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Early Warning Systems Stakeholders Mapping Exercise Across Central Asia

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Executive Summary

This *Early Warning Systems Stakeholders Mapping Exercise across Central Asia* summarizes the findings of an assessment of the current early warning systems (EWS) landscape in Central Asia, a collaborative effort of the UNDP Istanbul Regional Hub and the UNDRR Regional Office for Europe and Central Asia contributing to the overall Early Warning for All Initiative. This exercise identified the key early warning stakeholders, assessed the current context, identified existing gaps and challenges, showcased best practices at regional and local levels, and offered a set of actionable and forward-looking recommendations for strengthening the early warning value chain in Central Asia. Consequently, it aimed at fostering a transformational shift in how early warning is perceived and integrated into broader resilience-building efforts in the countries and the region's progress towards achieving comprehensive EWS for all.

This exercise provides a comprehensive overview of the diverse entities contributing to the early warning value chain at regional and national levels. It reflects the intricate collaborative efforts involving government agencies, national disaster management agencies, national hydrometeorological services, technical organizations, academia, non-governmental organizations, private sector entities, international partners, National Red Crescent Societies, and communities. This pioneering initiative in Central Asia underscores the complexity of stakeholder engagement necessary for enhancing early warning capabilities and ensuring the implementation of both vertical and horizontal early warning processes. While the lists are not exhaustive, they highlight the dynamic and multifaceted nature of stakeholder involvement in strengthening EWS. The mapping serves as a foundational step for replicating and scaling up the Early Warning for All Initiative across Central Asia and provides a basis for designing targeted policies and actions to ensure timely, effective, efficient and inclusive early warning processes.

The consolidated stakeholder mapping exercise was compiled across the four thematic areas of EWSs: disaster risk knowledge, monitoring and forecasting services, warning dissemination and communication, and preparedness and response capabilities. Consequently, the insights gleaned from assessments have been invaluable in shaping actionable recommendations aimed at strengthening the overall resilience-building efforts at regional, national and local levels. They encompass a range of strategies and policies – enhancing policies and regulations; designing inclusive institutional architecture; formulating inclusive processes; enhancing risk understanding, data collection and analysis capabilities; improving monitoring and forecasting services, communication and coordination mechanisms; investing in technology and infrastructure upgrades; ensuring stable and continuous funding and knowledgeable human resources; designing warnings and alerts to reach everyone in communities; bolstering community engagement and awareness-raising initiatives for impact-based forecasting and warning; and ensuring comprehensive preparedness for timely, effective and efficient response.

Aligned with existing global and regional frameworks and coupled with opportunities for the regional replication and scaling up of the Early Warning for All Initiative and other ongoing initiatives to establish EWS, the insights in this report form a solid foundation for advancing early warning processes at regional, national and local levels across Central Asia.

This commitment to inclusivity ensures that all stakeholders, including marginalized communities and vulnerable groups, are actively engaged and prioritized in efforts to enhance disaster preparedness and response. Ultimately, this collaborative approach strengthens resilience, reduces risks and saves live in the face of emergencies and disasters.

Acronyms and abbreviations

ACTED	Agency for Technical Cooperation and Development
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Centre
ADRC	Asian Disaster Reduction Center
AKAH	Aga Khan Agency for Habitat
CAIAG	Central Asian Institute of Applied Geosciences
CAREC	Central Asia Regional Economic Cooperation Program
CBEWS	Community-Based Early Warning Systems
CBOs	Community-Based Organizations
CD	Capacity Development
CESDRR	Centre for Emergency Situations and Disaster Risk Reduction
DIPECHO	ECHO Disaster Preparedness Programme
DRR	Disaster Risk Reduction
DRM	Disaster Risk Management
EBRD	European Bank for Reconstruction and Development
EWS	Early Warning System
EW4All	Early Warnings for All Initiative
FAO	Food and Agriculture Organization of the United Nations
GCF	Green Climate Fund
GEO	Group on Earth Observation
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSMA	Global System for Mobile Association
ICHA	International Center for Humanitarian Affairs
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
IFAS	International Fund for Saving the Aral Sea
IFRC	International Federation of Red Cross and Red Crescent Societies
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
ICT	Information and Communications Technology
ITU	International Telecommunication Union

IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MHEWS	Multi-Hazard Early Warning System
NGO	Non-Governmental Organization
OSCE	Organization for Security and Cooperation in Europe
RIMES	Regional Integrated Multi-Hazard Early Warning System
Sendai Framework	Sendai Framework for Disaster Risk Reduction 2015–2030
SCADA	Supervisory Control and Data Acquisition
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SECO	State Secretariat for Economic Affairs
SIDA	Swedish International Development Cooperation Agency
SMS	Short Text Messages
UDDS	Unified Duty Dispatch Service
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNITAR	United Nations Institute for Training and Research
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNOSAT	United Nations Satellite Centre
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
USAID	United States Agency for International Development
WB	The World Bank
WFP	United Nations World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization

Photo: UNDP / Khusrav Sharifov

Contents

CONTEXT AND THE RATIONALE FOR THE EARLY WARNING SYSTEMS IN CENTRAL ASIA

Photo: Department for emergency situations monitoring and forecasting, the Ministry of Emergency Situations of the Kyrgyz Republic

General Hazard Profile of Central Asia

Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) faces growing disaster risks across its vast territory of 4 million km^2 and its 75 million people. The region has encountered a diverse range of natural and human-made hazards, with recent decades witnessing a surge in occurrence and cost. Floods and mudflows are frequent and severe, with wildfires increasing and harming communities, nature and ecosystems. Weather events such as hailstorms, sandstorms, avalanches and heat waves are worsening, and earthquakes remain a major concern due to their catastrophic impact. Increased instability has affected millions regionally through water shortages, electricity deficits and border conflicts (Pannier, 2021; Talant, 2022). These disasters often have transboundary impacts, with 40 million people living under constant threat. Smaller-scale emergencies further strain community resilience, especially among the vulnerable. This trend is expected to escalate, challenging emergency response efforts and impacting various sectors.

"Over the past 30 years, the region suffered from 140 natural hazards – geophysical, hydrological, meteorological, and epidemiological events – that impacted more than 10 million people and caused more than $3.7 billion in damages."

Source: Huang, C.-Y., & Muldabayeva, D. (2022, April 22). How to support Central Asia build resilience against climate change and natural disasters. World Bank Blogs.

https://blogs.worldbank.org/en/europeandcentralasia/how-support-central-asia-build-resilience-against-climate-change-natural-disasters

Human-made hazards include industrial and transport accidents, uranium legacy sites (IAEA, 2021) near main river tributaries, and chemical waste facilities in densely populated areas The region has over 1,200 water management facilities (CESDRR, 2021a), with 110 large ones located in transboundary river basins such as the Amu Darya, Sirdarya, Ili and Irtysh, posing potentially devastating consequences if they fail. Major urban centres such as Bishkek, Almaty, Tashkent, Dushanbe, Ashgabat and Astana (Baiyzbekov, 2020) suffer from significant air pollution due to coal burning, vehicle emissions and dust storms. The COVID-19 pandemic further exposed vulnerabilities and inequalities, adding epidemics to the hazard profile (OSCE- OCEEA et al., 2021). Moreover, the region faces significant climate vulnerability, ranking among the most vulnerable due to limited adaptation measures. Tajikistan and Kyrgyzstan rank among the most vulnerable to climate change (World Bank, 2017). The region has been warming faster than the global average, with temperatures having risen 0.5° C in the past three decades (UNDP, 2018). Projections suggest a 2.0°–5.7° C increase by 2085. A 1.5° C temperature increase would increase rainfall by 5 percent, make water scarcer for 13 million people, and result in more river flooding, impacting people and infrastructure (United Nations, Economic and Social Commission for Asia and the Pacific, 2020). Climate change compounds existing challenges related to socioeconomic, political and natural hazards, weakening resilience and deepening inequalities (UNDP Kyrgyzstan, 2021). Extreme weather threatens security, infrastructure and services and may drive mass human movements (World Bank, 2021).

Early warning systems context

The multitude of threats faced in Central Asia underscores the urgent need for comprehensive risk reduction strategies, including robust early warning systems (EWS), to mitigate impacts effectively. Central to this effort is ensuring communities have access to timely and accurate early warnings, recognizing the critical role of such systems in disaster risk reduction (DRR) efforts (ICHA, 2021). EWS are vital for mitigating disasters and preventing humanitarian crises by enabling timely actions to protect lives, livelihoods and communities and minimize damages and losses. Activating an EWS 24 hours before an event can save many lives and reduce damage by 30 percent, offering significant financial benefits with a 10-fold return on investment (ILO, 2022). The Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC, 2021) recognizes multi-hazard early warning systems (MHEWS) and other disaster risk management (DRM) activities as crucial adaptation options that amplify the benefits of other adaptation measures (United Nations, 2023). Nevertheless, one-third of the global population is still not covered by timely and effective EWS. The Global Commission on Adaptation estimates that an investment of US$800 million in such systems in developing countries could prevent annual losses ranging from $3 billion to $16 billion (United Nations, 2023). The Midterm Review of the Implementation of the Sendai Framework shows progress but identifies gaps, including the lack of community-based systems, ineffective communication, and the failure to tailor systems to local contexts (UNDRR, 2023). To speed up implementation, United Nations Member States should focus on mobilizing resources, technology and capacity for inclusive EWS, with guiding strategies that integrate local knowledge and governance arrangements across all phases while addressing the needs of higher-risk groups (UNDRR, 2023).

