of Energy of RK (seismic, geophysical, hydrogeological, biological observations, and crustal movement monitoring);
- RSE on the Right of Economic Management “Kazvodkhoz” (hydrological monitoring and forecasting);
- Central Asian Regional Glaciological Center (CARGC) (monitoring and forecasting debris flows, landslides, and avalanches);
- JSC “National Center for Space Research and Technologies” of MCRIA RK (monitoring floodwaters, reservoir levels, forest conditions, geodynamic safety in seismic regions, early detection of forest and steppe fires, etc.);

- RSE “Kazavialesookhrana” (forest fire monitoring);
- and other scientific organizations.

**The centralized population alert system** in Kazakhstan was inherited from the Soviet Union, implemented in the 1970s, and is now both physically and technologically outdated. Consequently, a planned modernization of the national alert system is underway, incorporating contemporary technologies to improve its effectiveness and reliability.

### Available Methods for Public Alerting



Timely public information and alerting are achieved through a comprehensive set of measures, including the activation of electric sirens and voice-siren devices, interruption of television and radio broadcasts, dissemination of SMS messages, publication of information on government websites, use of mobile applications, and deployment of emergency response vehicles.

To alert government authorities and the central staff of the Ministry of Emergency Situations of the Republic of Kazakhstan (MES RK), the “Rupor” hardware-software complex has been deployed. This system also allows commands to be transmitted to regional duty services of MES territorial units for activating the alert system.

Currently, the national alert network includes 3,303 electric sirens and voice-siren devices, of which 1,655 are SRU units and 1,648 are S-40 units. The republican control panel for the alert system is connected to control panels in 14 regions (Almaty, Shymkent, and the Almaty, Akmola, Zhetysu, Atyrau, Aktobe, Ulytau, Karaganda, Kyzylorda, Mangystau, Turkestan, North Kazakhstan, and East Kazakhstan regions). This setup allows commands to be sent to regional duty services of emergency departments and enables centralized activation of sirens with voice message broadcasts.

Another tool for timely public information is the interruption of broadcasting channels. Currently, digital terrestrial television interruption is available in 13 regions (Almaty, Shymkent, Zhetysay, Aktobe, Akmola, Atyrau, Zhambyl, Karaganda, West Kazakhstan, North Kazakhstan, Kyzylorda, Pavlodar, and Mangystau), where modern equipment for channel interception is installed and operational in regional emergency departments and at the Kazteleradio JSC radio and television stations.

Mobile applications installed on smartphones, tablets, and other internet-enabled devices are also used to alert the population. One such application, “Darmen,” is managed at the national level and by regional duty services, enabling alerts to be delivered within four seconds to a specific area. The Darmen app also has automated functionality to send messages to citizens’ smartphones when seismic sensors detect an earthquake of magnitude 6 or higher.

Currently, efforts are underway to integrate Darmen with the automated earthquake early warning system in Almaty (ASRO). This system is being calibrated and integrated with voice-siren complexes and the Mass Alert population alert system implemented in Almaty. Mass Alert, introduced this year, allows the transmission of short messages to smartphones using the Cell Broadcast protocol.

### ***Interagency and International Coordination***

As part of ongoing interagency coordination, the Ministry of Emergency Situations of the Republic of Kazakhstan (MES RK) has established close cooperation with the Ministry of Emergency Situations of the Kyrgyz Republic. An operational protocol has been signed to govern the information exchange between duty shifts at the Crisis Management Center of MES Kyrgyzstan, ensuring timely sharing of information on emergencies and incidents.

At the territorial level, similar interaction plans have been adopted in the regional Emergency Departments bordering Kyrgyzstan, covering cross-border areas.

Under the Cooperation Action Plan with the Ministry of Emergency Situations of the Republic of Uzbekistan, a framework has been established for coordination and information exchange between crisis management centers, as well as a protocol for information interaction with the operational duty services of the Ministries of Emergency Situations of Uzbekistan and Kazakhstan.

## **2.2. Early Warning System in the Kyrgyz Republic**

### ***Legislation***

The emergency warning system in the Kyrgyz Republic is governed by a set of legal and regulatory acts that establish its organization, operation, and development as a critical component of state activity.

The primary legal framework is provided by the **Law of the Kyrgyz Republic** No. 54, dated 24 May 2018, “**On Civil Protection**,” which defines the rights and responsibilities of state authorities, local governments, organizations, and citizens in the field of civil protection. This law establishes procedures for the creation and operation of the civil protection system, including mechanisms for notifying the population about emergencies. It emphasizes the importance of timely and reliable public information and accountability for non-compliance with established standards.

A presidential decree (No. 176, dated 2 July 2024) “**On the Approval of the Regulation on the State Civil Protection System**” plays an important role by defining the system’s structure, the coordination procedures among different authorities, and the requirements for technical alerting equipment.

