Early Warning Systems Stakeholders Mapping Exercise Across the Western Balkans

May 2025

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Acknowledgements

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Executive summary

The stakeholder mapping exercise of early warning systems (EWS) in the Western Balkans summarizes the findings of an assessment of the current EWS value chain landscape and context in the Western Balkans, a collaborative effort of the United Nations Development Programme (UNDP) Istanbul Regional Hub and the United Nations Office for Disaster Risk Reduction (UNDRR) Regional Office for Europe and Central Asia, contributing to the overall Early Warnings for All initiative. This stakeholder mapping exercise has identified key stakeholders across the entire EWS value chain, highlighted gaps and challenges in four thematic areas, showcased best practices, and proposed actionable recommendations to achieve inclusive EWS for all communities.

EWS value chain stakeholders in the Western Balkans have competencies across various thematic areas that enhance intersectoral cooperation and coordination, vital for the effective implementation of these systems. Their collaboration builds community trust by helping keep the population informed and supported during emergencies. Diverse perspectives facilitate a comprehensive disaster risk management approach, yielding timely and tailored solutions for local needs. This collaborative framework not only strengthens EWS but also empowers communities to adopt proactive measures, boosting resilience against potential threats. In summary, stakeholder involvement is crucial for fostering a culture of preparedness and promoting sustainable practices in the Western Balkans.

There is significant potential to enhance the EWS value chain in the Western Balkans, providing a foundation for improved risk management and climate change adaptation. Advancements across thematic pillars, along with insights from past interventions and best practices, are driving notable improvements in EWS. These enhancements bolster the overall effectiveness and resilience of disaster risk management, enabling communities to better prepare for and respond to hazards.

By integrating successful strategies and lessons learned, the countries and territories of the Western Balkans can establish a more robust framework that promotes proactive measures and collaboration, ultimately contributing to a safer and more resilient environment for all.

This EWS stakeholder mapping exercise fosters a transformative shift in the perception and integration of EWS within broader resilience-building efforts. It positions these systems as proactive tools for disaster risk management and key climate adaptation measures, promoting a holistic understanding of building resilience. This shift paves the way for enhanced collaboration among stakeholders in the region—governments, technical agencies, academia, the private sector, NGOs, the Red Cross, media, local communities and more—facilitating a unified approach to disaster prevention, preparedness and response. As stakeholders recognize the value of EWS in empowering communities and fostering resilient development, their commitment to investing in these systems increases, aligning early warning and disaster risk reduction with central and local priorities to create more risk-informed policies and decisions.

Thus, this report aspires to catalyse a fundamental shift in the understanding and incorporation of EWS value chains into resilient and risk-informed development, paving the way for the Western Balkans to achieve fully inclusive EWS that serve all community members. Consequently, actionable and forward-looking recommendations have been derived from the assessment, not only to expand the Early Warnings for All initiative across the Western Balkans but also to contribute to the establishment of a foundation for effective, inclusive and transboundary early warning processes at regional, domestic and local levels, ensuring that no one is left behind.

Acronyms and abbreviations

CBOs	Community-Based Organizations
DPPI SEE	Disaster Preparedness and Prevention Initiative for South Eastern Europe
DRR	Disaster Risk Reduction
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
EM-DAT	Emergency Events Database
EWS	Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FEWS	Flood Forecasting and Early Warning System
FFWS	Flood Forecasting and Warning System
GARD	Get the Airport Ready
GCF	Green Climate Fund
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSMA	Global System for Mobile Association
IAEA	International Atomic Energy Agency
ICPDR	International Commission for Protection of the Danube River
IFRC	International Federation of Red Cross and Red Crescent Societies
IHMS	Institute of Hydrometeorology and Seismology of Montenegro
IOM	International Organization for Migration
IPA	Instrument for Pre-accession
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunication Union
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
KfW	KfW Development Bank
MEFFIS	Montenegro Forest Fire Information System
MHEWS	Multi-Hazard Early Warning System
MKFFIS	Macedonian Forest Fire Information System
NATO	North Atlantic Treaty Organization

NDMAs	Disaster Management Agencies in the countries and territories
NDRRS	National Disaster Risk Reduction Strategy
NFFIS	National Forest Fire Information System
NGO	Non-Governmental Organization
NMHSs	National Meteorological and Hydrological Services
ODA	Official Development Assistance
OSCE	Organization for Security and Cooperation in Europe
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 Message Service
UNCCD	United Nations Convention to Combat Desertification
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
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 Bosnia and Herzegovina / Jim Marshall

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CONTEXT AND RATIONALE FOR EARLY WARNING SYSTEMS IN THE WESTERN BALKANS

General Hazard Profile of the Western Balkans

The Western Balkans,[1] encompassing Albania, Bosnia and Herzegovina, Kosovo,[2] Montenegro, North Macedonia and Serbia, spans an area of 218 591 km[2] and is home to approximately 17 million people. The region covers a range of landscapes with specific local climate conditions, including the Adriatic Sea coastal areas, the complex topography of the Dinaric Alps (with elevations of up to 2 700 m) and the continental-influenced lowlands of the Sava, Morava and Danube rivers (UNEP, 2021). The Western Balkans face an increasing risk of disaster and climate change that threaten both its population and territory, exacerbated by persistent vulnerabilities and inequalities. It has "a complex regional risk profile with almost all natural and human-made hazards, climate change impacts, and high environmental degradation and pollution, coupled with the legacy of past conflicts and interethnic tensions, as well as new and emerging security risks and threats" (Popovski et al., 2023: 11).

> During the past **20 years**, the region has experienced **118 natural hazards**—hydrological, meteorological and geophysical events—that have impacted more than **4 million people** and caused more than **US$6.6 billion** in damages.
>
> **Source:** Author's own elaboration based on Emergency Database EM-DAT data gathered on 08 September 2024 from https://www.emdat.be/.

[2] References to Kosovo shall be understood to be in the context of the United Nations Security Council Resolution 1244 (1999).

The region is highly exposed to a diverse range of natural hazards largely shaped by its complex topography, geological features and varying climatic conditions. Among these, climate-related hazards such as floods, storms, hail, drought, extreme temperatures and windstorms are the most frequent and severe, occurring with increasing intensity and magnitude. For example, in Southeastern Europe over the past five decades, floods have caused about 30 percent of deaths and more than half of all damages. Storms, meanwhile, have contributed to around 10 percent of damages, and extreme temperatures have been responsible for nearly 60 percent of deaths. Droughts have led to approximately 20 percent of damages of all damages related to weather, climate and water disasters (World Meteorological Organization, 2024). The rising number of wildfires presents serious threats to ecosystems, endangering nature, biodiversity and natural resources. In Southeastern Europe, these fires have been responsible for more than 10 percent of all damages caused by disasters related to weather, climate and water in the same period (World Meteorological Organization, 2024). Earthquakes, though less frequent, continue to be a major concern due to their potential for the widespread devastation of societies, communities, infrastructure and human lives.

Extreme weather is fast becoming the "new normal" in the Western Balkans (GFDRR, 2018), which considered a hotspot in Europe in terms of climate and other natural hazards. On average, the Western Balkans are considered highly vulnerable in most of the critical dimensions of climate resilience (World Bank Group, 2024). For example, the unprecedented floods during the past decade (i.e. in May 2014) resulted in US$2.4 billion in damages and losses in Bosnia and Herzegovina—nearly 15 percent of the country's gross domestic product (GDP) (Government of Bosnia and Herzegovina, 2014)—and $1.8 billion in Serbia, nearly 5 percent of the GDP there (Government of Serbia, 2014).