The early warning value chain is "a concept whereby the process of producing a warning is represented by a chain of sources of expertise (components), connected by bridges that convey bi-directional information exchange."

Source: Royal Meteorological Society. (2024). The Warning Value Chain: Understanding the End-to-End Warning Chain for Weather-Related Hazards. RMetS.

https://www.rmets.org/event/warning-value-chain-understanding-end-end-warning-chain-weather-related-hazards

Early warning systems are effective in saving lives and reducing losses related to weather, climate, water and other environmental hazards (WMO, 2022). Hence, they are critical to efforts to adapt to climate change (WMO, 2022). EWS must be versatile, covering various hazards independently or simultaneously (multi-hazard) and comprehensive, from hazard detection to response (across all phases). They also must prioritize people's needs for prompt and appropriate action (people-centred). In this context, **MHEWS** address multiple hazards and impacts, considering their potential interrelated effects (UNDRR, 2017a). These systems must be efficient in their use of resources, integrated with DRR, inclusive and participative, and they must foster cooperation and coordination across sectors with the communities actively involved during the MHEWS value chain. **People-centred early warning** empowers communities to reduce disaster impacts through the use of forecasts and the anticipation of hazards, enabling them to understand and communicate risks and foster readiness for timely responses. Finally, a proficient EWS has four key components:

Purpose and approach of this document

This document summarizes the findings of the EWS stakeholder mapping exercise through identifying key stakeholders, assessing the landscape, highlighting gaps and challenges, showcasing best practices, and offering forward-looking recommendations. Consequently, it contributes to fostering a transformational shift in how EWS is perceived and integrated into broader resilience-building efforts in the region. Stakeholder mapping involves identifying involved parties and assessing their influence and engagement strategies to build trust and cooperation. The exercise used a comprehensive approach and methodology across four thematic areas of EWS, despite such limitations as time constraints and issues with data access.

1

building disaster risk knowledge via efforts to understand risks, collect data and conduct risk assessments

2

monitoring hazards and forecasting by developing and running detection, observation, monitoring, forecasting and early warning services

3

sharing alerts and delivering timely, accurate and actionable warnings to communities, especially the vulnerable, via various communication strategies disseminated "during the last mile" (Shrestha et al., 2021)[1]

4

preparedness and response capabilities, including the provision of resources at all levels to enable effective responses

[1] According to Shrestha et al. (2021), "the last mile" refers to gaps in the early warning process that hinder the communication of warning messages to the most vulnerable.

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EARLY WARNING SYSTEMS STAKEHOLDERS IN CENTRAL ASIA

Photo: UNDP / Khusrav Sharifov

Categories of EWS stakeholders and their roles and functions in the four EWS thematic areas

To operationalize people-centred EWS effectively, key stakeholders must be identified and a well-structured institutional framework established to clarify roles and responsibilities. The stakeholder network is categorized into three groups reflecting roles and responsibilities within the EWS value chain: national, local and international.

Stakeholders involved at the national level are the national governmental bodies (government commissions/bodies, national disaster management authorities, key ministries and agencies, and specialized technical institutions), academic and research and development institutions, private sector entities, national associations, and national non-governmental organizations. Their distinct mandates, competencies and functions are directly aligned with their designated roles and responsibilities within the overarching framework of national DRM systems, which includes the EWS thematic areas.

At the local level, stakeholders encompass local governments (including regional and provincial governments), communities and community organizations, which not only serve as initial responders but also are evolving into proactive prevention and mitigation agents. They play a significant role in local-level early warning and alerting dissemination, comprehensive preparedness and timely and efficient response.

The forefront of international stakeholders is a diverse array of entities, including numerous United Nations and other multilateral agencies, regional and multilateral organizations and technical agencies, international financial organizations and multilateral financing entities, donors and technical agencies, and international and regional non-governmental organizations. Collectively, these entities function as development partners, actively contributing to the promotion of resilience-building and EWS.

Consequently, this analysis categorizes Central Asian EWS stakeholders into three clusters and 16 categories, identifying 96 entities involved in early warning processes. The regional categorization of EWS stakeholders is outlined in Table 1. This exhaustive list was screened against the competencies in the four thematic areas and their predominant functions and roles. This approach confirms the existence of a palette of stakeholders contributing to the overall early warning chain and aims to facilitate the replication and scaling up of the Early Warning for All Initiative in other Central Asian countries.

Table 1 Categories of EWS stakeholders and functions in the four EWS thematic areas in Central Asia

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
I. NATIONAL LEVEL				
State systems, government commissions and bodies	I, NG		I, NG	I, NG
National disaster management agencies	CD, I, TS, NG, F	CD, I, TS	CD, I, TS, NG, F	CD, I, TS, NG, F
Key ministries				
Internal affairs, defence	CD, I, TS, NG	I	I	CD, I, TS, NG
Agriculture, health, water management/resources, environment/natural resources, industry/energy	CD, I, TS, NG	CD, I, TS, NG	CD, I, TS, NG	CD, I, TS, NG
Digitalization	CD, I, TS, NG	NG	CD, I, TS, NG	CD, I, TS, NG
Social affairs	CD, I, NG	I, TS, NG	CD, I	CD, I, TS, NG
Finance	NG, F	F	F	NG, F
Transport	I, TS, NG		CD, I	CD, I, TS, NG
Education/science	CD, I, TS, NG		CD, I, TS, NG	CD, I, TS, NG
Economy/trade	CD, I, TS, NG			CD, I, TS, NG
Justice	NG		NG	NG
Culture/tourism	TS, NG			CD, TS, NG
Key agencies/services/technical institutions				
National hydrometeorological services, national seismological services, public health centres, veterinary control	CD, I, TS	CD, I, TS, F	CD, I, TS	I, TS
Transport/infrastructure entities	CD, I, TS	I, F	I, F	CD, I, TS, F
Regulatory bodies, e.g. communications/insurance	TS	NG	NG	TS
National statistics agencies	TS			
Academia/research and development institutions				
Universities, education facilities, research and development organizations, innovation hubs/incubators	CD, I, TS	CD, I, TS		

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
Private sector associations/entities				
Mobile operators	TS	I	I, TS, F	I, TS, F
Economic chambers/associations	CD, I, TS		I, TS	I, F
Specialized private sector entities	CD, I		I, TS	CD, I
Media	I, TS	I	I	I
Insurance associations/companies				
National associations	CD, I, TS, F			
National Red Crescent societies	CD, I	I	CD, I, TS, F	CD, I, TS, F
National NGOs			CD, I	CD, I
II. LOCAL LEVEL				
Regional/local governments	I, NG, F		I	I, NG, F
Local NGOs/CBOs	CD, I		I	CD, I
Communities	I		I	I
III. INTERNATIONAL LEVEL				
UN and multilateral agencies				
UNDP, UNICEF, WHO, FAO, UNOPS, UNESCAP, European Union, GFDRR	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
UNDRR	CD, I, TS, F	CD, I, TS	CD, I, TS, F	TS, F
UNESCO	CD, I, TS, F	I, TS, F	I, TS, F	CD, TS, F
UNEP	CD, I, TS, F	TS, F	TS, F	TS
OSCE	CD, I, TS, F	I, F	I, F	CD, I, F
IOM	CD, I, TS, F	TS	TS, F	I, TS, F
UNECE	CD, I, TS, F		I, TS	TS
UN Women, UNFPA	CD, I, TS, F		TS	CD, I, TS, F
ITU	CD, I, TS, F		CD, I, TS, F	CD, I, TS, F
UNOCHA	I, TS, F			CD, I, TS, F
UN-Habitat	CD, I, TS			CD, I, TS, F
UNOSAT	CD, TS	CD, TS	CD, TS	CD, TS
WFP	TS			I, TS, F
UNITAR	CD			CD
IUCN	CD, I, TS, F			

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
Regional and multilateral organizations/technical agencies				
CESDRR	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS
CAREC	CD, I, TS, F		CD, I, TS, F	CD, I, TS, F
IFAS	CD, I, TS, F			CD, I, TS, F
CAIAG	CD, I, TS	CD, I, TS	TS	TS
ADRC	CD, I, TS		TS	TS
ADPC	CD, TS	CD, I, TS	CD, TS	CD, TS
RIMES	CD, TS	CD, TS	CD, TS	CD, TS
International financial institutions/multilateral financing entities				
ADB, EBRD, WB, IDB, GCF, IFAD, GEF	F	F	F	F
Donors/technical agencies				
Japan/JICA, Germany/GIZ	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
China, Russian Federation	CD, I, TS, F	F		CD, I, TS, F
CIMA research foundations	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS
Korea/KOICA	TS, F	F	F	F
Sweden/SIDA	TS, F		F	F
Switzerland/SDC/SECO	F	F	F	F
USA/USAID	F		F	F
United Kingdom of Great Britain and Northern Ireland/UKAID	F			F
International and regional NGOs/associations				
IFRC	CD, I, TS, F	I, TS	CD, I, TS, F	CD, I, TS, F
AKAH	CD, I, TS, F			CD, I, TS, F
ACTED	CD, I, TS			CD, I, TS
GEO	I, TS			I, TS
Mission East, Helvetas	CD, I			CD, I
Médecins Sans Frontières	I			I
GSMA			CD, TS	
CARITAS				CD, I

Source: Author's own elaboration.