The warning system is also regulated by government resolutions. Resolution No. 16, dated 28 January 2019, “**On Civil Protection Services of the Kyrgyz Republic**,” outlines the powers of various bodies and structures involved in emergency alert operations. It establishes the responsibilities of the Ministry of Emergency Situations, local authorities, and organizations for maintaining system readiness and ensuring its effective functioning.

Thus, the legal and regulatory framework of the emergency warning system in the Kyrgyz Republic constitutes a comprehensive set of legislative, organizational, and technical measures aimed at protecting the population and territories. It ensures prompt response to emergencies and timely information dissemination, forming a vital element of the state civil protection system.

### *Existing Monitoring and Early Warning Systems*

Given its geographic location and natural conditions, the Kyrgyz Republic is actively modernizing its risk management approaches, drawing on advanced technologies and best international practices. This work is coordinated by the Ministry of Emergency Situations of the Kyrgyz Republic (MES KR), which implements comprehensive measures to minimize disaster impacts and enhance public safety.

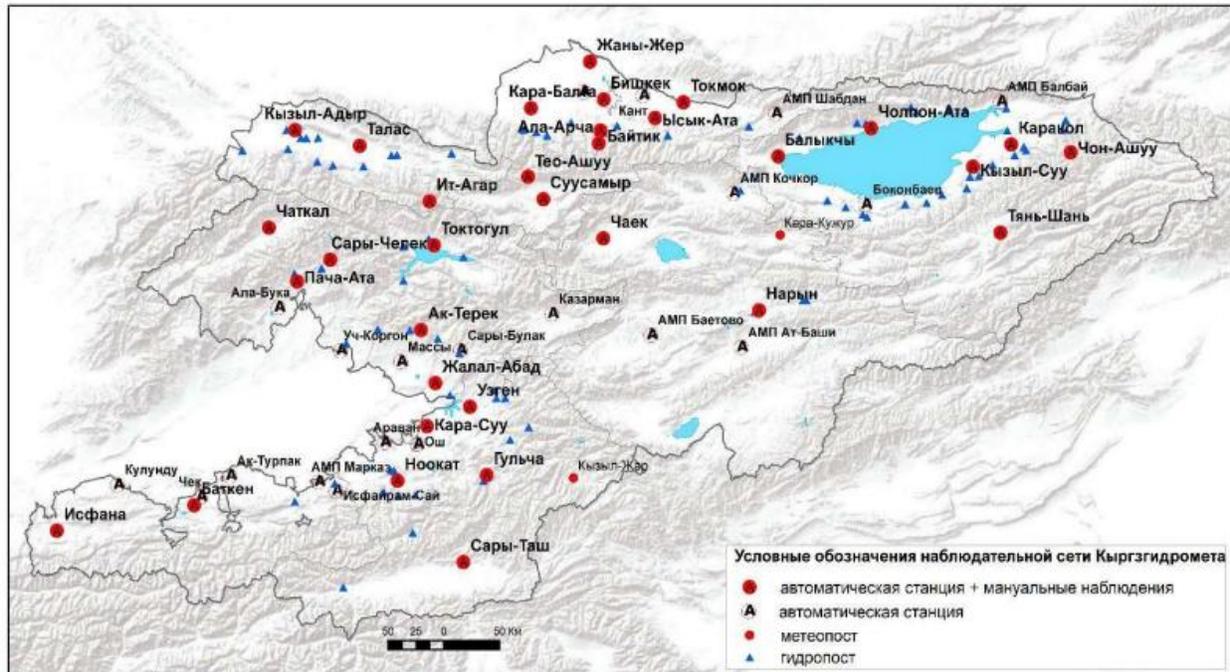
The main natural hazards in Kyrgyzstan include earthquakes, landslides, mudflows and floods, potentially dam-breaking lakes, snow avalanches, inundations, as well as rockfalls, scree, and collapses. Earthquakes reaching magnitudes of up to **9** pose a threat across the entire country. Over **4,554** landslide-prone sites, **2,503** mudflow and flood-prone areas, and **367** potentially dam-breaking lakes require continuous monitoring and preventive measures. In addition, **779** avalanche-prone regions require constant observation, and flooding affects approximately **3,200** km<sup>2</sup>. There are also **571** locations at risk of rockfalls, scree, and collapses.

To reduce risks and prevent catastrophic consequences, the MES KR has implemented the Unified System for Comprehensive Monitoring and Forecasting of Emergencies (USCMFE), which covers the main areas of natural hazards.

Within this system, hydrometeorological monitoring is conducted through **79** automated stations, including **34** meteorological stations, **10** agrometeorological stations, and **78** hydrological posts. Specialized equipment is also utilized, including automated complexes and posts for air pollution monitoring. Localized monitoring systems are installed in landslide-prone areas to track slope

dynamics. An important element of the system is the use of satellite data, which enables the remote assessment of avalanche risks, landslides, and potential breaches of high-mountain lakes.