Smaller flooding events in North Macedonia in 2015 and 2016 resulted in $177 million (Popovski, 2022: 3), while a single earthquake event in November 2019 in Albania claimed $1.19 billion in damages and losses, nearly 6.4 percent of the 2018 GDP (Government of Albania, 2020). On the other hand, the escalating threat of wildfires is evident today in North Macedonia; in 2024, 132 wildfire incidents affected 95,214 ha (European Commission, 2024) of forest and woodland, approximately 3.6 percent of the total area of the country. This underscores the growing exposure and vulnerability of the region to such natural hazards.

These disasters often have transboundary impacts, given the sharing of river basins, forest ecosystems and seismic belts, making the risk reduction efforts from floods, wildfires, droughts and earthquakes a shared priority and requiring regional coordination in prevention, monitoring, forecasting, early warning, preparedness and response. On the other side, many smaller-scale emergencies, while less visible than large disasters, further erode the resilience fabrics of society and communities. These frequent, localized events (i.e. flash floods, landslides or localized droughts) strain the local critical infrastructure, disrupt livelihoods and deplete finite resources. The cumulative impact of smaller emergencies weakens local recovery capacity, exacerbates inequalities, deepens poverty and undermines long-term development; sustained attention, early intervention and strengthened community resilience are thus essential.

Human-made hazards include industrial, transport and maritime accidents; unexploded ordnance as remnants from past wars and conflicts; environmental degradation; former chemical waste and mining operations;[3] air, soil and water pollution; and more. Furthermore, numerous legacy hazardous sites—for instance, at the administrative boundary line between Kosovo and Serbia—are exposed to floods and other hazards; they serve as significant contributors to methane emissions and air pollution (World Bank Group, 2024: 22). In that sense, residents of the major urban agglomerates in the Western Balkans breathe air containing concentrations of pollutants up to five times higher than levels specified in domestic and European guidelines, resulting in 5,000 premature deaths annually directly attributable to air pollution (UNEP, 2021: 9).

Furthermore, according to Popovski (2021: 40), "the COVID-19 pandemic emphasized the absence of an adequate pandemic risk framework, expertise and related infrastructure," significantly strained the critical health infrastructure and further deepened existing vulnerabilities and inequalities while creating new ones. Despite rebounding strongly from the pandemic, the Western Balkans now face such challenges as rising energy and food prices, high inflation, and slowing trade and investment, all compounded by the war in Ukraine (World Bank, 2022b).

This disaster trend is projected to intensify as the effects of climate change become more pronounced, leading to more frequent and extreme weather events in most of the region, along with rising temperatures and shifting environmental conditions. The Western Balkans have been designated a "climate change hotspot", and the growing risks to communities, ecosystems and infrastructure will continue to exacerbate existing vulnerabilities and create new challenges for resilience-building efforts. Climate change in the region is anticipated to drive greater fluctuations in precipitation and extreme temperatures, which will, in turn, interact with changing soil conditions, shifting ecosystems and growing seasons, altered wind patterns, and worsening environmental stresses. These interlinked factors are expected to intensify the complexity, severity and unpredictability of climate-related shocks, with floods, droughts, wildfires, extreme temperatures and landslides becoming increasingly prominent threats (World Bank Group, 2024: 18). In this context, average summer temperatures could rise by 7.5 °C above pre-industrial levels, with more frequent heat waves affecting up to 80 percent of summer months in a 4 °C warmer world. Rainfall may decrease by 20–30 percent, leading to a 20 percent increase in drought days, which poses significant risks to agriculture and water availability. River discharges could decline by 45 percent by 2100, with winter and spring flood risks increasing, especially along major rivers. Health risks also are expected to rise, with heat-related mortality increasing by 20 percent alongside the potential spread of diseases such as dengue fever (World Bank, 2015).

Early warning systems context

In today's interconnected and crowded world and complex systems, the impacts of climate and disaster risks increasingly cascade across countries and territories, regions and sectors. The creation of risk outpaces risk reduction efforts due to increased underlying risk drivers such as poverty, inequality, climate change, rapid urbanization, demographic change, unsustainable use of natural resources, declining ecosystems and pandemics, among other factors. As systems are more cohesive, they also become more vulnerable, amplifying risks in a progressively unpredictable landscape. This complex situation poses challenges for sustainable and resilient development and calls for a systemic, coherent and comprehensive risk reduction approach that includes robust EWS to help mitigate impacts effectively, engaging multiple sectors and stakeholders at all levels. The Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC, 2021) recognizes multi-hazard early warning systems (MHEWS) and other disaster risk management activities as crucial adaptation options that amplify the benefits of other adaptation measures (World Meteorological Organization, 2023).

In the context of the Western Balkans, early warning systems (EWS) are essential tools for mitigating the adverse impacts of climate and disaster risks, safeguarding development gains and preventing humanitarian crises by enabling timely actions to protect lives, livelihoods and communities and minimize damages and losses. When functioning timely and effectively, these systems alert communities to impending natural and human-made hazards, giving them critical time to prepare and respond accordingly.

EWS are "integrated systems of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enable individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events" (UNDRR, 2017). EWS save lives, protect livelihoods, reduce disaster impacts, deliver significant financial benefits and contribute to achieving the objectives of the sustainable and resilient development frameworks (e.g. the Sendai Framework for Disaster Risk Reduction 2015–2030, the Sustainable Development Goals and the Paris Agreement). The benefits of timely, effective and efficient EWS are summarized in Table 1.

Multi-hazard early warning systems address several hazards and/or impacts of similar or different types in contexts in which hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, taking into account the potential interrelated effects.

Source: UNDRR (2017). Sendai Framework Terminology on Disaster Risk Reduction. Available at http://www.undrr.org/terminology/early-warning-system (accessed 29 August 2023).

Table 1   Early warning systems benefits

EWS protect lives and minimize impacts on those affected by disasters

Activating an EWS 24 hours before an event can save many lives (ILO, 2022).

Thanks to EWS, catastrophic mortality rates are thankfully history (Frost, 2023).

While climate-driven disasters increased by five times over 50 years, the number of deaths decreased by less than three times, thanks to improvements in early warnings and disaster risk management systems (Demir and Kim, 2022).

In Bangladesh, modern EWS reduced casualties from Cyclone Sidr in 2007 to 3,000, just 1 percent of the 300,000 deaths caused by the similarly powerful Cyclone Bhola in 1970, despite significant population growth (UNDP, 2018: 5).

EWS reduce economic impacts by minimizing direct damage and reducing the cost of disaster response and recovery

Activating an EWS 24 hours before an event can reduce damage by 30 percent, offering significant financial benefits with a ten-fold return on investment (ILO, 2022).

The Global Commission on Adaptation estimates that an investment of $800 million in EWS systems in developing countries could prevent annual losses ranging from $3 billion to $16 billion (World Meteorological Organization, 2023).

EWS provide time for industries, businesses and authorities to safeguard assets, shut down vulnerable operations or activate contingency plans.

EWS allow communities to prepare by harvesting crops early, moving livestock or securing equipment, helping protect their livelihoods from damage.

Depending on the hazard type and the overall response capacity of communities, EWS could bring investment returns up to 500:1 for flood-prone areas (e.g. Bangladesh), and 2,500:1 for heat waves in densely populated urban areas (e.g. Philadelphia), according to Teisberg & Weiher (2008).

EWS improve the resilience-building of society and communities

EWS enable emergency services, humanitarian organizations and government agencies to respond swiftly by pre-positioning resources, activating disaster teams and efficiently mobilizing relief operations, significantly reducing response times.

EWS are crucial in raising risk awareness by continuously monitoring and reporting hazards, keeping communities informed and prepared to take preventive action, and fostering a proactive approach to disaster management.

EWS foster a culture of preparedness, empowering communities to take proactive measures against disasters; combined with proper training and preparedness plans, this enhances resilience and reduces long-term vulnerabilities.