Note: The functions and roles shown in this table are capacity development (CD), implementation (I), technical support (TS), normative guidelines (NG) and donor funding (F).

KEY FINDINGS ACROSS FOUR THEMATIC AREAS

Contexts, Current Practices and Challenges

Photo: Department for emergency situations monitoring and forecasting, the Ministry of Emergency Situations of the Kyrgyz Republic

General disaster risk management and early warning system contexts in Central Asia

The general context of EWS in Central Asia refers to the intersection of DRM and early warning, the existence of the MHEWS, policy and regulations, institutional architecture, coordination and cooperation, resources, and regional dimensions of EWS. While the region's MHEWS are operational and provide relevant early warnings, there's a need to broaden the understanding beyond monitoring, forecasting and warning dissemination. Currently, disaster risk knowledge and preparedness/response capabilities are often treated separately from the early warning value chain, which is typically seen as warning of and alerting to imminent dangers rather than potential threats, hindering the proactive action of at-risk communities. The integration of EWS within existing DRR systems remains a challenge. In that context, this analysis has pointed out that the region's EWS encounters challenges in governance, implementation and action, including inadequate risk understanding, limited anticipation for emerging risks, underutilization of digital solutions, insufficient consideration of vulnerabilities, and monitoring and forecasting capacity gaps, as outlined in individual thematic pillars. It is essential to emphasize early warning as a long-term strategy to reduce community vulnerability and align it with DRR measures.

Impact-based forecasting/ warning considers the vulnerability of people and property to the weather and warns of the associated impacts, as well as the likelihood of them occurring.

Source: Met Office. (2024). Accelerating impact-based forecasting—WCSSP case study. Met Office.

https://www.metoffice.gov.uk/research/approach/collaboration/wcssp/insights/accelerating-impact-based-forecasting

Central Asian countries have established robust policy frameworks and institutional architectures, facilitating the implementation of EWS within comprehensive DRM systems. Each country has developed a set of DRM legislative and regulatory legal bases in the field of civil defence/protection and the prevention and elimination of emergencies (CESDRR, 2020a). This normative framework includes the competencies and responsibilities of EWS, and the resolution of the Cabinet of Ministers of Uzbekistan on the establishment and development of an automated system for information and warning of the population of the Republic of Uzbekistan from threats and emergencies is considered good practice in the regulatory formulation of EWS. Furthermore, all countries have developed national strategic documents on DRR[2] – Kazakhstan,[3] Tajikistan (Committee of Emergency Situations and Civil Defense of Tajikistan, 2018), Turkmenistan (United Nations Turkmenistan, 2019)[4] and Uzbekistan – or strategic policy concepts (Kyrgyzstan). These strategic documents and policies contribute not only to the advancement of risk reduction but also to the advancement of national development and alignment with global sustainability and resilience mechanisms, including the SDGs, the Sendai Framework, the Paris Agreement and others. On the other side, the institutional architecture for EWS in Central Asian countries designates key responsibilities to various stakeholders, such as national disaster management agencies, meteorological services, seismological institutes and key ministries related to the environment, health and agriculture.

[2] The national strategic documents for Kazakhstan and Turkmenistan were not obtained and are not publicly available.

[3] Within the National Security Strategy of Kazakhstan there is a section on national DRR strategic priorities.

[4] National Strategy for implementing the main principles of the state policy on civil defence for the period of 2019-2030 and its National Action Plan.

However, understanding is fragmented and involvement is limited to just a few stakeholders (regional and local governments, academia and community-based organizations) with others, such as the private sector, overlooked despite varied competencies in the EWS value chain. Roles and responsibilities are insufficiently clarified in existing policies, leading to coordination issues and weak communication. Disruptions at any level or sector can compromise warning information or result in cascading hazard impacts. Early warning funding mainly relies on government budgets and external sources, such as donations and loans, but the absence of dedicated budgets and the lack of stable multiannual funding is a major issue compounded by insufficient internal funds, hindering the function of EWS. Relevant contingency reserves for disaster management exist at local and national levels.[5]

Regional cooperation and advocacy are crucial across all areas of EWS, particularly in warning dissemination, monitoring and forecasting, along with preparedness and response capabilities and disaster risk knowledge. Notable practices include the Centre for Emergency Situations and Disaster Risk Reduction's regional work on advancing regional EWS and initiatives like the Central Asia Region Flash Flood Guidance System and ongoing efforts by Kazakhstan and Kyrgyzstan for transboundary early warning for earthquakes. However, recent events – including floods and the anthrax outbreak in the Akmola region of Kazakhstan – emphasize the need for closer cooperation and a comprehensive EWS for timely warnings and responses.

Last, impact-based forecasting is not widespread due to various reasons – e.g. policy barriers, data gaps and financial constraints – but good practices, such as the project initiative in Uzbekistan (UNDP Uzbekistan, 2021), aim to address these challenges.

Consequently, the identified gaps and challenges in general DRM and EWS contexts in Central Asia can be summarized as follows:

- The prevailing approach to DRM in the five countries tends to remain reactive, prioritizing preparedness and response over the proactive mitigation of risks.
- The early warning process is fragmented, lacking coherence across its four thematic areas, with biological hazards often overlooked.
- Policy and regulatory frameworks need to prioritize early warning, aiming to streamline people-centred EWS across the region and countries.
- Institutional architecture fails to encompass the entire EWS value chain and often lacks the inclusivity of key stakeholders.
- Risk information is not effectively integrated into intersectoral decision-making processes, nor is it mainstreamed into national and local development policies.
- Funding shortages hinder EWS development, leading to fragmented development and maintenance and limiting broader and inclusive participation.
- Regional cooperation mechanisms and advocacy are underutilized for effective early warning processes.
- Impact-based early warning and forecasting are still in the early stages of development and are not widely applied in the region.

[5] More on the provision of finances for DRR can be found in the document 'Forum on Financial Protection against Natural Disasters in Central Asia: Proceedings' (World Bank and Global Facility for Disaster Reduction and Recovery, 2019).

THEMATIC AREA

Disaster risk knowledge

A strong EWS depends on understanding risks and creating accurate risk scenarios. Warning centres use risk scenarios to decide when to issue warnings, and emergency responders use them to know when and how to respond promptly to threats, guided by acceptable risk levels for communities. Despite the importance of risk knowledge, just 22 percent of countries globally report having accessible, understandable, usable and relevant disaster risk information and assessment available to the people at national and local levels (Sendai Framework monitor Indicator G-5), according to the 2023 'Global Status of Multi-Hazard Early Warning Systems' report from the UNDRR (UNDRR and WMO, 2023). This is the lowest value of all Target G indicators (UNDRR and WMO, 2023). From among Central Asian countries, only Kazakhstan (2021), Kyrgyzstan (2018 and 2019) and Tajikistan (2016 and 2017) reported it for different years since 2016 through the Sendai Monitor (UNDRR, 2017b, 2019a, 2021).

In Central Asian countries, risk and hazard assessments are still linear, focusing on existing hazards and vulnerabilities and analysing past events but overlooking signals of future and emerging risks. National and local governments, along with specialized stakeholders, disseminate risk information, but accessibility could remain limited. While some countries, such as Kyrgyzstan (Ministry of Emergency Situations of the Kyrgyz Republic, 2024), publish risk assessments on national disaster management authority websites, others limit data accessibility to official use only (FAO, 2022d). Also, risk and hazard assessments often lack accessibility for all, such as persons with disabilities.

An exception is the website of the Ministry of Emergency Situations of Kyrgyzstan, which provides a version for the visually impaired.[6] Policy frameworks allow for multi-risk assessments, led by national disaster management authorities and key government bodies, with sector-specific institutions often taking the lead. However, some entities lack expertise in risk and hazard assessment or have insufficient competencies, like national hydrometeorological services. Therefore, it is crucial to share these assessments with all key entities involved in the early warning process to streamline the EWS value chain. Nevertheless, the challenges still include incomplete risk understanding, limited focus on vulnerabilities, and inadequate community engagement. Hazard maps lack detail and are not regularly shared with communities. GIS databases for risk information storage are not universally established, hindering the use of ICT solutions for DRR. Regarding the collection and analysis of disaster damages and losses, national disaster management authorities typically play the main role, yet not all countries have digitalized platforms for this purpose. Challenges include a lack of clear methods and sufficient skills and resources for assessment, along with problems in collecting, analysing and sharing data. For instance, in Uzbekistan, no regular statistics on disaster damages and losses, including in agriculture, are collected (FAO, 2022a). In Tajikistan, data on damages and losses come from reports on emergency situations submitted by the Committee on Emergency Situations and Civil Defence under the Government of the Republic of Tajikistan (FAO, 2022b). Last, integrating risk and hazard assessment results into risk management plans and warnings is insufficient for policies and actions informed by early warning.