### Hydrometeorological Observation Network of the Kyrgyz Republic



A key tool for emergency warning is the Statewide Integrated System for Public Information and Alerting (OKSION). This system enables the automatic activation of sirens, the interruption of television and radio broadcasts to relay emergency messages, and the use of mobile applications capable of notifying citizens within seconds. Additionally, voice alert systems have been installed in locations with large gatherings and in government administration buildings.

To ensure full territorial coverage, an additional **450** hardware-software complexes are planned for installation in the coming years.

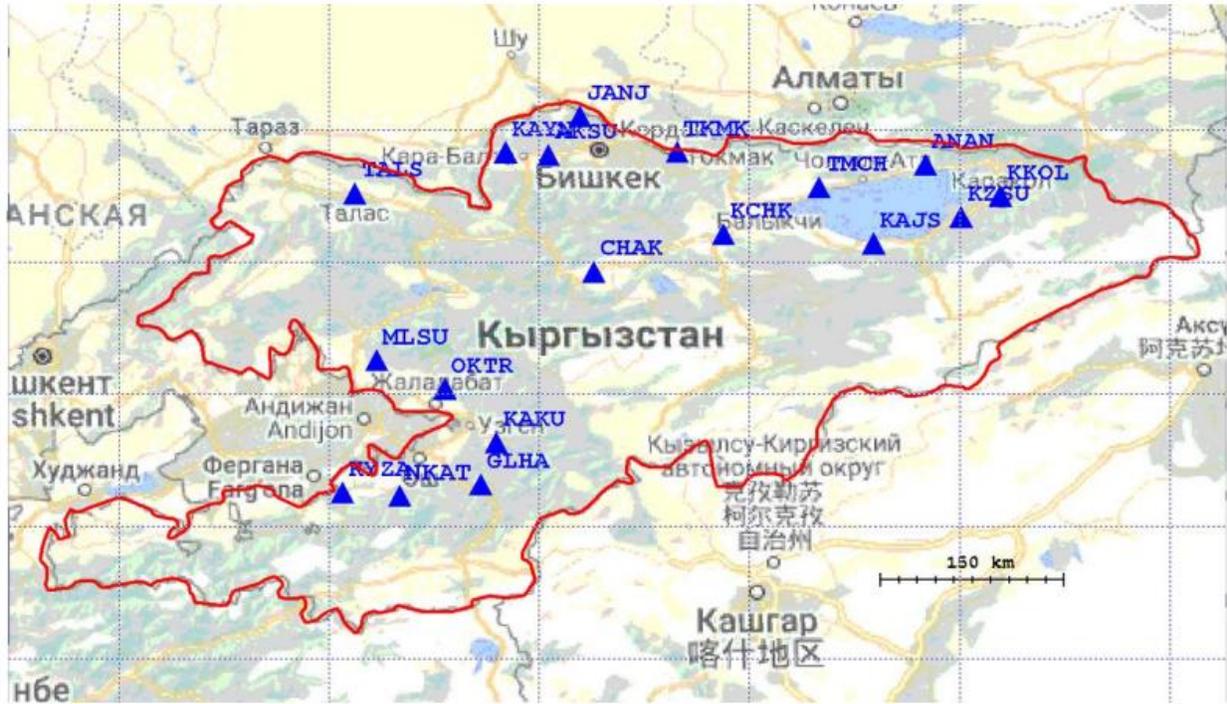
Modern technologies play a crucial role in enhancing monitoring and forecasting capabilities. Radar data and cartographic materials are used for geo-risk modeling. Geospatial databases containing more than 40 information layers allow for threat analysis and the development of precise forecasts. SCADA systems are being implemented for landslide monitoring and crisis management, alongside various measurement tools, including piezometers and extensometers, to monitor groundwater, land subsidence, and seismic activity.

### *Earthquake Monitoring System in Kyrgyzstan Based on the ACROSS Network*

The earthquake early warning system in the Kyrgyz Republic was developed by the Central Asian Institute for Applied Earth Studies (CAIES) in collaboration with the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences.

In 2014, the ACROSS strong-motion seismic network was deployed in Kyrgyzstan. This network comprises 18 three-component accelerometers, providing high-precision detection of strong ground motions. The system is designed to monitor seismic activity and to rapidly alert the population to potential hazards.

### ACROSS Strong-Motion Seismic Station Network



### *Key Challenges and Prospects*

Seismic data collected by the stations are transmitted to the information processing center using the SeedLink protocol. For rapid earthquake detection and alert dissemination, the PRESTo system, developed by the University of “Federico II” in Naples, Italy, is employed. This software platform analyzes incoming data in real time and distributes earthquake information via the internet, enabling prompt responses to hazardous events.

From February 2017 to October 2022, the system recorded 189 events, of which:

- **104** events were confirmed by data from the Seismology Institute of the National Academy of Sciences of Kyrgyzstan and the International Seismological Centre (ISC).
- **50** events occurring outside Kyrgyzstan were erroneously localized within the country.
- **35** events were false alarms.