Disasters frequently cause cascading effects—e.g. floods leading to disease outbreaks or earthquakes damaging infrastructure—and EWS help mitigate these secondary impacts by enabling authorities to prepare for follow-up risks, such as mobilizing medical teams and preparing shelters.

An effective EWS fosters trust among the public, government and disaster response agencies, encouraging people to follow warnings, while also enhancing coordination among various levels of government, regional partners and international bodies for improved outcomes.

Incorporating EWS into long-term development planning helps ensure that investments are designed with hazard risks in mind. This approach minimizes future vulnerabilities, contributes to climate change adaptation, promotes sustainable growth and strengthens the resilience of economies against future risks and uncertainties.

EWS protect sustainable and resilient development gains.

EWS contribute to the increased resilience of countries and territories and help ensure alignment and progress with regard to sustainable and resilient development frameworks such as the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction and the Paris Agreement.

By implementing and strengthening EWS, countries and territories fulfil these commitments and contribute to global disaster resilience efforts.
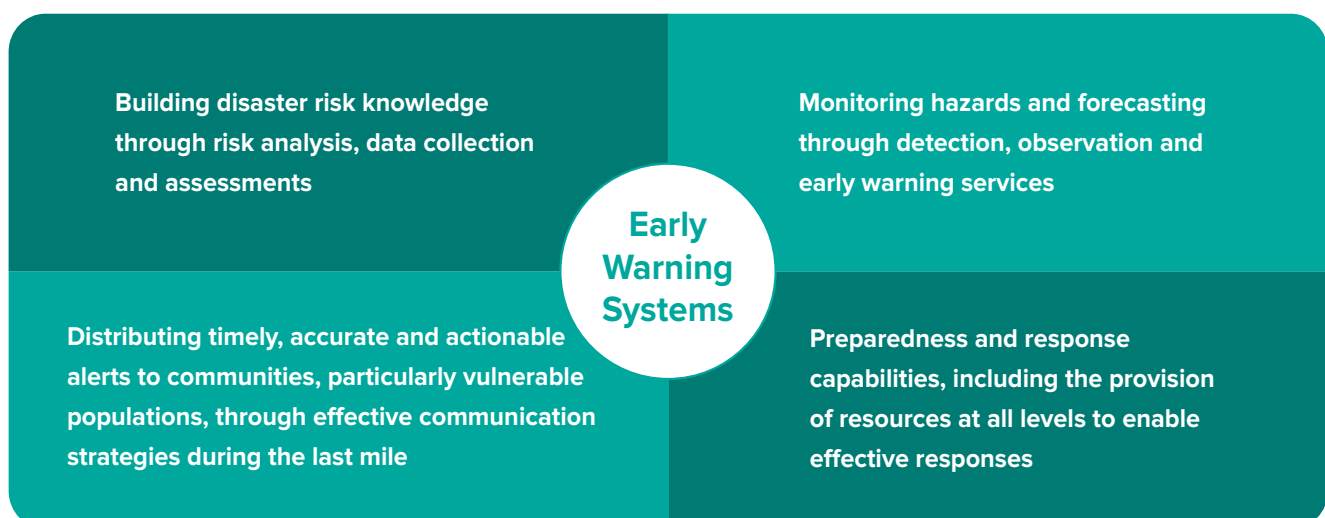
Nevertheless, there are many challenges to streamlining EWS among countries and territories globally. Today, one-third of the world's population, mainly in the least-developed countries, are still not covered by EWS (ILO, 2022). In Europe and Central Asia, just 55 percent of the countries and territories declared the existence of MHEWS in 2023, whereas on the global scale, two-thirds of WMO members reported having fully operational warning and alerting services and more than half incorporate hazard, exposure and vulnerability information in their warning products. However, less than one-third of countries reporting on Indicator G4 (percentage of local governments having a plan to act on early warnings) indicated "substantial progress" towards achieving MHEWS (UNDRR and WMO, 2023). Many of these challenges across the four thematic pillars of EWS have been identified during this stakeholder mapping exercise in the Western Balkans countries and territories and will be elaborated in the text.

The Midterm Review of the Implementation of the Sendai Framework shows progress but identifies gaps, including a lack of community-based systems, ineffective communication and a failure to tailor systems to local contexts. To speed up implementation, United Nations Member States should focus on mobilizing resources, technology and capacity for an inclusive EWS, with guiding strategies that integrate local knowledge and governance arrangements across all phases while addressing the needs of higher-risk groups (UNDRR and WMO, 2023).

EWS must be adaptable, addressing multiple hazards independently or simultaneously (multi-hazard), and comprehensive, encompassing all phases from hazard detection to response (across all phases). These systems should prioritize the needs of people to ensure timely and effective action (people centred), while also being resource efficient and integrated with broader disaster risk reduction efforts. Inclusivity and participation are essential, fostering cooperation across sectors and ensuring active community involvement throughout the MHEWS value chain. By empowering communities to anticipate hazards and understand risks, people-centred EWS enhance preparedness and enable timely responses. A well-functioning EWS is built on four key components (Figure 1).

These four components, according to the UNDRR, "need to be coordinated within and across sectors and multiple levels for the system to work effectively and to include a feedback mechanism for continuous improvement. Failure in one component or a lack of coordination across them could lead to the failure of the whole system" (UNDRR, 2017). Accordingly, the four thematic areas of EWS are identified for this stakeholder mapping exercise as the following: disaster risk knowledge, monitoring and forecasting, warning dissemination and communication, and preparedness and response capabilities.

Figure 1   Four key components of early warning systems

Building disaster risk knowledge through risk analysis, data collection and assessments

Monitoring hazards and forecasting through detection, observation and early warning services

Early Warning Systems

Distributing timely, accurate and actionable alerts to communities, particularly vulnerable populations, through effective communication strategies during the last mile

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

Purpose and approach of this document

This document summarizes the findings of the EWS stakeholder mapping exercise in the Western Balkans by identifying key stakeholders, assessing the disaster risk reduction 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. The methodology and approach follow the framework of a similar exercise conducted in 2023 for Central Asia, and this report is complementary to the extensive efforts to understand the EWS value chain context in the broader Europe and Central Asia region.

An **early warning system value chain** is a chain of expertise and information sources linked together to generate and share information. This helps ensure effective responses to potential threats and allows information to flow in both directions. Stakeholders play a pivotal role in the chain, working together to bolster resilience, ensure swift responses and safeguard communities from disasters.

Source: Source: Popovski V and Menchise C (2024). UNDP. Available at https://www.undp.org/eurasia/blog/staying-ahead-disaster-mapping-early-warning-systems-central-asia (accessed 18 April 2025).

EARLY WARNING SYSTEMS STAKEHOLDERS IN THE WESTERN BALKANS

Categories of early warning system stakeholders and their roles and functions in the four thematic areas

The departing point in the operationalization of the EWS value chain is the identification of the key stakeholders, along with an assessment of the existing architecture built around their competencies. These stakeholders span the four thematic areas of EWS, playing integral roles at various stages of the system's development and functioning. Based on their roles and responsibilities within this value chain, stakeholders can be organized into three key categories: central, regional/local and international.

At the central level, key stakeholders encompass government committees and commissions, ministries, disaster management authorities, specialized technical institutions, academic and research institutions, private-sector entities, associations and non-governmental organizations. Each of these stakeholders operates under well-defined mandates and areas of expertise, contributing to the broader domestic disaster risk management system, and their distinct competencies and functions are directly aligned with their designated roles and responsibilities within the overarching framework of the four EWS thematic areas. Their involvement is crucial for policy and strategic planning and supervision, the implementation of measures and actions across the four thematic areas, and the coordination of resources within the EWS.