[6] This website is available online at https://www.mchs.gov.kg/en/.

At the regional and country levels, there are notable practices for advancing disaster risk knowledge through coordinated efforts by competent institutions. The Centre for Emergency Situations and Disaster Risk Reduction supported capacity enhancement for recording and analysing damage and loss data in Kazakhstan, Kyrgyzstan and Tajikistan (CIMA Research Foundation, 2022), integrating it with the DesInventar Sendai Module for timely reporting to the Sendai Framework Monitoring Platform,[7] while the Digital Atlas of Transboundary Hazards of Central Asian Countries integrates existing systems, providing interactive maps with layered risk information (CESDRR, 2023b).

In Kazakhstan, within the comprehensive study of earthquake-prone areas in southeast Kazakhstan, the basis for an EWS for strong earthquakes was established through the organization of an observation network, the conducting of field reconnaissance and the establishment of a data processing centre integrated into the Almaty emergency response system (Ministry of Emergency Situations of the Republic of Kazakhstan, 2022). In addition, the Ministry of Emergency Situations, in cooperation with Centre for Emergency Situations and Disaster Risk Reduction, is developing the Digital Safety Passport and Atlas of Emergency Situations, with interactive maps (CESDRR, 2023a). The Unified System for Comprehensive Monitoring and Forecasting of Emergency Situations in Kyrgyzstan involves collecting, analysing and synthesizing data for natural and anthropogenic disasters, informing national and local development agendas through 2040 (Cabinet of Ministers of the Kyrgyz Republic, 2022). Mandatory state statistical reporting on damages has been submitted semi-annually and annually since the establishment of the national database DesInventar Sendai in 2022.

In Tajikistan, village-level hazard, vulnerability and risk assessments were conducted and risk maps produced by the Aga Khan Agency for Habitat, along with the Committee on Emergency Situations and Civil Defense and other partners. A multi-hazard risk assessment, conducted in 58 districts, resulted in the launch, with UNDP support, of the National Multi-Hazard Risk Assessment Platform of Tajikistan[8] (Government of Tajikistan, 2022).

Turkmenistan invested in strengthening national capacities for seismic risk assessment, prevention and response through a comprehensive project initiative, with a pilot activity in Ashgabat informing future efforts in seismic risk areas (UNDP Turkmenistan, 2024). Uzbekistan integrates ICT systems to advance the current EWS to utilize predicted hydrometeorological and vulnerability data for risk identification and planning, supporting hazard and risk mapping, zoning and socioeconomic risk models to assess the potential impacts of forecasted hazards (UNDP, 2021).

[7] The Sendai Framework Monitoring Platform is available online at https://sendaimonitor.undrr.org/.

[8] This website is available online at https://riskinfo.tj/.

Prevailing gaps and challenges are evident in this thematic area across Central Asian countries, as summarized below:

- Inadequate disaster risk understanding and knowledge necessitate capacity strengthening for key stakeholders in this area.
- Methodologies for risk and hazard assessment are not fully utilized to inform better decision-making and risk management strategies and policies, and failure to anticipate emerging risks results in a lack of mitigation and preparedness measures.
- Limited community engagement in the assessment impedes the integration of their perceived risks and coping strategies and the application of traditional knowledge for community-aligned actions.
- Insufficient attention to social, economic and environmental vulnerability in early warning neglects the building of community resilience.
- Climate change projections are not fully integrated into EWS policies.
- Practical application gaps in disaster risk knowledge hinder effective early warning.
- Data gaps exist due to the limited availability and analysis of disaggregated data (e.g. regarding age, sex, geography and disability), limited data-sharing platforms and procedures, stand-alone collection, etc.
- There is limited integration and consolidation of risk-related information across the key sectors for making risk-informed decisions and policies. For example, FAO identified insufficient integration of the disaster risk assessment in the agriculture sector in Kazakhstan (FAO, 2022c), Kyrgyzstan (FAO, 2022d), Tajikistan (FAO, 2022b) and Uzbekistan (FAO, 2022a).
- Stakeholders at different levels often do not have the information needed to contribute effectively to early warning processes and decision-making.
- There is inadequate inclusion of biological hazards, such as health-related threats (e.g. epidemics and pandemics) within the disaster risk knowledge framework for EWS.
- Insufficient interoperability of existing disaster risk data platforms remains at national and subnational levels.
- Insufficient utilization of innovation and technology in the realm of risk knowledge highlights the imperative to harness these advancements more efficiently for risk assessment and EWS.
- Improvements are needed regarding accessibility and customization options for stakeholders using mapping services.

THEMATIC AREA

Monitoring and forecasting service

This thematic area is essential for timely, effective and efficient early warning, since it provides a crucial input to this process and connects the disaster risk knowledge phase with operational phases, e.g. warning dissemination and alerting and response actions. Only one-third of Member States have reported having hazard monitoring and forecasting systems, representing substantial progress towards effective MHEWS implementation, as per Indicator G-2 (UNDRR and WMO, 2023). Central Asian countries Tajikistan (2016) and Kyrgyzstan (2019) reported their systems through the Sendai Monitor in different years since 2016 (UNDRR, 2016, 2020). Moreover, 53 percent of national meteorological and hydrological services have noted limited capacity in providing effective early warning services, citing deficiencies in observing and monitoring infrastructure, data processing and forecasting systems, communication, information management systems and institutional support (WMO, 2022).

In Central Asia, monitoring and forecasting systems are well-established, with wide-ranging hazard coverage, locally suited equipment, trained essential personnel, application of scientific and technological methods and access to regional data sources, and they meet the international standards for data and forecasting. Institutional mechanisms and norms are in place, but vertical standard operating procedures are needed to clarify roles and responsibilities and enhance coordination. Mutual agreements ensure consistent warning language, but further protocols are required for streamlined communication. Cooperation with international organizations is operational and facilitated by multilateral and bilateral agreements.

Regional coordination also is functional, facilitated by bilateral agreements or memorandums between countries (e.g. between Turkmenistan and Uzbekistan, Tajikistan and Kazakhstan, Kazakhstan and Kyrgyzstan, Uzbekistan and Kazakhstan, etc.), establishing a network for effective early warning. Monitoring and evaluating operational processes ensure forecasting quality with the potential for further enhancements. Despite that forecasts are primarily related to weather and less localized, they inform the population of potential threats and duration. Forecasting information provides a clear basis for operational decisions to trigger reactions (e.g. evacuation). Nevertheless, there are many challenges identified across the countries. For example, national hydrometeorological services do not include the responsibilities and functions of DRR (FAO, 2022c: 37). Additionally, warnings are issued by different departments – often with the lack of a single issuing service (ZAMG, 2022: 10) – and warnings are issued without impact-based-information and with limited localization and impact prediction (FAO, 2022c). Usually, forecasts and warnings are delivered to governments and ministries, national disaster management authorities, businesses and the media and are published over various channels (e.g. radio, television, social media, etc.) to reach populations and communities.

At the regional and country levels, there are several practices to be noted for advancing monitoring and forecasting services coordinated and implemented by competent regional and national institutions. The **WMO** supported the establishment of the Regional Specialized Meteorological Centre in Tashkent, Uzbekistan, which provides numerical weather forecasting and supports the regional access and downscaling of weather products, regional severe weather forecasting quality control of observation data, and the global and regional exchange of data (Zoï Environment Network, 2019: 74).

The International Fund for Saving the Aral Sea established the Almaty Regional Centre of Hydrology to conduct research, studies and expeditions on glaciers and water resources; support hydrology practices and training; and coordinate international projects in climate and hydrometeorology, enhancing monitoring and forecasting. From 2011 to 2023, the World Bank ran the Central Asia Hydrometeorology Modernization Project, focused on upgrading national hydrometeorological services in Kyrgyzstan and Tajikistan.[9] This included station renovations, online satellite data access and training programmes. The **World Bank** also introduced advanced forecasting technologies like the Consortium for Small-Scale Modelling Central Asia (COSMO CA) and set up the Central Asian Flood Early Warning System to handle regional weather, climate and water risks.[10] **The Central Asian Institute of Applied Geosciences** supported monitoring and forecasting by the establishment of various monitoring networks, such as a Global Navigation Satellite Systems network (with 30 permanent stations across Central Asia for the regional monitoring of tectonic movements and surface deformation in Central Asia, including fault lines, landslides and glaciers), a hydrometeorological network (with 11 stations for hydrometeorological parameters) and a seismic network (with 39 stations and five tidal stations at Issyk-Kul Lake). The Sensor Data Storage System[11] houses more than a billion data points from 500 observation spots and an earthquake EWS with two interfaces, one for receiving accelerograms and another for notifying users with a sound signal. It displays the event on the map and calculates the model intensity for 32 settlements of Kyrgyzstan and also creates a local seismic bulletin and sends a message to subscribers via a Telegram chat.