These findings highlight the need for further refinement of data processing algorithms to minimize false alerts.

A system has been established that integrates data from seismic stations and transmits it to users via the UDP protocol. Earthquake notifications are disseminated through audible alarms and the Telegram platform, ensuring rapid public and service awareness. This approach reduces response times during emergencies and enhances overall safety.

The system operates in real time, analyzing earthquake phases with minimal delay. Epicenters are determined using an error minimization method, improving accuracy. It can also detect events occurring outside the station network, which is particularly important for border regions. Earthquake magnitudes are calculated based on P-wave amplitudes relative to the distance from the epicenter, and intensity is assessed according to the MSK-64 scale, facilitating evaluation of potential impacts on settlements. The system allows the inclusion of additional populated areas for more precise risk assessment.

Since June 2023, the system has been successfully operating in test mode, detecting earthquakes of magnitude 3.5 and above. It has demonstrated effectiveness and reliability and is recommended for broader implementation by the Kyrgyzstan emergency services to provide timely warnings and reduce risks to the population.

### 2.3. Early Warning System in the Republic of Tajikistan

Despite significant achievements, the monitoring and warning system faces several challenges. Key issues include the limited geographical coverage of automated stations, the need to improve forecast accuracy, and the integration of advanced technologies, such as artificial intelligence.

To address these challenges, the Ministry of Emergency Situations of the Kyrgyz Republic (MES KR) is actively working to expand the monitoring network, develop high-resolution hazard maps, and strengthen cooperation with international organizations and neighboring countries.

In collaboration with the Ministry of Emergency Situations of the Republic of Uzbekistan and the Central Asian Institute for Earth Studies (CAIES), seismic stations in Uzbekistan have been integrated, and a data exchange framework between Kyrgyzstan and Uzbekistan has been established.

### *Legislation*

The emergency warning system in the Republic of Tajikistan is governed by a comprehensive legal and regulatory framework, encompassing primary laws, government resolutions, acts of specialized authorities, and international agreements.

A key element of this framework is the Law of the Republic of Tajikistan “**On the Protection of the Population and Territories from Natural and Technological Emergencies.**” This law establishes the legal and organizational foundations for population protection, setting out the main principles for the operation of the emergency warning system. It regulates the obligations of state bodies, organizations, and citizens in the prevention of and response to emergencies.

Government resolutions of the Republic of Tajikistan play an important role in the development of the warning system. They approve procedures for the creation and operation of monitoring and early warning systems and regulate coordination among various authorities and administrative levels.

Acts issued by the Committee for Emergency Situations and Civil Defence under the Government of the Republic of Tajikistan (CESCD) form an essential part of the legal framework. These internal documents specify operational procedures for warning, monitoring, and response, covering aspects such as the use of mobile operators for emergency messaging, coordination with local authorities, and the implementation of preventive measures.

Special attention is given to **international agreements and treaties** involving Tajikistan, which aim to strengthen cooperation in emergency prevention and the exchange of best practices with other countries. These instruments support the improvement of the warning system, the integration of international standards, and the adoption of modern technologies.

Thus, Tajikistan's emergency warning system is based on a comprehensive legal foundation, comprising laws, government resolutions, agency acts, and international treaties.

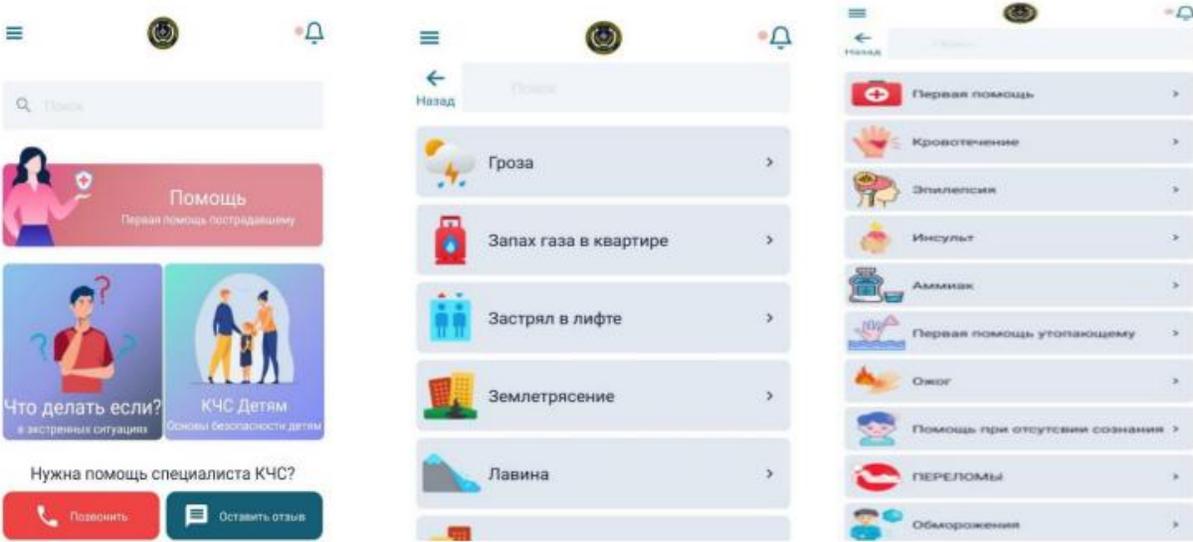
### *Existing Monitoring and Early Warning Systems*