Regional and local stakeholders—such as regional and local government authorities, community-based organizations, communities and local non-government organizations—are vital to ensuring that EWS are not only implemented but also adapted to the unique needs and vulnerabilities of specific regions and areas. They not only serve as initial responders but also evolve into proactive prevention and mitigation agents. Their proximity to affected communities allows for more responsive and contextually appropriate actions, facilitating timely local-level early warning and alerting dissemination, comprehensive preparedness and timely and efficient response.

International actors—including various United Nations agencies, regional and multilateral organizations, international financial and multilateral financing entities, donor organizations, and international and regional non-governmental organizations—provide essential support in the form of technical expertise, financial resources and cross-border and global collaboration. Collectively, these entities function as development partners, actively contributing to the promotion of the overall resilience-building of the countries and territories including the EWS. Their involvement enhances the capacity of central and local systems by bringing in global best practices, facilitating knowledge transfer and ensuring that EWS efforts are aligned with international and regional cooperation frameworks. This multitiered collaboration strengthens the EWS value chain at every level, ensuring a cohesive and well-supported approach to reducing climate and disaster risks.

Following the EWS stakeholder mapping matrix introduced with the mapping exercise in Central Asia,[4] this analysis categorizes the key stakeholders in the Western Balkans into three clusters, with 15 categories and 96 stakeholders in all involved in the EWS value chain. Table 2 below details the regional categorization of EWS stakeholders. This comprehensive list was evaluated against the competencies within the four thematic areas, along with their primary functions and roles. This process verifies a diverse range of stakeholders involved in the EWS chain and supports the expansion of the Early Warnings for All initiative to Western Balkan countries and territories. This mapping exercise was conducted specifically for the objectives of this assignment and does not preclude the existence of other entities within its frameworks. It provides a solid foundation for ongoing mapping and updates, potentially incorporating new entities as they arise.

Table 2 Early warning systems stakeholder categories and functions in the four thematic areas in the Western Balkans

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
I. CENTRAL LEVEL				
I.1 Central-level systems, government bodies	I, NG		I, NG	I, NG
I.2 Disaster management agencies	CD, I, TS, NG, F	CD, I, TS	CD, I, TS, NG, F	CD, I, TS, NG, F
I.3 Key ministries				
Internal affairs, defence	CD, I, TS, NG	I, TS	I, TS	CD, I, TS, NG
Agriculture, health, water management/resources, environment/natural resources	CD, I, TS, NG	CD, I, TS, NG	CD, I, TS, NG	CD, I, TS, NG
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
I.4 Key agencies/services/technical institutions				
Hydrometeorological services, seismological services, public health centres, veterinary control	CD, I, TS	CD, I, TS, F I, F	CD, I, TS	I, TS
Transport/infrastructure entities	CD, I, TS	NG	I, F	CD, I, TS, F
Regulatory bodies, e.g. electronic communications/energy/insurance	TS		NG	
Statistics agencies	TS			TS
I.5 Academia/research and development institutions				
Universities, education facilities, research and development organizations, innovation hubs/incubators	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
I.6 Private sector associations/entities				
Telecommunications/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	I	I
Insurance associations/companies	CD, I, TS			
I.7 Insurance associations/companies				
Red Cross/Red Crescent Societies	CD, I, TS, F	I	CD, I, TS, F	CD, I, TS, F
NGOs	CD, I		CD, I	CD, I
Mountain rescue services	CD, I	I	CD, I, TS	CD, I, TS, F
Scouts	I		I	CD, I
II. LOCAL LEVEL				
II.1 Regional/local governments	I, NG, F		I, NG, F	I, NG, F
II.2 Local NGOs/CBOs	CD, I, TS		I	CD, I, TS
II.3 Communities	I		I	I
III. INTERNATIONAL LEVEL				
III.1 United Nations and multilateral agencies/organizations				
UNDP	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
UNICEF	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
FAO	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
WHO	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
European Union	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
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
UNOPS	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS
UNECE	CD, I, TS, F		I, TS	TS
WMO	TS	CD, I, TS, F	CD, I, 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
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

CATEGORIES OF EWS STAKEHOLDERS AND TITLE	RISK KNOWLEDGE	MONITORING & FORECASTING	WARNING & DISSEMINATION	PREPAREDNESS & RESPONSE
UNOSAT	CD, TS	CD, TS	CD, TS	CD, TS
WFP	TS			I, TS, F
UNITAR	CD			CD
IUCN	CD, I, TS, F			
NATO	CD, I, TS, F	CD, I, TS	CD, I, TS	CD, TS, F
IAEA	CD, I, TS, F	CD, I, TS, F	CD, I, TS	CD, I, TS, F
III.2 Regional and multilateral organizations/technical agencies				
DPPI SEE	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS
Regional Cooperation Council	CD, TS		CD, TS	CD
Western Balkans Fund	F			F
III.3 International financial institutions/multilateral financing entities				
EBRD, EIB, WB, IDB, GCF, IFAD, GEF, KfW	F	F		
III.4 Donors/technical agencies				
Japan/JICA, Germany/GIZ	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F	CD, I, TS, F
China	CD, I, TS, F	F		CD, I, TS, F
CIMA research foundations	CD, I, TS	CD, I, TS	CD, I, TS	CD, I, TS
Sweden/SIDA	TS, F		F	F
Switzerland/SDC/SECO	F	F	F	F
USA/USAID	F		F	F
French ODA	F		F	
United Kingdom of Great Britain and Northern Ireland/UKAID	F			F
III.5 International and regional NGOs/associations				
IFRC	CD, I, TS, F	I, TS	CD, I, TS, F	CD, I, TS, F
ACTED	CD, I, TS			CD, I, TS
GEO	I, TS			I, TS
Helvetas	CD, I			CD, I
Médecins Sans Frontières	I			I
GSMA			CD, TS	
CARITAS				CD, I
Catholic Relief Services				CD, I
Friedrich Ebert Foundation	CD			
Friedrich Naumann Foundation for Freedom	CD			

Source: Author's own elaboration.   **Note:** The functions and roles shown here 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

General disaster risk management and early warning system contexts in the Western Balkans

The current EWS in the Western Balkans encompass the intersection of disaster risk management, EWS and climate change adaptation, including the operation of MHEWS. These systems include policies and regulatory guidance, institutional frameworks, communication, coordination and collaboration, availability of resources, and regional cooperation. Nevertheless, while EWS provide relevant warning and alerting information, their scope remains limited. As in Central Asia, these systems primarily focus on monitoring and forecasting, often neglecting the critical aspects of identifying emerging risks, ensuring effective communication channels and strengthening overall preparedness and response capabilities. This fragmentation of the EWS value chain narrows the system's focus to imminent threats, rather than addressing the potential risks that could impact societies and hinder proactive action. As a result, integrating EWS with broader disaster risk management strategies remains a significant challenge.

This stakeholder mapping analysis highlights key challenges in domestic and regional disaster risk governance and across four thematic areas. At the governance level, issues include incomplete domestic frameworks—such as gaps in policies, regulations and institutional structures—and insufficient coordination and cooperation among stakeholders. Specifically, the thematic areas reveal an insufficient understanding of existing and systemic risks and anticipation of emerging ones, in addition to limited attention paid to social and economic vulnerabilities. Other issues include data availability and sharing, gaps in monitoring and forecasting due to limited capacities and services, underutilization of digital solutions and new technologies, and insufficient stakeholder engagement in warning dissemination and risk communication, with the inexistence of action-related warnings. Additionally, the private sector's involvement in EWS is not fully realized, and disaster preparedness and response planning, particularly for at-risk communities, is insufficient.