In **Kazakhstan**, the earthquake programme enhanced the seismological observation network, integrated it into Almaty's emergency system and linked to the Darmen app, sending push notifications regarding earthquakes with a magnitude of 4 or higher. The Automated Glacial Lake and Mudflow Monitoring System uses 31 stations to track conditions and prevent mudflows, while the Avalanche Monitoring System, with data from 36 stations, safeguards Almaty. In Kyrgyzstan, notable practices include combined monitoring of breach-dangerous lakes using remote, aerial and ground surveillance; individual EWS along vulnerable sections of the Bishkek–Osh Road Corridor – i.e. Boam Gorge and the Dolon avalanche monitoring station (UNDP Kyrgyzstan, 2023), Chapchyma and the Bashky-Terek station (Chatkal district, Jalal-Abad region); and local landslide monitoring systems using SCADA systems for decision-making.

In **Tajikistan**, the National Disaster Risk Management Project, funded by the Asian Development Bank, strengthens the EWS by developing the national EWS concept, supplying a new C-band Doppler weather radar for improved detection of severe weather events, and modernizing the anti-hail system for the remote monitoring of a territory of up to 250 km and anti-hail protection of 609,000 ha of agricultural land in the Hissar Valley and the Vakhsh Valley. It also supports the modernization of the Lake Sarez EWS, with improved monitoring systems and communication infrastructure transmitting data directly to the control centre in Dushanbe (Government of Tajikistan, 2022: 8), including 30 new EWS sirens and a data centre.

In **Uzbekistan**, the Enhancing Multi-Hazard Early Warning System project improves hydrometeorological observation networks and forecasting by upgrading monitoring networks for weather, climate, hydrology and cryosphere, installing new monitoring devices like automatic weather stations and radar, developing hazard-specific forecasting procedures, training Uzhydromet staff, and implementing data quality assurance procedures (UNDP Uzbekistan, 2021).

[9] The website for this project is available online at https://projects.worldbank.org/en/projects-operations/project-detail/P120788.

[10] The website for the Central Asian Flood Early Warning System is available online at https://www.worldbank.org/en/news/infographic/2021/12/10/cafews.

[11] Visit the Sensor Data Storage System online at https://sdss.caiag.kg/sdss/.

Prevailing gaps and challenges are evident in this thematic area across Central Asian countries, as summarized below:

- Limited integration of EWS with national DRM systems hampers risk-informed planning, highlighting the need for better coordination.
- Normative and procedural gaps hinder coordination among EWS stakeholders.
- The current observation and monitoring systems in these countries inadequately address challenging environments (e.g. topography, cascading multi-hazard profiles, complex climate dynamics, etc.), resulting in lower data resolution and accuracy and limited localization of weather information and services.
- The insufficient number and profiles of monitoring stations require the expansion and automation of the stations. This also affects the provision of sector-specific monitoring and observation, as in the case of the agrometeorological network in Tajikistan.
- The delivery of sector-specific services is ineffective, impeding the ability of the sector entities to make well-informed decisions.
- Weather radar coverage and remote-sensing applications need enhancement.
- Cellular network limitations in some regions may lead to occasional data flow gaps or delays.
- Limited technical capabilities, outdated equipment and software, ineffective real-time data collection, and challenges in conducting risk assessment hinder effective monitoring and forecasting.
- The restricted availability of historical hydrometeorological data impedes comprehensive analysis and forecasting, limiting the effectiveness of EWS.
- The centralization of hydrometeorological data restricts access by other ministries, hindering innovative use and the coordination of responses across agencies.
- Resource constraints, including shortages in trained personnel and necessary equipment, pose obstacles to effective monitoring and forecasting, necessitating urgent attention to enhance reliability and effectiveness.
- There are inadequate automation and digital solutions for monitoring and forecasting.
- Forecasting information often uses technical language, posing comprehension challenges for non-specialists.
- In many cases, weather information is issued by a different department inside the national hydrometeorological service (e.g. synoptic, meteorological, hydrological, ecology, etc.), which leads to fragmented forecasting and the lack of a “single issuing service” (ZAMG, 2022: 10).
- Limited capacity exists in utilizing sophisticated data-intensive hazard modelling and risk assessment tools (specifically for mudflows, floods, hydrological droughts, and landslides).
- The dissemination of forecasting information to all stakeholders is delayed or incomplete, especially among local authorities and communities.
- There are insufficient financial resources for investment and maintenance.
- There is a lack of expertise and know-how in impact-based forecasting, considering the population distribution and infrastructure.
- Insufficient information about transboundary hazards and risks results in inefficient early actions.
- Feedback mechanisms for improving forecasting services are absent or inadequate.

THEMATIC AREA

Warning dissemination and communication

Timely warnings with straightforward, actionable information facilitate prompt responses, protecting lives, livelihoods and communities. Efficient communication is vital, as it translates forecasts into early actions within at-risk communities, maximizing preparedness and minimizing adverse impacts. According to Coughlan de Perez et al. (2022), "breakdowns in communicating weather information to the public were cited as major problems in most of the big disasters of this century." Pillar 3 (warning dissemination and communication) stands out, with 89 countries (46 percent of the world) reporting positive scores, indicating that citizens are covered by early warning information (UNDRR and WMO, 2023: 39). Four of the Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan), reported on this through the Sendai Monitor (UNDRR, 2019b). The analysis focuses on channel attributes for effective communication, aiming to empower individuals with practical information for informed decisions and enhanced responsiveness.

In Central Asia, effective warning dissemination relies on robust policy frameworks, institutional structures and empowered authorities. Stakeholders translate forecasting messages into warnings, but challenges persist in clarifying responsibilities, leveraging professional and volunteer networks, and establishing feedback mechanisms for verification and addressing disruptions. The main channels for information dissemination in Central Asia include television, SMS and social media, while others, such as public speakers and volunteers, are underused, especially in remote areas. It is not always clear whether warnings are being received, and cooperation with the media sector varies across the region. However, with widespread mobile network coverage and Internet accessibility, there are significant opportunities to improve communication and accessibility for disaster risk communication.

The existing warning systems in Central Asia reach most communities but lack customization for vulnerable groups and are not inclusive in the creation and dissemination process. They also do not adhere to the Common Alerting Protocol, which standardizes emergency warnings and alerts across various communication networks, enhancing their effectiveness, keeping the consistency of the warning message and simplifying dissemination tasks (ITU, 2024). Delays between forecasts and warnings, ranging from minutes to hours, are common, with information updates typically occurring hourly during events. The early warning infrastructure needs regular testing, maintenance and upgrades to ensure business continuity, as demonstrated by the interchangeable server equipment in critical situations in Kyrgyzstan (the Crisis Management Centre's server equipment in Bishkek and Osh are interchangeable in critical situations, and one can back up the other).

In **Kazakhstan**, the Unified State Monitoring System includes Kazhydromet for forecasting, the Crisis Management Centre for coordination, the Unified Duty Dispatch Service (UDDS) 112 for emergency services, and radio and television for alerts. Prompt communication within UDDS 112 involves telephone and SMS notifications, street siren activation, and broadcasting alerts via various channels (FAO, 2022c: 43). The Ministry of Emergency Situations uses social media for warning dissemination, and the Darmen mobile app[12] provides regional emergency notifications. Advanced warning dissemination systems, including regional control panels and consoles, are installed nationwide, and a pilot project with Kazakhtelecom tests cell broadcast technology for emergency alerts (UNDP, 2012). Finally, the Earthquake Early Warning Testing System in Almaty notifies users of earthquakes with a magnitude of 4 or higher via push notifications, providing faster alerts than SMS (EL.KZ, 2023). This model could serve as a regional solution for integrated earthquake EWS across five countries.

[12] For more information on the Darmen mobile app, please visit https://www.keu.kz/attachments/article/7498/Darmen.pdf

In **Kyrgyzstan**, a unified information management system for EWS was established, comprising four main components: crisis management centres, a public alert system, a duty dispatch service (112), and an integrated monitoring and forecasting system. The monitoring system collects and analyses data, develops forecasts, and disseminates information (FAO, 2022d). Crisis management centres in Bishkek and Osh coordinate crisis responses. The Unified State Duty Dispatch Service 112 (Sistem-112) receives messages and coordinates responses. The public alert system, OKSION, sends targeted alerts via SMS and other channels for various emergencies. Alert channels include television, radio, mobile, Internet and social media. The 112 Kyrgyzstan mobile app provides weather and emergency information and allows users to send messages and media. The system covers 98 percent of the population, with plans for seismic sensor integration. The installation of public notification systems is ongoing, focusing on crowded areas and government buildings. Centralized activation of sirens is feasible, with plans for full coverage and solutions for disabled citizens. The integration of seismic sensors into the app is planned for automatic warnings.