The emergency early warning system in the Republic of Tajikistan, coordinated by the Committee for Emergency Situations and Civil Defence under the Government of the Republic of Tajikistan (CESCD), is a multi-level structure aimed at reducing the risks and impacts of natural disasters. The system takes into account the country's geographical and climatic features, which contribute to frequent natural emergencies, including heavy rainfall, mudflows, landslides, heavy snowfall, extreme cold, avalanches, droughts, and floods.

The system operates on a hierarchical structure encompassing four levels: national, regional, district, and facility. At the national level, the CESCD coordinates nationwide efforts for emergency prevention, including oversight of monitoring and warning operations. At the regional and district levels, tasks are carried out in cooperation with local state authorities, while the facility level covers enterprises and institutions.

### **Sarez Lake Monitoring and Early Warning System**





The monitoring system also includes the work of the Hydrometeorology Agency, which analyzes data on adverse weather events and transmits it to the Committee for Emergency Situations and Civil Defence (CESCD). *The Agency's hydrological network comprises 98 monitoring posts, including 92 on rivers and 6 on lakes and reservoirs.* Information is conveyed to the population through a structured data transmission scheme that reaches local authorities, jamoats, and rural communities. This approach ensures the even distribution of information and facilitates timely response to threats.

## Public Alert and Notification Tools



A critical function of the system is not only the issuance of warnings but also the subsequent analysis of the effectiveness of measures taken. Upon receiving information about potential emergencies, local authorities are required to implement appropriate actions to prevent or minimize their impacts. After the completion of these measures, reports are prepared and submitted to the Committee for Emergency Situations and Civil Defence (CESCD) for analysis and further improvement of response mechanisms.

Thus, the early warning system in Tajikistan is based on the use of modern technologies, multi-channel communication systems, and structured coordination among different levels of government.

### 2.4. Early Warning System in the Republic of Uzbekistan

#### *Legislation*

The operation of the emergency warning system in the Republic of Uzbekistan is governed by a set of normative legal acts. The principal document is the Law of the Republic of Uzbekistan “**On the Protection of the Population and Territories from Natural and Technological Emergencies**” (No. ZRU-790, dated 17 August 2022), which establishes the legal framework for population protection, defines the powers of state authorities, and sets out procedures for their coordination in the prevention and mitigation of emergency consequences.

Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 361, dated 11 August 2023, “**On the Development of an Automated Emergency Threat Warning System and Its Efficient Use,**” approves provisions defining the objectives, levels, and operational procedures of the warning system, including the use of modern technologies for public information.

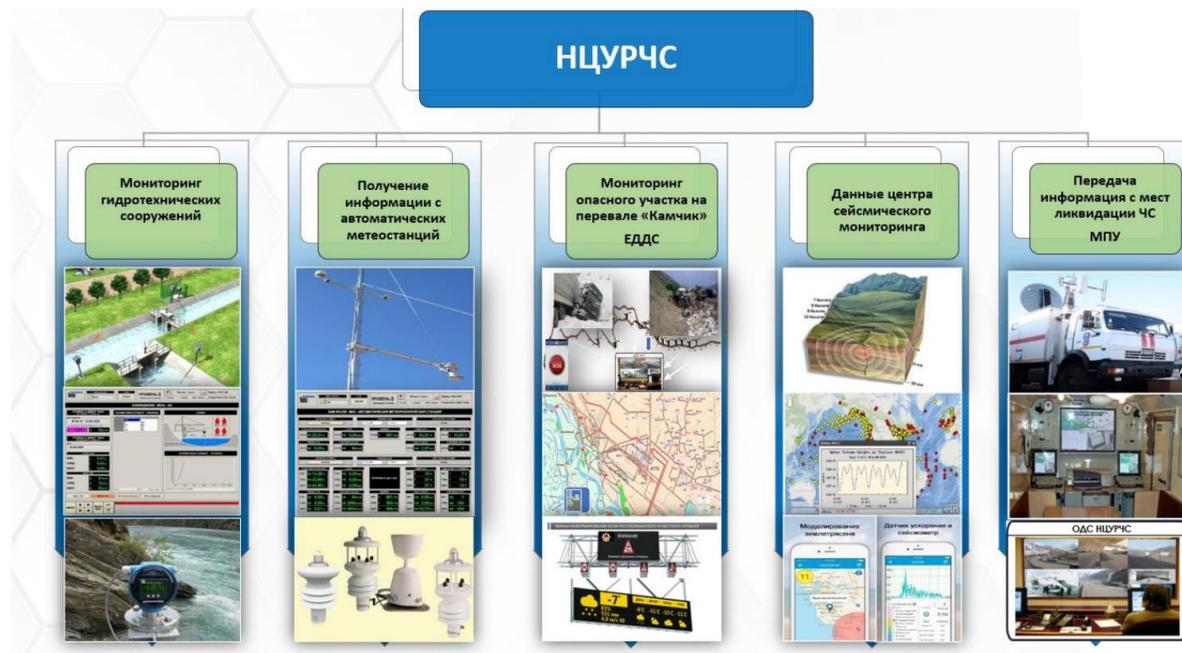
Resolution of the Cabinet of Ministers No. 601, dated 8 August 2017, defines the organizational and functional structure of the automated system for public warning and information in Uzbekistan and its technological infrastructure, including the use of radio, television, and mobile communications. The document outlines procedures for informing the public at all stages of emergencies, from preparedness to the elimination of consequences.