Therefore, it is essential to view early warning as a long-term strategy aimed at reducing community vulnerability and to integrate it effectively with disaster risk reduction and climate change adaptation efforts.

Each country and territory in the Western Balkans has established key policy and regulatory frameworks for disaster risk management. These documents not only enhance risk reduction, including EWS, but also support development and align with global sustainability and resilience mechanisms such as the Sustainable Development Goals, the Sendai Framework and the Paris Agreement. **Albania** and **Kosovo** have recently adopted disaster risk reduction strategies, while **Serbia** and **Montenegro** are finalizing theirs. However, **Bosnia and Herzegovina** and **North Macedonia** have yet to start this process.

The National Disaster Risk Reduction Strategy (NDRRS 2023–2030)[5] of Albania aims to enhance EWS, including obligations under the Union Civil Protection Mechanism, improving wildfire alerts, establishing an impact-based EWS for climate resilience, and strengthening flood risk assessments. The strategy for reducing risk from natural and other disasters (2023–2028)[6] of **Kosovo** emphasizes investment in scientific capabilities for generating and analysing disaster warnings. In Serbia, the draft Disaster Risk Reduction Strategy and Management of Emergency Situations in the Republic of Serbia (2023–2030)[7] includes a specific measure for advancing EWS to improve disaster response preparedness. Lastly, the draft version of the National Strategy for Disaster Risk Reduction for the period 2025–2030 with an Action Plan for 2025–2026[8] of Montenegro focuses on developing a modern EWS using video surveillance and advanced monitoring equipment.

Each country or territory in the Western Balkans has established legal frameworks for disaster risk management, detailing the competencies and responsibilities for the EWS, within both thematic and sectoral laws such as hydrometeorological and seismological services. Notable examples include the cases from **Serbia** and **Albania**. The Law on Disaster Risk Management and Emergency Situation Management (2018)[9] of **Serbia** outlines operational aspects and responsibilities for early warning, notifications, and the 112 operational centres and the Albanian Law on Civil Protection (2019)[10] includes also provisions for disaster loss data and processing and providing alerts for persons with disabilities. The Law No. 04/L-027 for protection against natural and other disasters[11] in **Kosovo** establishes the legal basis for a unique notification and warning system managed by the Ministry of Internal Affairs, detailing such elements as monitoring networks, emergency notification centres and warning. In **Montenegro**, the Law on Protection and Rescue[12] includes measures for information and warning, including 112 operational centres, alerting and warning signals. In **Bosnia and Herzegovina**, early warning as monitoring and alerting are managed by entities under specific laws—in the Federation of Bosnia and Herzegovina, through the Law on the protection and saving of people and materials goods from natural and other accidents[13] and in Republika Srpska through the Law on Protection and Rescue in Emergency Situations,[14] with the Framework Law on the protection and rescue of people and property in the event of natural or other disasters in Bosnia and Herzegovina[15] regulating the Communication Centre. In **North Macedonia**, the Law on Crisis Management[16] incorporates early warning as part of the crisis management framework, defining roles for the Crisis Management Centre in informing and alerting. These laws collectively enhance disaster preparedness and response across the region.

Over time, the importance of EWS has been increasingly recognized in domestic development strategies, documents related to the United Nations Framework Convention on Climate Change (UNFCCC)[17] (national climate change communications and national adaptation plans) and some key sectoral strategies. A notable example is the National Development Strategy (2022–2042) of **North Macedonia**, which prioritizes a functional EWS within the strategic area "secure, safe and resilient society".[18] This approach aims to enhance resilience through improved risk understanding, monitoring, forecasting and communication, ensuring timely and accurate alerts that are inclusive of gender and disabilities, using various technologies and data sources with impact-based forecasting. Similarly, the National Strategy for Sustainable Development of Montenegro by 2030 plans to establish an EWS for mitigation of natural and anthropogenic hazards impacts.[19]

Integrating EWS into UNFCCC-related policies is increasingly seen as one of the key adaptation measures. The **Albania** Fourth National Communication on Climate Change (2022)[20] emphasizes the need for comprehensive EWS for disaster prevention and climate monitoring, focusing on effective communication and multi-hazard warnings, including floods. The **Bosnia and Herzegovina** Fourth National Communication under the United Nations Framework Convention on Climate Change (2021)[21] highlights developing EWS to safeguard health from climate impacts and improve flood forecasting and torrential information systems. The Third National Communication on Climate Change (2020)[22] from **Montenegro** calls for updating EWS across sectors: forestry (fires and hydrometeorological hazards), agriculture (droughts), coastal areas (floods and storm surges) and health (vulnerable populations). Finally, the Fourth National Climate Change Communication (2023)[23] from **North Macedonia** stresses the importance of innovative early warning solutions to mitigate loss and damage. Collectively, these efforts enhance risk understanding, monitoring, forecasting and communication for better adaptation.

EWS are vital adaptation measures integrated into national plans to strengthen climate resilience and reduce climate-related disaster impacts. For example, the **Albania** National Adaptation Planning to Climate Change Framework (2021)[24] emphasizes upgrading civil defence and disaster risk reduction through enhanced EWS under Priority Action 14. From **Bosnia and Herzegovina**, the National Adaptation Plan (2021)[25] calls for better synergy between early warning institutions and public health bodies to address rising climate-related events such as floods and extreme temperatures. These systems are crucial for agriculture (weather extremes), forestry (wildfire alerts) and public health (ultraviolet radiation and air/water quality monitoring). In Serbia, the Climate Change Adaptation Programme for 2023–2030[26] outlines upgrades to its meteorological and forecasting systems to improve early warnings and to upgrade the capacities of the Regional Hydrometeorological Service of Serbia for better forecasting and delivery of climate products. On the other hand, **Montenegro** is finalizing its National Adaptation Plan, **North Macedonia** has not started the process, and **Kosovo** is developing a new Climate Change Adaptation Strategy.

EWS also are increasingly prioritized in key development sectors across the Western Balkans. In **Albania**, the National Strategy of Water Resources Integrated Management 2018—2027[27] includes the establishment of an EWS. In **North Macedonia**, the Food Safety Strategy 2021—2025[28] advances food security, with national monitoring and EWS to protect critical food and water infrastructure. Also, the country's Spatial Plan of the Republic of North Macedonia 2021–2041 identifies MHEWS as key to societal resilience. The **Serbia** Water Management Strategy (until 2034)[29] emphasizes monitoring and forecasting hydrometeorological events, including flood forecasting and early warning. In **Kosovo**, the Water Strategy (2023—2027)[30] incorporates early warnings for drinking water protection, and in **Montenegro**, the National Drought Monitoring Plan (2020)[31] calls for advanced monitoring and a unified EWS, highlighted by a drought early warning project in collaboration with the Plantaže winemaking company and the Institute of Hydrometeorology and Seismology of Montenegro.

The institutional framework for disaster risk management assigns early warning responsibilities to a variety of entities, including disaster management agencies, hydrometeorological services, seismological institutes and key ministries such as environment, health and agriculture, as well as municipalities and public enterprises. However, broader stakeholder involvement in disaster risk reduction remains fragmented, with insufficient participation from academia, research and development institutions, donors, NGOs, and local communities. In addition, the potential contributions of the private sector often are overlooked despite their resilience-building potential in knowledge, expertise and resources. This fragmentation, along with inadequate procedures and insufficient capacities at both central and local levels, hinders effective prevention, preparedness and response to the needs of communities and populations.

The existing national disaster risk reduction platforms in the Western Balkans—in **Bosnia and Herzegovina**,[32] **Montenegro, North Macedonia** and **Serbia**—are not effectively contributing to societal resilience. To improve, these platforms need to actively involve a wider range of stakeholders and enhance their focus on early warning and response systems. On the other hand, with the support of UNDRR, the Central Bosnia Canton[33] in the Federation of Bosnia and Herzegovina established a cantonal disaster risk reduction (DRR) platform (UNDRR, 2022) as a permanent consultative body, providing a community space to identify and launch DRR activities, raise awareness of community risk drivers, and support resilience initiatives, as well as to integrate DRR into local strategic and financial frameworks.