In **Tajikistan**, the Agency of Hydrometeorology issues warnings for natural hazards such as heavy rains, floods, landslides, snowfalls and droughts, which are then disseminated by the Committee on Emergency Situations at national, regional, district and on-site levels using mobile cellular communication and other means. Also, the Committee on Emergency Situations cooperates with mobile providers to disseminate weather warnings and road accessibility information (FAO, 2022b). Several EWS have been installed, including the Sarez Lake and Yakhsu River basin systems, with plans for a comprehensive nationwide system (Committee on Emergency Situations and Civil Defence under the Government of the Republic of Tajikistan, 2018). The Committee on Emergency Situations also uses Internet sites and social media for warning dissemination, including its website and its Facebook, YouTube, Instagram and Telegram accounts. The modernized Sarez Lake EWS provides real-time monitoring and warnings for potential outbursts and other hazards, with audio signals in settlements and SMS alerts for officials. Additional EWS were installed at Kayrakkum Dam and in other priority areas prone to mud flows. These systems warn through audio signals in settlements and notify officials via SMS (FAO, 2022b: 49).

In **Turkmenistan**, the late evening news at 21.00 includes air quality information, introduced during the COVID-19 pandemic. Alongside the "implementation of hydrometeorological support and delivery of the necessary information to ministries, departments, public organizations and the population" (Agalkhanova, n/d: 3), Turkmenhydromet regularly issues weather-related warnings (e.g. heat, cold and windstorms); through the local authorities (provincial municipalities), they are disseminated to key stakeholders such as hospitals, schools and communal services. Nevertheless, they are not disseminated to the general public, which is informed by word of mouth.

In **Uzbekistan**, Uzhydromet issues warnings to the Ministry of Emergency Situations and other government bodies for extreme weather events. The Ministry of Emergency Situations disseminates warnings to the public through television, radio, newspapers, the Uzhydromet website,[13] and SMS messages, covering such risks as heatwaves and mudflows. The Ministry of Emergency Situations utilizes mobile operators (e.g. Beeline Uzbekistan, Ucell, Perfectum Mobile, UZMobile, Humans and Mobi UZ) for SMS dissemination and public sirens for alerts. The Ministry coordinates with control centres, including those in Kazakhstan, and plans to enhance public awareness with the Meteoalert system. Recently, the Automated System for Warning and Information of the Population has been upgraded with new technology, including telecommunication systems and unmanned aerial vehicles for monitoring and alerts in remote areas. The Ministry of Emergency Situations integrates early warnings into its mobile app, providing emergency services and educational materials. Regional crisis management centres conduct training and forums to improve community response to warnings. Collaboration among Uzhydromet, government entities, providers and users will enhance warning systems.

[13] The Uzhydromet website is available online at https://www.meteo.uz/.

The prevailing gaps and challenges are evident in this thematic area across Central Asian countries, as summarized below:

- Norms and standard operating procedures lack clarity, causing uncertainty in EWS stakeholder roles and hampering effective warning communication. This ambiguity stems from unclear messaging and inadequate methods for reaching all community members.
- Enhancing the dissemination of early warnings and ensuring effective preparedness requires the prioritization of an active plan of action, communication equipment, and emergency shelters and procedures.
- Automated EWS are lacking, particularly in industrial enterprises and social facilities.
- Public alert systems may not be fully functional due to topographical challenges, and populations may be unaware of their existence or signals.
- The effectiveness of real-time information reaching communities or individuals directly is uncertain and thus needs to be assessed. There also is a need for a feedback mechanism for end users to ensure that forecasts and warnings meet community needs.
- Insufficient cooperation exists in data sharing, system digitalization/automation, and community engagement for early warning.
- The Common Alerting Protocol is not implemented in Central Asian countries, leading to challenges in interoperability and consistency in conveying alert information across different systems and platforms.
- Cell broadcasting is not implemented and integrated into the warning dissemination schemes.
- Alerts lack customization and specific details about at-risk areas, reaction models and potential impacts, hindering effective communication and response.
- Insufficient public awareness and education delay early responses, emphasizing the need for comprehensive efforts to enhance understanding and promote proactive actions.
- Gender and disability mainstreaming are absent in early warning and alerting processes.
- Limited involvement from the private sector undermines comprehensive risk reduction efforts, necessitating increased participation to strengthen resilience and responsiveness.
- The lack of impact-based warning systems impedes the communication of specific hazards. Implementing such approaches is essential for providing actionable information and enhancing community preparedness.

THEMATIC AREA

Preparedness and response capabilities

The final step in an effective EWS value chain is preparedness and response; it is essential for communities to understand local risks, recognize forecasts, interpret warnings and be ready to act early to minimize impacts. Collaborative plans are crucial at all levels, ensuring everyone – including communities, local governments, national agencies, non-governmental organizations and community-based organizations – knows how to respond to warnings. These plans should be practised through exercises and drills and supported with training and resources for effective action (UNDRR and WMO, 2023: 65). This pillar is crucial for effective disaster response, requiring education, training and coordination at all levels to enhance readiness and align with national priorities, especially for vulnerable groups. Less than one-third of countries globally have reported having local government plans to act on early warnings, indicating a potential lack of such plans for over two-thirds of the world's local governments (UNDRR and WMO, 2023). Among Central Asian countries, only Kazakhstan (since 2017) and Uzbekistan (since 2018) have submitted reports to the Sendai Monitor regarding the existence of local government plans for early warnings (UNDRR, 2019c).

Central Asian countries focus primarily on preparedness and response, and these capabilities are prioritized in strategies and plans. While they invest in disaster planning and allocate resources, systematic community involvement remains challenging, particularly among vulnerable groups. Education and training for at-risk communities are insufficient, as are defined roles for key stakeholders such as the national hydrometeorological services. Regular drills are conducted on several hazard scenarios, but community participation varies. Anticipatory actions are not widely implemented in Central Asia, though some countries have initiated individual efforts as part of various projects (IFRC, n/d).

State reserve funds are often perceived as anticipatory measures, but they are reactive and mainly used for response and immediate recovery. The anticipatory action is more of an ex ante preparedness measure. For example, Tajikistan implemented measures for heatwaves and cold waves from 2019 to 2021[14] that benefited more than 2,000 households (Anticipation Hub, 2024a), while the actions in Kyrgyzstan from 2019 to 2022 helped 18,074 people (Anticipation Hub, 2024b). In Kazakhstan, the IFRC and the Kazakh Red Crescent developed a Simplified Early Action Protocol in 2022 that was activated in December 2023 ahead of cold waves and allows for increased flexibility and faster response in anticipation of this hazard in the targeted regions of North Kazakhstan, Pavlodar, Kostanay, Eastern Kazakhstan, Abay, Akmola and Karaganda and Astana city (IFRC, 2023a, 2023c). Scaling up climate-smart DRR and anticipatory action is a priority for the IFRC network plan for Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) in 2023 (IFRC, 2023b).

Several effective practices in boosting preparedness and response capacities among national DRR stakeholders and promoting regional cooperation are evident in the region, as highlighted in this section. The Regional Forum - Meeting of the Heads of Emergency Authorities of Central Asian countries plays a key role in strengthening regional cooperation for disaster preparedness and response (CESDRR, 2014). One of the pillars of the regional strategy for the development of cooperation of countries of Central Asia in DRR for 2022–2030 focuses on operational coordination, supporting response services, enhancing interstate information exchange, and expanding preparedness capacities and emergency reserves (CESDRR, 2021b).

[14] Heat wave anticipatory actions were activated in July 2019 for districts in the Khatlon province (N. Khusrav, Shahrituz, Kabodiyon, and Panj) and the Sughd province (Asht, Zafarobod and Mastcho), while the cold wave actions were activated in February 2020 for the Districts of Republican Significance (Lakhsh and Rasht), Gorno Badakshan Autonomous Oblast (Darvoz and Murgob), Khatlon province (Khovaling) and Sughd (Mastchohi Kuhi).

On the other side, **the CESDRR** plays a key role in promoting regional collaboration for effective disaster response, evident from its various project initiatives[15] aimed at enhancing overall resilience. Notable activities include establishing the CESDRR Regional Situation Room (CESDRR, 2020b); the concept of a regional register of capacities and assets for rescue operations during emergencies (CESDRR, 2019a); the regional register of experts in the field of civil protection/defence, DRR, prevention and liquidation of emergency situations (CESDRR, 2019b); the concept of a regional mechanism for response to a large scale and transboundary emergency situations (CESDRR, 2019c); and more. Furthermore, the **European Union**'s DIPECHO programme invested around EUR 47 million in 110 projects from 2003 to 2018 to boost the preparedness and response capacities of Central Asian countries (European Commission, 2023). In 2022, over EUR 3.1 million was allocated to address emergencies in the region, including the escalation of violence along the Kyrgyz–Tajik border. Additionally, **UNICEF and IFRC**, with support from the **United States Agency for International Development/Bureau for Humanitarian Assistance**, are enhancing local and national capacities for earthquake risk reduction and emergency response, benefiting 298,132 beneficiaries since 2019 (USAID et al., 2023). Finally, a regional project from UNESCO focuses on strengthening emergency preparedness for cultural sites and institutions in Central Asia (UNESCO, 2023).