Operational matters are regulated by orders issued by the Ministry of Emergency Situations, which specify procedures for conducting drills, applying technologies to improve forecast accuracy, and coordinating with other agencies.

Thus, Uzbekistan’s emergency warning system is based on a comprehensive legal and regulatory framework that ensures its effective functioning and development, incorporating modern technologies and inter-agency coordination.

### *Existing Monitoring and Early Warning Systems*

The emergency early warning system in Uzbekistan, coordinated by the Ministry of Emergency Situations of the Republic of Uzbekistan (MES RU), plays a central role in ensuring public safety and mitigating the impacts of natural, technological, and environmental disasters. The primary objective of the system is the timely identification of potential hazards, the warning of the population, and the prompt organization of measures to prevent and respond to the consequences of emergencies.



**Hydrometeorological monitoring** is a critical component of the early warning system. Currently, more than 80 meteorological stations are operational, 63 of which are automated. These stations monitor climatic conditions and provide data for forecasting hazardous weather events, such as heavy rainfall, droughts, and floods.

The system also includes a network of 131 hydrological posts, which track the status of water bodies, a function that is particularly important for flood risk management and the safety of hydraulic structures.

**Seismological monitoring** is another essential element. The Republican Center for Seismic Prognostic Monitoring (RCSPM) of the Ministry of Emergency Situations serves as the key body responsible for observing and forecasting seismic activity across the country. The Center's activities are aimed at warning the population and minimizing the impacts of earthquakes.

Across Uzbekistan, a network of seismic monitoring stations has been deployed to record strong ground motions and to provide rapid assessments of threats to both the population and infrastructure. Since 2023, the phased implementation of the National Early Warning System for Strong Earthquakes has been underway. This system monitors seismic activity in real time. Upon detecting strong tremors (magnitude 5 and above), the population receives alerts through a mobile application and other communication channels.

By 2025, 200 ETNA-2 Kinematics stations are planned to be deployed, capable of recording strong motions within a radius of up to **200** km from the epicenter. The arrival time of initial warnings for major cities, such as Tashkent and Samarkand, is expected to range from 20 to 50 seconds, depending on the distance.

Key measures include strengthening the seismic station network through expansion and technical upgrades, implementing modern technologies—including the use of accelerographs to improve forecast accuracy—and enhancing international cooperation for data exchange with neighboring countries to refine regional forecasts. In this context, integration has been carried out with seismic stations in the Kyrgyz Republic through collaboration with the Central Asian Institute for Earth Studies (CAIES), establishing data exchange between Kyrgyzstan and Uzbekistan.