Disaster risk management in the Western Balkans remains underfunded and largely reactive, focusing more on post-disaster responses (ex post financing) rather than proactive, pre-event financing (ex ante). For instance, for its National Disaster Risk Management Programme Action Plan, Serbia allocated EUR 320,000 from its national budget and secured EUR 62.4 million in international aid and loans but faced a funding gap of over EUR 1 billion (European Union Civil Protection, 2019: 31).

Extreme heat in 2018 led to hundreds of fires across the Balkans and a drought in Serbia that dropped agricultural output by 10 percent and forced Albania to spend EUR 200 million on energy imports (Van Gelder, 2018). Similarly, firefighters in North Macedonia operate with limited funding; municipal expenditures on fire protection rank sixth among 12 local jurisdictions, with just EUR 33,000 allocated for protection and rescue services (Popovski, 2020a). At the end of 2020, a series of shocks—climate-related natural disasters, earthquakes, the pandemic and the energy crisis—led to elevated debt levels (World Bank Group, 2024: 15).

The countries and territories in the Western Balkans face significant challenges due to the absence of established risk financing tools—leaving them financially unprepared and susceptible to disasters, economic shocks and unforeseen crises—as their governments have not established clear strategies or appropriate instruments to introduce ex ante risk financing mechanisms (Kim et al., 2024). Securing consistent funding for EWS is critical for disaster preparedness but remains a significant challenge, often leading to gaps in coverage and technological advancements. These systems largely rely on government budgets, grants and loans, but the absence of stable, long-term funding weakens their effectiveness.

Some budget contingency reserves for disaster management do exist within central and local budgets. For example, in **North Macedonia**, these reserves equal 3 percent but are predominantly used for response and immediate recovery. On the other hand, **Albania** has on-budget contingency lines, regular budget accounts managed by a designated agency that typically lapse at the end of the year and usually do not allow for the investment of idle resources—e.g. the Reserve Fund of the Council of Ministers; the Civil Emergencies account (budget line 10910); the reserves of line ministries, agencies and local governments; the Solidarity Fund and the State Reserve (World Bank, 2020).

The countries and territories in the Western Balkans can enhance their disaster resilience and reduce their long-term vulnerability by allocating resources to EWS, infrastructure improvements and disaster preparedness programmes (Kim et al., 2024).

Regional cooperation and advocacy are essential for strengthening all aspects of the EWS value chain across thematic areas. Although a regional MHEWS is not yet in place, several initiatives promote prevention and preparedness. These include the Disaster Preparedness and Prevention Initiative for South Eastern Europe,[34] the Southeast European Multi-Hazard Early Warning Advisory System[35] and the Drought Management Centre for South-East Europe.[36] Other notable programmes include the Sava River Basin Flood Forecasting and Warning System[37] and the Danube River Basin international flood warning system,[38] which provides up to 10 days of lead time for large floods. Additionally, the Early Warnings for All initiative,[39] launched in 2022, aims to enhance disaster and climate event warnings in the Western Balkans through regional cooperation (Goering, 2023) via the DisasterAWARE platform[40] (World Bank Group, 2024). Resilience-building efforts also include early warning projects for transboundary river basins such as the Drini and Drina rivers or flood and earthquake resilience through flood and seismic risk assessment (Global Earthquake Model Foundation, 2025). A specific example of regional cooperation is the Agreement on Cooperation in Protection Against Disasters in the Western Balkans under the auspices of the Open Balkan initiative[41] currently adopted by Albania, North Macedonia and Serbia.

Finally, given the aspirations of all countries and territories from the Western Balkans for European Union membership, integration with its civil protection mechanism and institutions is essential for streamlining the domestic systems with the European Union resilience objectives and goals. In that sense, cooperation with the European Union Civil Protection Mechanism,[42] the European Flood Awareness System[43] or the European Forest Fire Information System;[44] access to the Emergency Response Coordination Centre;[45] or advancing the scientific part of EWS with the Joint Research Centre[46] is crucial on the membership pathway. In addition, this resilience-building cooperation has resulted in several regional Instrument for Pre-accession Assistance (IPA) project initiatives, such as the completed Programme for Disaster Risk Assessment and Mapping,[47] IPA Floods and Fires,[48] or the ongoing IPA CARE Programme on the capacity for risk management of earthquakes and health emergencies in Türkiye and the Western Balkans.[49]

Beyond these domestic and regional efforts, these countries and territories also have joined forces to strengthen the cross-border adaptation capacities and EWS, recognizing the cross-border impacts of these climate events. For instance, all institutions participating in the **Serbia** EWS actively engage with similar services in other countries through official communication channels, such as with **Montenegro** for forest fires and with **Croatia** and **Bosnia and Herzegovina** for floods (European Union Civil Protection, 2018: 38).

In addition, there is a series of cross-border projects for enhancing EWS in participating countries and territories:

- Construction of systems for the prevention and early warning of floods[50] between North Macedonia and Bulgaria;

- Setting up of a System for Prevention and Early Warning of Floods[51] between Serbia and Bulgaria;

- Flood Shield[52] between North Macedonia and Greece;

- Development and implementation of a smart and sustainable integrated forest fire management system in the cross-border area[53] between North Macedonia and Albania; and

- Disasters do not know borders 2[54] between Montenegro and Albania.

These examples of fruitful and active project cooperation emphasize the need for closer cooperation and comprehensive regional EWS for timely warnings and responses.

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). Met Office. Available at https://www.metoffice.gov.uk/research/approach/collaboration/wcssp/insights/accelerating-impact-based-forecasting (accessed 9 September 2024).

All countries and territories are committed to the Sendai Framework for Disaster Risk Reduction 2015–2030, but not all provide updates on their progress. So far, only Bosnia and Herzegovina[55] and Montenegro[56] have submitted voluntary national reports for the midterm review of the framework's implementation. Regarding Global Target G[57] to substantially increase the availability of and access to MHEWS and disaster risk information and assessments by 2030, the reporting status in the Sendai Framework Monitor[58] is as follows: for 2023, **Serbia** and **Montenegro** are still in the process of reporting (UNDRR, 2025a). In 2022 and 2023, **Albania** reported on all relevant indicators, while **Serbia** and **Montenegro** reported on some indicators (UNDRR, 2025b, 2025c). In that context, 32.59 percent (2023) of the Albanian population is exposed to or at risk from disasters protected through pre-emptive evacuation following early warning. Only Bosnia and Herzegovina and North Macedonia have not submitted reports to the Sendai Monitor, whereas Kosovo, which is not a member of the United Nations, does not have an obligation to submit reports to the Sendai Monitor.

Impact-based EWS are not yet widely integrated into policies and practices in the region due to several challenges, including policy and regulation barriers, data gaps, insufficient cooperation, limited availability of technological solutions, financial constraints and limited knowledge among practitioners. Nevertheless, good practices in the initiation of this approach are identified in **Albania**, as the country's National Disaster Risk Reduction Strategy NDRRS 2023–2030 includes building a multi-risk impact-based EWS for early action (Republic of Albania, 2023), and **North Macedonia**, as the country's **National Development Strategy 2022–2042** includes impact-based forecasting as the main foundation of the transformed EWS and related processes.

Photo: UNDP Bosnia and Herzegovina

Consequently, based upon the extensive review of the countries and territories in the Western Balkans and the feedback provided by key informants in the online survey, the gaps and challenges related to disaster risk management and EWS can be summarized as the following:

The overall disaster risk management in the six countries and territories remains largely reactive, prioritizing preparedness and response rather than proactive prevention and disaster risk mitigation.