In September 2021, **Kazakhstan** hosted the Ger-2021 International Command and Staff Exercise at the Astana training ground. It aimed to train civil protection services for earthquakes and involved more than 3,000 formations from the country, including more than 70,000 people and 6,000 units of equipment (Ministry of Emergency Situations of the Republic of Kazakhstan, 2022: 9). Also, the Ministry of Emergency Situations, in partnership with CESDRR and supported by UNICEF, developed the capacities for emergency preparedness and response using unmanned aerial vehicles (UNICEF, 2023).

In **Kyrgyzstan**, efforts include improving the normative framework with the development of national and local emergency plans in sectors such as agriculture, forestry and fisheries. The Ministry of Health has set up a Public Health Emergency Operations Center to coordinate responses to public health emergencies (Cabinet of Ministers of the Kyrgyz Republic, 2022: 39).

In **Tajikistan**, special training and education programmes have been developed for secondary school students, students of higher educational institutions, commanding staff, workers and employees on the basics of emergency preparedness and civil defence (Government of Tajikistan, 2022: 17).

Finally, in **Turkmenistan**, the General Directorate of Civil Defense and Rescue of the Ministry of Defense conducts regular and specialized education and training for stakeholders, including in the energy sector. The National Red Crescent Society of Turkmenistan also contributes by educating DRR practitioners and at-risk communities, such as by assisting the population in emergencies and implementing health and social welfare programmes (Milli Goşun, 2021).

[15] A list of projects is available online at https://cesdrr.org/en/projects.

Prevailing gaps and challenges are evident in this thematic area across Central Asian countries, as summarized below:

- Policy and regulatory frameworks for preparedness and response need to streamline international standards, and standard operating procedures do not reflect the preparedness and response of all.
- Existing subnational coordination needs to be improved through intersectoral agreements to integrate preparedness and response services more closely.
- Inadequate assessment of community readiness for early warnings hampers targeted resilience efforts. Comprehensive assessments are vital for identifying strengths and improvement areas.
- Regular education and training efforts face such challenges as resource constraints and the maintenance of engagement over time, affecting effective preparedness.
- Regular simulation exercises and drills are not consistently conducted, highlighting the necessity of establishing guidelines regarding their frequency, scope and scale for more effective preparedness.
- Limited funding hampers upgrading tools, technology development and specialist training, hindering disaster response capabilities.
- The lack of anticipatory actions, including forecast-based financing mechanisms, leads to resource gaps in community preparedness and response efforts.
- There is a need to empower local non-governmental organizations to actively participate in education and training for taking early and anticipatory actions in the EWS.
- The insufficient involvement of the private sector in preparedness and response activities hampers effective crisis response and business continuity.

UNDRR

UNDP

EARLY WARNING SYSTEMS BEST PRACTICES IN CENTRAL ASIA

Photo: UNDP Uzbekistan

Regional initiatives by the Center for Emergency Situations and Disaster Risk Reduction, based in Almaty, Kazakhstan, play a prominent role in advancing regional early warning efforts. The centre's mandate includes establishing effective risk reduction mechanisms, coordinating joint responses among Member Countries, and fostering regional and international cooperation in disaster management. Its initiatives encompass various aspects of early warning processes and systems. A **regional early warning** and **mutual information system** for disaster threats and occurrence is planned to integrate the national EWS of the five Central Asian countries and aims to inform both populations and territories about potential threats or ongoing emergencies, divided into two regional systems: one for earthquakes and one for disaster threats and occurrences (CESDRR, 2022). Accordingly, a technical working group on the creation of the aforementioned system was established in September 2023 to coordinate its establishment. Within the auspices of the Regional Forum-Meeting of the Heads of Emergency Authorities of the Central Asia countries held on 10 November 2023 in Almaty, an appeal of the heads of the emergency authorities of Central Asian countries to the United Nations Secretary-General on creating a regional EWS and mutual information about the threat and occurrence of transboundary emergencies within the framework of the United Nations global initiative Early Warnings for All (EW4All) was signed. It reaffirms the dedication of the five countries to establish the regional EWS and consequently requests its support through its inclusion in the EW4All initiative.

The Central Asian Flood Early Warning System (CAFEWS) is a virtual platform facilitating data exchange and weather forecasting to manage transboundary weather, climate and water risks in Central Asia. It enhances the sharing of information among forecasters in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, with potential expansion to Afghanistan for the rivers Amu Darya and Syr Darya. Utilizing modern ICT solutions, including cloud computing, CAFEWS employs advanced numerical weather prediction and hydrological modelling for seamless data exchange and enhanced forecasting. It supports decision-making in weather-sensitive sectors such as transport and agriculture, fostering regional cooperation and contributing to climate adaptation and DRR efforts, as demonstrated by its success in issuing early warnings, including predicting a recent mudslide event in Tajikhydromet (UNDRR and WMO, 2023: 18).

The UNESCO project Glacial Lake Outburst Floods in Central Asia aims to reduce vulnerabilities to flooding in glacier lakes. It enhances risk assessment, establishes tailored EWS, integrates DRR and climate adaptation into local planning, and conducts training for at-risk communities. Operating across Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, the project benefits nearly 90,000 people by providing EWS and by enhancing resilience through training and awareness.

The Climate Change and Resilience in Central Asia regional project aims to enhance stability and climate resilience in the Ferghana Valley across Kyrgyzstan, Tajikistan and Uzbekistan. Pilot activities include the establishment of community-based early warning systems (CBEWS) in the Ferghana Valley and the improvement of last-mile communication with all community members by 2024. Beneficiaries include governments, experts, academia, civil society organizations and local communities. The project prioritizes EWS for such hazards as mudflows, droughts, insects and social cohesion, with defined processes. It recently hosted the Second High-Level Dialogue on Climate Change and Resilience in Central Asia 'Early Warning Systems for Climate Resilience', which highlighted the importance of EWS, deepened understanding among participants, shared best practices and lessons learned, and fostered cooperation throughout Europe and Central Asia.

Through the project 'Enhancing Multi-Hazard Early Warning System to Increase Resilience of Uzbekistan Communities to Climate Change-Induced Hazards', which recognizes the increasing impacts of hydrometeorological disasters due to climate change, Uzbekistan is prioritizing climate adaptation and allocating funds for an MHEWS. Focusing on floods, mudflows, landslides, avalanches and drought in the Ferghana Valley, the project aims to modernize the EWS, introduce impact-based forecasting based on socio-economic risk modelling, and explore and facilitate forecast-based financing. By shifting from reactive to proactive warnings and enhancing detection capabilities, the system aims to translate weather forecasts into actionable warnings that are disseminated to users who understand their content and how best to react. The project also aims to develop risk knowledge products for targeted areas, setting a precedent for effective EWS and DRM in Uzbekistan and beyond.

Tajikistan has been identified as the inaugural country in the Central Asia region to receive support through the **#EW4All initiative**, which aims to enhance resilience to various risks. Supported by UNDRR, WMO, ITU and IFRC, the effort spans four pillars: risk knowledge, detection, warning dissemination and preparedness. A national consultation engaged 60-plus key stakeholders from various sectors and domains (government agencies, international organizations, the United Nations, private sector entities such as mobile operators, media outlets, and civil society organizations) in identifying gaps and challenges and formulating priorities. The National Platform for DRR will coordinate efforts, with key focal points having been nominated. The next steps include finalizing the gap analysis exercise, developing a medium-term action plan, and adopting a national road map for scaling up and strengthening national EWS through targeted support.

CONCLUDING REMARKS AND THE WAY FORWARD

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Photo: UNDP / Khusrav Sharifov

Overall conclusions and forward-looking recommendations

This stakeholder mapping analysis of EWS in the Central Asia region assessed the current context, identified common gaps and challenges in alignment with global frameworks, recognized best practices, and proposed actionable steps to progress towards achieving comprehensive EWS for all in society and communities. The analysis revealed a diverse range of stakeholders involved in advancing the EWS value chain, emphasizing collaborative efforts regionally and nationally. While not exhaustive, it serves as a milestone for enhancing early warning capabilities. Forward-looking actionable recommendations have been derived from assessments, aiming for regional replication and expansion of the Early Warning for All Initiative across Central Asia and laying the groundwork for effective and inclusive early warning processes at both national and local levels while leaving no one behind. Consequently, general recommendations are outlined to steer both regional and national efforts towards attaining EWS reference levels across Central Asia, as follows:

- **Promote a shift from reactive to proactive DRM, prioritizing resilience and sustainability over risk concentration. Embrace comprehensive approaches that encompass all hazards, involve all societal sectors, consider the entire disaster life cycle and emphasize forward-thinking risk reduction policies for a future-oriented approach.**
- Expand regional and national EWS stakeholder lists through mapping exercises to comprehensively understand their roles and responsibilities in the early warning cycle.
- **Fortify the entire value chain to strengthen EWS. This includes understanding risk, improving data collection, enhancing monitoring and forecasting, disseminating warnings effectively, and ensuring prompt responses. By fortifying each link, risks can be mitigated, communities protected and a resilient future for all built.**
- Improve policy and regulatory frameworks to prioritize early warning, focusing on people-centred MHEWS in the region, and restructure institutional architecture for greater inclusivity and participation of all stakeholders in the early warning process.
- **Contribute to the #EW4All initiative by replicating successful models and scaling up efforts to enhance the reach and impact of EWS.**
- Elevate the importance of MHEWS in policy discussions and decision-making agendas – recognizing their pivotal role in enhancing resilience and mitigating risks for a safer and more secure future – and integrate risk information and early warning mechanisms into national and local development policies to enable early warning-informed decision-making.
- **Promote effective early warning partnerships by integrating traditional and non-traditional DRR actors, enhancing their capacities and connecting with global networks for knowledge exchange. In that sense, the private sector can benefit from the ARISE network for streamlined risk reduction and MHEWS implementation.**
- Establish a sustainable funding mechanism for MHEWS to ensure stability and inclusiveness in development and maintenance, exploring diverse funding sources and advocating for dedicated budget allocations.
- **Support the transition of existing EWS towards impact-based early warning, emphasizing a proactive approach for community safety and resilience.**
- Integrate national early warning systems with the Regional Earthquake Early Warning System to facilitate vital information exchange on transboundary earthquake emergencies.