### **Notification of the Population and Governing Authorities**

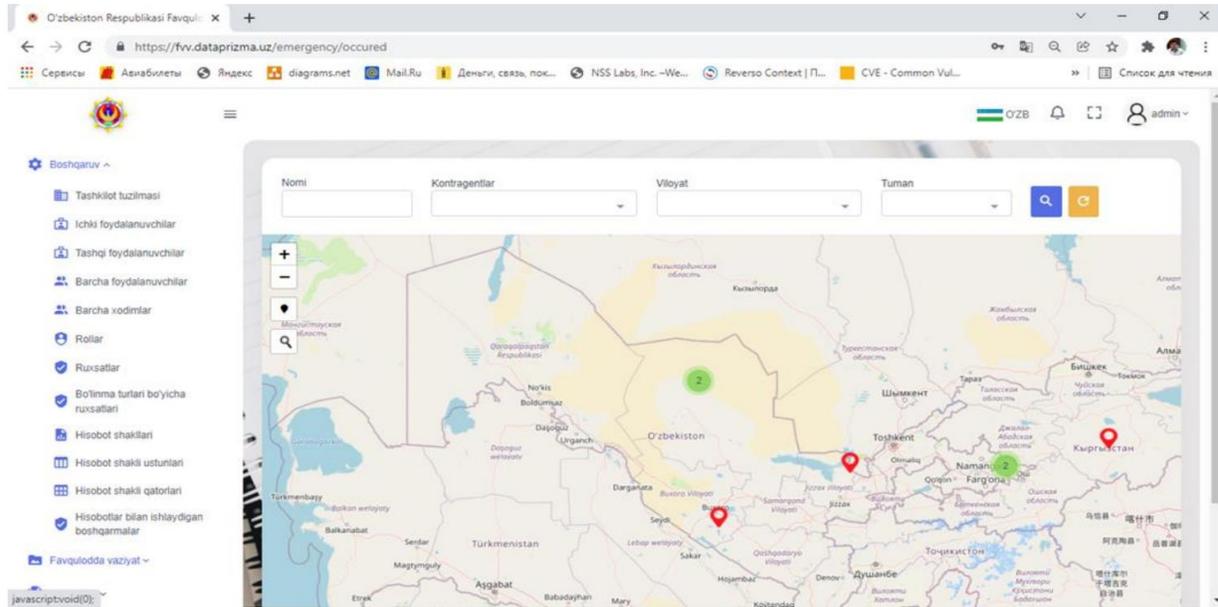


Various communication channels are used to inform the population and governing authorities about impending threats:

- **SMS alerts** enable the rapid and mass dissemination of information on emergencies directly to citizens' mobile devices.
- **Television and radio channels** are widely employed to broadcast emergency messages, reaching the largest possible audience.
- **Sirens and loudspeakers** are effectively used in densely populated areas, providing immediate alerts and evacuation instructions when reaction time is limited.

### *Inter-Agency Coordination*

A key element of the system's effectiveness is inter-agency coordination. Data exchange among the Ministry of Emergency Situations, Uzbekhydromet, seismological services, and other relevant agencies is conducted through an integrated information platform. This enables timely data processing, rapid dissemination of information on natural and technological hazards, and coordinated on-site response.



### *Key Challenges and Prospects*

Despite the progress achieved, the early warning system faces several challenges:

- The need for further **technological modernization**, including the automation of the observational network and the installation of additional equipment, such as accelerographs and meteorological stations.
- **Data integration** and strengthened coordination among different services remain a priority to enhance the timeliness of response.
- **Public information and education**: the effectiveness of the system will significantly increase if citizens know how to respond correctly upon receiving warnings.

The Ministry of Emergency Situations of Uzbekistan continues to actively develop the early warning system, with particular focus on the implementation of advanced technologies, such as ultra-early warning systems, and the expansion of international cooperation. Strengthening collaboration with neighboring Central Asian countries is especially important given shared transboundary hazards, including floods and earthquakes.

Uzbekistan's emergency early warning system is currently undergoing active modernization and improvement. Efforts are directed at reinforcing the monitoring network, automating stations, and improving communication channels to ensure timely information dissemination. However, to achieve maximum effectiveness, continued work is required to enhance inter-agency coordination and increase public awareness. These measures will substantially reduce the impacts of emergencies and improve overall safety in the country.

## 2.5. Early Warning System in Turkmenistan

In Turkmenistan, the operation of the emergency warning system is regulated by a set of normative legal acts aimed at ensuring the safety of the population and territory. Key documents include the Law of Turkmenistan “On Civil Defence”, which defines the organizational foundations of civil defence, including measures for the prevention and elimination of emergency consequences and procedures for public notification, and the Law of Turkmenistan “On the Prevention and Elimination of Emergency Situations”, which establishes the legal and organizational framework for activities in this field. The authorized body responsible for the prevention and response to emergencies is the Ministry of Defence of Turkmenistan.

The warning system also includes measures for public information. For example, the evening news broadcast at 21:00 provides information on air quality, a practice introduced during the COVID-19 pandemic. In addition, Turkmenhydromet carries out functions related to the provision of hydrometeorological services and the dissemination of necessary information to ministries, agencies, public organizations and the population. The organization regularly issues warnings of adverse weather conditions, such as heatwaves, cold spells and storm winds. These warnings are transmitted through local authorities (provincial municipalities) to key stakeholders, including hospitals, schools and public utility services. However, the general public often receives information about these warnings primarily through informal channels, which limits their coverage and the timeliness of notification.

### III. Transboundary Risks

The Central Asian region is vulnerable to the impacts of climate change. One of the most significant consequences of global warming in Central Asia is glacier retreat and the associated formation of moraine-dammed lakes.

Throughout their history, the countries of Central Asia have repeatedly suffered from destructive disasters causing economic losses and loss of life. The region is exposed to virtually all types of natural and technological hazards, including earthquakes, floods, landslides, mudflows, avalanches, droughts and extreme temperatures. Earthquakes, however, represent the most serious threat, leading to casualties and the destruction of buildings and infrastructure, while also triggering secondary hazards such as landslides, debris flows, outbursts of high-mountain lakes, avalanches and others.