Like in many other regions globally, the early warning process is fragmented, lacking recognition and integration across its four thematic areas and the inclusion of natural and human-made hazards within this profile (e.g. biological hazards or industrial accidents).

Key informant statement:
"The legal basis does not sufficiently support the implementation of EWS."

Current policy and regulatory frameworks fail to prioritize the development of MHEWS as timely and effective solutions for enabling early actions for saving lives and minimizing the adverse impacts of disasters.

Even though there are good practices related to the integration of EWS into key strategies and policies, there remains a need for better integration in both policy development and decision-making processes. EWS are considered one of the most effective "no-regret" solutions for building resilience and need to be fully streamlined to ensure long-term risk-informed development.

Institutional structures do not fully cover the entire EWS value chain, from hazard detection to response. Moreover, some of the key stakeholders—such as the private sector, NGOs, academia, research and development institutions and local communities—often are either not recognized or are excluded, weakening the effectiveness of these systems.

The lack of dedicated and sustained funding for the functioning and development of EWS results in fragmented systems that are inconsistently maintained or upgraded, leading to delayed warnings and information. This also limits multi-crisis preparedness, inclusive participation and the effective dissemination of warning information to all, further weakening the overall effectiveness of early warning mechanisms.

A regional EWS has not been fully established, overburdening cross-border/administrative boundary line cooperation and information dissemination across the region and resulting in fragmented, delayed or ineffective processes and actions. Furthermore, the absence of this cooperation framework hinders the potential for shared capacity development, knowledge and learning and a coordinated approach to EWS.

Impact-based early warning and forecasting are still in the early stages of development and have not been widely implemented across the region. Expanding these systems is critical to improving disaster preparedness and response.

Irregular or incomplete reporting on the alignment of the Sendai Framework hinders the understanding of the progress in alignment and overall resilience-building efforts, including EWS.

Consequently, to strengthen disaster risk management and enhance EWS value chains, these countries and territories must shift towards proactive risk reduction, update policies and regulations, enhance institutional inclusivity, secure consistent funding and foster greater regional collaboration. Additionally, integrating impact-based early warnings and risk information into broader development frameworks will be key to building long-term resilience.

Disaster risk knowledge

Understanding the existing and emerging risks is the departing point in building timely and actionable EWS. Disaster risk knowledge is the foundational pillar of effective early warning and "informs many of the actions and activities within the other pillars, from guiding which hazards need to be monitored to planning public awareness campaigns about hazards and responses to mitigate negative impacts" (UNDRR and WMO, 2023: 44). In that sense, the risk assessments and scenarios are the main input for the dissemination of warning and alerting information to everyone in at-risk communities and to the building of capacities for preparedness and response. Despite the critical importance of disaster risk knowledge, just 22 percent of countries globally report having accessible, understandable, usable and relevant disaster risk information and assessments available to people at central and local levels (Sendai Framework Monitor Indicator G-5) (UNDRR and WMO, 2023). This also means that there are significant gaps in terms of risk information and assessment globally. Only Albania from the region has initiated reporting on this indicator.

Over the past decade, the countries and territories in the Western Balkans have made significant steps in understanding and assessing risks, especially following major disaster events. They have worked to align their risk and hazard assessment practices with European Union guidelines, updating domestic assessments and advancing these efforts at local levels. This marks a shift from a reactive stance to a proactive approach focused on prevention, emphasizing early intervention and risk reduction to mitigate potential hazards before they escalate.

This transformation aims to enhance disaster resilience by integrating risk assessments into development planning. Adopting European Union standards helps ensure that these assessments and corresponding measures are standardized and effective throughout the region. These policies and regulations facilitate the multi-hazard, multi-risk and multisector assessment usually led by disaster management agencies and in cooperation with key institutions at central and local levels. Nevertheless, some of them, such as National Meteorological and Hydrological Services (NMHSs), might lack the competencies, knowledge and resources for risk and hazard assessment. Therefore, it is crucial to include all entities and at-risk communities and share these assessments with all key stakeholders involved in the early warning process to streamline the EWS value chain. In that sense, a good practice is identified in **Montenegro** with its development of the 2023 Assessments of Disaster Risk Management Capabilities,[59] which broaden the risk assessment process by assessing the administrative, technical and financial capabilities of the involved institutions and stakeholders in the system. However, challenges remain, including incomplete risk understanding, lack of anticipation of emerging risks and threats, limited understanding of the systemic nature of risk, insufficient focus on vulnerabilities and difficulties in integrating the root causes of disasters into risk and hazard assessments, limited data availability and sharing, and inadequate community engagement.

Good practices related to methodological approaches are identified in all countries and territories, with the distinction of North Macedonia[60] and Serbia.[61] Except for North Macedonia, other countries and territories—Albania,[62] **Bosnia and Herzegovina** (Federation of Bosnia and Herzegovina[63] and Republika Srpska),[64] Kosovo,[65] Montenegro[66] and Serbia[67]—have published their own risk and hazard assessments. **North Macedonia** has established a best practice in digitalizing risk and hazard assessments through its E-Assessment Platform.[68] This platform facilitates the unified preparation and updating of assessments for the state and the local government units in North Macedonia, including 80 municipalities and the city of Skopje. Designed with a bottom-up approach, local assessments are conducted first, allowing for a synthesized national analysis and assessment (Popovski, 2022). Local risk assessments establish a solid evidence base for the national risk assessment system to identify capabilities and needs across the country (European Union Civil Protection, 2018: 41). Another good practice related to local-level risk and hazard assessment is the case of the municipality of Kraljevo in **Serbia**, where the process for the creation of the local disaster risk assessment is presented on the website of the Civil Protection Unit.[69] The whole process is presented in steps with information and documents attached, helping ensure greater visibility and transparency for the risk assessment.

With regard to central Geographic Information System (GIS) databases to store disaster risk data and information, practices are different across the region. Some countries and territories have established similar systems, while others still have not embarked on the centralization of data and information for spatial and visual presentation. In that sense, the INSPIRE Directive[70] is under implementation in the Western Balkans. It establishes the basis for multi-hazard, multi-risk and multisector spatial infrastructure; facilitates the sharing of spatial information among public-sector organizations; enhances public access to spatial data; and assists in cross-border policymaking. In **North Macedonia**, the National Spatial Data Infrastructure Geo Portal[71] was established to provide the review and use of geospatial data via web-oriented services and interoperable infrastructure. As part of this platform, the Crisis Management Centre provides spatial data related to natural risks (e.g. floods, landslides, avalanches, forest fires and earthquakes).

The Disaster Risk Register[72] in **Serbia** is an interactive geographic database managed by the Ministry of Internal Affairs Sector for Emergency Management in collaboration with key institutions. The register contains essential data for disaster risk management, including physical and geographical information, population exposure and vulnerability, infrastructure details, past disaster impacts and hazard characteristics. Some data, while publicly accessible, are protected by regulations. Additionally, the Beyond Landslide Awareness (BEWARE) project[73] has standardized the post-event landslide database through the BEWARE GIS web portal,[74] facilitating data unification, enhancing municipal land-use planning, identifying critical rehabilitation sites and updating the national landslide database. Two GIS web portals in **Bosnia and Herzegovina** have improved risk understanding. The Disaster Risk Analysis System[75] provides free access to flood, landslide and earthquake hazard data, enhancing local disaster risk awareness. The portal features Google Maps hazard overlays, information on vulnerable populations, and tools for spatial risk assessments for local authorities. Meanwhile, the Vrbas GeoPortal[76] offers flood hazard maps, a flash flood sensitivity model, landslide and torrential stream cadastres, real-time hydrometric measurements, and a participatory GIS tool for local flood risk management.