Recommendations per EWS thematic area

The proposed enhancements address technical, normative and institutional deficiencies across all four the matic areas to ensure that timely and accurate warnings can reach all community members at risk. Some enhancements have been previously discussed, while others stem from identified gaps and challenges.

THEMATIC AREA

DISASTER RISK KNOWLEDGE

- Improve risk and hazard assessment to address the complex and systemic nature of risks, anticipate emerging risks, and integrate climate change trends for informed early warning decisions and risk management strategies.
- Expand the MHEWS via the closer integration of biohazards into the national EWS framework.
- Foster inclusive and participatory risk assessment processes, incorporating traditional knowledge and perspectives of at-risk communities to align actions with their needs and capacities.
- Strengthen national and local capacities to understand and address social, economic and environmental vulnerabilities, enhancing preparedness and response within EWS.
- Generate disaster risk knowledge at national and local levels, producing assessments, maps and operational plans for seamless integration into EWS.
- Regularly collect and share gender-sensitive and disability-inclusive data for EWS planning, warning dissemination and operational preparedness and response.
- Integrate and consolidate risk-related information across key sectors (e.g. agriculture, health and transport) into strategies, programmes and action plans for making risk-informed decisions and policies.
- Consolidate existing risk information into interoperable national and regional digital repository platforms accessible to multiple stakeholders for informed decision-making across the DRM and early warning cycle.
- Improve disaster risk data access at regional, national and local levels for all relevant EWS stakeholders to contribute effectively to early warning processes and decision-making.
- Address loss and damages comprehensively by enhancing the normative framework, digitalizing data collection and analysis, and leveraging global mechanisms like the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts.
- Scale up the Digital Safety Passport and Atlas of Emergency Situations initiatives.

THEMATIC AREA

MONITORING AND FORECASTING SERVICE

- Clarify roles and responsibilities and enhance coordination among vertical and horizontal EWS stakeholders and integrate early warning into national DRM systems, enabling monitoring and forecasting for improved risk awareness and planning.
- Expand observation networks to overcome topographical challenges and multi-hazard profiles, encompassing flash floods, mudflows, droughts, avalanches and glacial lake outburst floods, improving the data accuracy and resolution of forecasting products and localizing weather information services to adapt to complex climate dynamics.
- Enhance real-time monitoring systems for meteorological and hydrological data by automating existing stations, installing new automated stations with real-time data transmission, and digitalizing processes for improved efficiency and accuracy.
- Improve observation parameters and sensors to capture the cascading effects of severe hydrometeorological conditions effectively.
- Develop and integrate solutions for rapid-onset weather-related events, such as flash floods, to enhance preparedness and response capabilities.
- Invest in education, training, equipment and tools for national hydrometeorological services to enhance monitoring and forecasting capabilities.
- Streamline departments to deliver unified forecasts, enhancing coordination and communication for prompt response.
- Decentralize hydrometeorological data access for effective coordination across agencies at national, regional and local levels.
- Integrate impact-based warning systems to improve early warning communication and response.
- Simplify forecast language for better comprehension by non-technical users.
- Enhance information flow on transboundary hazards.
- Implement feedback mechanisms to improve forecasting service quality based on user input.

THEMATIC AREA

WARNING DISSEMINATION AND COMMUNICATION

- Improve warning procedures and responsibilities in the normative framework, especially the standard operating procedures, to resolve ambiguities in warning dissemination, ensure clear guidance for all EWS stakeholders, and enable geolocated alerts via mobile networks.
- Expand EWS stakeholders to include professional networks, volunteer groups, the private sector and civil associations for timely warning dissemination.
- Ensure public alerting system functionality with adequate design and spatial distribution for nationwide coverage, including the improvement of automated EWS in industrial and other facilities.
- Strengthen preferred and trusted warning dissemination, using digital solutions where possible; integrate an effective communications system for targeted alerts with clear, easily understandable messages across various channels (e.g. communities and businesses) to ensure business continuity; and implement a feedback mechanism for enhanced effectiveness.
- Establish diverse communication channels for community warnings, from low-tech to high-tech.
- Improve the effectiveness and efficiency of the warning dissemination by Common Alerting Protocol and building capacities and know-how for its application.
- Develop hazard-specific reaction models alongside risk thresholds for notification of communities and impact-based warnings for initiating early actions.
- Integrate at-risk communities into the EWS and ensure continuous public awareness and education on warning dissemination to prompt early response actions by all.
- Develop an online platform for risk communication, integrating both warnings and educational materials for broader accessibility and understanding by ensuring gender-sensitive and disability-inclusive warning and alerting.
- Integrate national warning dissemination and communication channels into a regional EWS, enabling timely and effective warning for impacted populations across the region.
- Develop the essential capacities and provide the necessary resources for a fully integrated regional early warning and alerting system, coupled with adequate financing.
- Replicate the pilot in Kazakhstan and broadly apply cell broadcasting to provide timely, effective and localized warning information.

THEMATIC AREA

PREPAREDNESS AND RESPONSE CAPABILITIES

- Review and modify the normative solutions and planning documents against international standards, and improve standard operating procedures to reflect the preparedness and response of all.
- Enhance subnational coordination through intersectoral agreements and advance the closer integration of preparedness and response services.
- Boost national and local preparedness with impact-based approaches that empower first responders to react promptly and effectively to early warning alerts.
- Evaluate at-risk community needs for tailored response strategies that address their unique needs and challenges.
- Develop scenario-based preparedness and response plans from national to local levels.
- Regularly train stakeholders and communities with drills and exercises to test the preparedness level and response system.
- Involve the private sector in crisis response and continuity planning.
- Invest in equipment upgrades, technology development and specialist training.
- Incorporate disaster preparedness into sector-specific plans and programmes (e.g. education curricula, public health assessments and operational plans, contingency planning and business continuity, resilience-building programmes for critical infrastructure, etc.).
- Apply anticipatory actions more broadly, including forecast-based financing in at-risk communities.
- Engage local NGOs in education and training for early and anticipatory actions in early warning.
- Nurture initiatives and solutions for effective preparedness and prompt response across the region.

Potential resilience building of early warning pathways

After conducting stakeholder mapping for the EWS and reviewing the regional context in Central Asia, it was evident that a transformative shift is necessary in the approach to timely and efficient EWS at regional, national and local levels. As a result, three potential development pathways have been identified:

The status quo scenario assumes that the current state of EWS will remain unchanged. Existing systems will operate within their current policy, norms and institutions, with minimal effort expended to improve their functionality. This might include involving more stakeholders, enhancing risk awareness, implementing operational plans, expanding observation networks, and improving communication and coordination. Existing human, material and technical resources will be utilized according to established procedures.

The advance scenario entails substantial enhancements to policy, legislation and institutions, including adopting the impact-based warning system, fostering stronger public–private partnerships, investing more in EWS, targeted capacity-building, expanding monitoring networks, and implementing impact-based forecasting.

The altering scenario is grounded in the expectation to establish a modern EWS comprehensively. This includes enacting new legislation, implementing organizational reforms, conducting extensive capacity-building and awareness-raising initiatives, ensuring stable resource provision, fully integrating impact-based forecasting and warning systems, employing location-based warning and alerting, and embedding anticipatory actions into community resilience efforts, among other transformative measures.

Table 2 Potential EWS development pathways

SCENARIO	STATUS QUO SCENARIO	ADVANCE SCENARIO	ALTERING SCENARIO
MODEL	Regular	Progress	Towards next-gen EWS
FRAME	Regular and ongoing activities, minimal improvement	Improvement of the policy and normative, institutional and operational frameworks	Creation of innovative frameworks and solutions for EWS
TIME FRAME	0–12 months	12–24 months	24–36 months
PROGNOSIS	Present	Anticipated	Least anticipated
FINANCIAL RESOURCES	$	$$	$$$
COUNTRIES	Majority of them	Some of them	Few of them

Source: Author's own elaboration.

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