Emerging hazards have a transboundary character, and their consequences may affect the territories of several States simultaneously; such examples have unfortunately been recorded in the history of the region (e.g. the breach of the Sardoba Reservoir dam in Uzbekistan). In the future, major earthquakes followed by the failure of dams and moraine-dammed lakes containing significant volumes of water (including the potential outburst of Lake Sarez and others) remain possible, increasing risks for territories located along the borders of Central Asian countries.

In this regard, the Governments of Central Asian States are taking steps to strengthen regional cooperation in various areas related to disaster risk reduction and technological accident prevention.

The basis for cooperation among Central Asian countries on transboundary issues in this field consists of various multilateral interstate agreements on cooperation in disaster risk management and technological accident prevention, as well as in response and recovery.

Taking into account the exposure of the region to transboundary disasters, existing multilateral and bilateral international agreements on disaster risk management do not sufficiently address issues of early warning of hazards between Central Asian countries, operational response and the provision of international assistance.

The Centre for Emergency Situations and Disaster Risk Reduction (hereinafter “the Centre”) conducts active work in the Central Asian region. In a relatively short period, the Centre has established a high-level regional disaster risk reduction platform — the Regional Forum/Meeting of the Heads of Emergency Authorities of Central Asian countries — whose members are the heads of the competent civil protection authorities. The Centre has ensured the sustainable functioning of this platform, which now supports an active intergovernmental dialogue on disaster risk reduction at the regional level.

In 2021, in Tashkent, within the framework of the Regional Forum, the Centre presented a prototype for the integration of the earthquake early warning systems of Kazakhstan and Kyrgyzstan. The initiative received support from the ministers of the Central Asian countries, who proposed expanding the system to the entire region, incorporating not only seismic sensors but also meteorological, hydrological and other sensors used in existing national emergency monitoring systems.

Accordingly, the ministers of the Central Asian countries confirmed the need to establish a regional early warning system for transboundary hazards. At present, the Concept of a transboundary early warning system is being actively promoted by the Centre. This initiative has attracted the interest of several international organizations, including UNDP, OSCE and the United Nations Office for Disaster Risk Reduction (UNDRR), which are considering possibilities for financial support.

## IV. Challenges and Solutions

Monitoring and evaluation of operational processes ensure the quality of forecasts, with potential for further improvement. Although forecasts are largely weather-related and have limited spatial localization, they inform the population of potential hazards and their duration. Forecast information provides a clear basis for operational decision-making, including evacuation.

Nevertheless, numerous challenges have been identified across all countries of the region. For example, national hydrometeorological services do not include disaster risk management functions within their mandates. In addition, warnings are issued by different agencies, and there is often no single authority responsible for their dissemination. Warnings are released without sufficient consideration of their impact and with limited localization and consequence forecasting. Typically, forecasts and warnings are communicated to government institutions and ministries, national emergency management authorities, businesses and the media, and are also disseminated to the public and local communities through various channels (e.g. radio, television, social media and others).

Overall, early warning systems in the countries of Central Asia face a number of challenges that reduce their effectiveness in preventing and minimizing the consequences of emergencies. The principal challenge is the limited geographical coverage of monitoring and warning systems. Automated monitoring stations are often absent in remote or mountainous areas, which hinders timely notification of the population. In addition, many systems, including centralized warning systems, are technologically and physically obsolete, having been installed decades ago and no longer meeting modern technological standards.

Existing transboundary hazards require a high level of coordination and data exchange among the countries of the region. However, current agreements do not always cover operational warning and response, resulting in fragmented systems. Within countries, the absence of a single authority responsible for issuing warnings leads to duplication of information and delays. Furthermore, forecasts are often generalized, with limited localization and detail, reducing their practical value for local communities. A significant problem is the low level of public awareness: most citizens do not know how to respond appropriately upon receiving warnings, which substantially diminishes system effectiveness.

Significant investment is required to modernize early warning systems, including the upgrading of equipment and the introduction of modern technologies. However, financial support in this area remains limited. Among the solutions, an important step is to expand the geographical coverage of monitoring systems through the installation of additional automated stations in remote and mountainous regions. Modernization of outdated warning systems through the use of digital technologies, such as mobile applications and satellite monitoring, is also necessary.

It is equally important to provide active public education and awareness-raising on appropriate actions during emergencies. This requires regular drills and information campaigns. The attraction of international investment and partnerships with organizations such as UNDP, OSCE and the United Nations Office for Disaster Risk Reduction (UNDRR) would provide additional financial and technical support. Monitoring systems should be integrated with additional sensors — meteorological, hydrological and others — to create a comprehensive warning approach. Automation of response processes through the introduction of data-processing algorithms and automatic alert activation would reduce response time.

To address transboundary hazards, promoting the establishment of a regional early warning system for transboundary threats remains a key step toward enhancing safety in Central Asia. Such a system would ensure regional-level coordination of efforts, integration of advanced technologies and strengthened cross-border cooperation, thereby significantly reducing the impacts of emergencies and supporting the sustainable development of the region.