In response to unprecedented floods over the past decade, flood risk is thoroughly addressed through assessments, hazard and risk maps, and management plans at the national and transboundary river basin levels. These products are in the process of integration into ongoing risk assessments and key development policies across many countries and territories. Understanding of landslides and earthquakes is improved through landslide susceptibility maps, seismic zoning, vulnerability assessments and the mapping of at-risk areas. The CRISIS project[77]—involving **Albania**, Greece, Italy and **North Macedonia**—has facilitated cross-border multi-hazard assessments, harmonized seismic and landslide hazard cross-border mapping, supported the cross-border risk assessment of basic services and transport infrastructure, and created a cross-border database platform for risk and emergency management.

A notable initiative is the establishment of Forest Fire Information Systems, supported by the Japan International Cooperation Agency (JICA). The initiative originated in North Macedonia and has since been replicated in Kosovo and Montenegro. These interactive GIS platforms utilize various information and communications technology tools, including remote-sensing and open data analysis, to improve forest fire prevention and early warning. In **North Macedonia**, the MKFFIS (Macedonian Forest Fire Information System)[78] integrates prevention and early warning efforts, providing a common platform for sharing data and information among relevant institutions based upon day-to-day web-based GIS. It also is used for spatially presenting the E-Assessment Platform and its modules, including past disaster events, risk elements (population and infrastructure), resource registries, crisis-related assets and nature-based solutions. The main goal of the Montenegro Forest Fire Information System[79] is to collect satellite-detected fire incident data and enhance response procedures for emergency services in **Montenegro**. Meanwhile, **Kosovo** has developed the Forest Fire Information System,[80] a comprehensive web-based GIS platform that aggregates diverse data to support proactive fire management and early warning strategies.

Considering the collection and analysis of data related to damages and losses, disaster management agencies play a pivotal role in coordination with key sectoral institutions. All of the countries and territories have updated methodological frameworks, with some of them in line with post-disaster needs assessment principles (**Montenegro**, for example, has developed a new legislative solution aligned with these principles).[81] Given the impacts of the seismic risk, **Albania** has initiated a project for seismic building damage assessment.[82] Except for **North Macedonia**, all countries and territories utilize the DesInventar disaster information management system for the systematic collection, documentation and analysis of data about losses caused by disasters associated with natural hazards. **North Macedonia** has developed Sendai Framework and SDG 13 modules[83] as part of the E-Assessment Platform, enabling systematic data collection and reporting of data on events and damages, allowing institutions to enter information aligned with Sendai and SDG indicators.

This initiative is the initial step in the creation of the National Disaster Loss Database (Popovski, 2022). Nevertheless, challenges considering damage and loss assessments persist, including the lack of clear methodologies related to post-disaster needs assessments; the collection, sharing and analysis of disaster damage and loss data; the lack of digitalization of related processes; differences with the loss and damage approach under the climate risk assessment; a lack of resources, etc.

At the **regional level**, there have been several initiatives[84] for enhancing the risk and assessment process, including the European Union-funded IPA Programme for Disaster Risk Assessment and Mapping.[85] This led to the creation of the Electronic Regional Risk Atlas,[86] a regional atlas developed from the myDEWETRA platform,[87] aggregating damage and risk data to support natural risk planning and management. The IPA Floods and Fires programme[88] provided technical support for the development of forest fire risk assessments in participating countries and territories. For a better understanding of risk and its three dimensions (hazards and exposure, vulnerability and coping capacity), **UNDRR**, in cooperation with the **Disaster Preparedness and Prevention Initiative for South Eastern Europe**, developed the subnational INFORM model for South East Europe,[89] which also includes **Albania**, **Montenegro** and **North Macedonia**. It is developed at the local/municipal level and supports a proactive disaster risk management framework resulting in better understanding, anticipation, mitigation and preparedness.

In addition, with regard to flood risk, two subregional interventions are notable: Adaptation to Climate Change through Transboundary Flood Risk Management in the Western Balkans[90] implemented by GIZ, and the UNDP-implemented integrated climate-resilient transboundary flood risk management in the Drin River basin in the Western Balkans,[91] with a focus on Albania, Kosovo, Montenegro and North Macedonia. The former resulted in a palette of activities to increase flood risk knowledge, such as the Preliminary Flood Risk Assessment for the Drin/Drim—Buna/Bojana River Basin,[92] the flood hazard map for potentially significant areas in the river basin,[93] vulnerability and adaptation action plans for Tirana,[94] Podgorica[95] and Belgrade,[96] capacity development, the raising of flood risk awareness,[97] etc.

An innovative practice for a better understanding of the resilience of private-sector entities is the development of a risk assessment methodology[98] for small and medium enterprises[99] in **Serbia** based on the existing UNDRR tools, such as the Quick Risk Estimation Tool for Micro, Small and Medium Enterprises.

Consequently, thematic gaps and challenges are prevalent across the Western Balkan countries and territories, as outlined below:

Still-insufficient risk understanding and knowledge, especially for the systemic nature of the risk and anticipation of emerging and new risks, such as climate change uncertainties and security-related risks. These gaps may lead to inefficient operational preparedness planning and response strategies.

Insufficient integration of climate change projections and models into the risk and hazard assessment and scenarios.

The lack of competencies among disaster risk reduction actors for risk and hazard assessment, leading to inadequate preparedness, ineffective response strategies and increased community vulnerability to disasters. In addition, various actors at all levels often lack the necessary information to effectively engage in early warning processes and decision-making, challenging multisectoral coordination and cooperation.

Challenges persist in regularly updating risk and hazard assessments, particularly at the local level, resulting in outdated assessments and their ineffective integration into operational preparedness/protection and rescue planning documents.

Assessed risks often fail to translate into actionable, risk-informed policies and decisions due to a lack of coordination among disaster risk assessments, strategies and development plans at both central and local levels, as well as the limited integration and consolidation of risk-related information.

Poor data availability and quality due to the limited existence of comprehensive historical data sets or insufficient data on previous disaster events, limited existence of disaggregated data sets, inconsistent data collection methods, limited availability and analysis of disaggregated data (e.g. regarding age, sex, geography, marginalized groups, religion, vulnerability, disability, etc.), and access to statistical data sources and data-sharing platforms, among other reasons.

Inadequate assessments of social, economic and environmental vulnerabilities in EWS, undermining efforts to enhance community resilience and hindering timely and effective action.

Incomplete river basin flood risk and river basin management plans across the region.

While hazard maps are created for various risks—such as floods, landslides and earthquakes—they often lack comprehensive vulnerability mapping. Critical infrastructure may be omitted due to data gaps, and social vulnerability mapping is insufficient, either due to inadequate data or the absence of a methodological framework. Additionally, existing maps for at-risk areas are not consistently shared with communities, hindering their awareness and preparedness for timely and effective responses.

Limited inclusion and participation of at-risk communities in all phases of this thematic area hinder the effective integration of their perceived risks, coping strategies and knowledge into community-aligned actions.

Access to disaster risk information is limited for persons with disabilities. Not all information reaches them, and the information that does is often not in an accessible format. To be comprehensible to persons with disabilities, information should be provided in such formats as interpretive language, Braille, simplified language and more (Popovski, 2023a).

Despite effective practices in streamlining post-disaster needs assessments with damage and loss assessment methodologies and regulatory solutions, challenges remain in the practical implementation of assessment processes. Primarily, the lack of digitization results in lengthy procedures and inefficiencies, hindering timely decision-making and response efforts.

THEMATIC AREA

Monitoring and forecasting service

The thematic area of monitoring and forecasting is crucial for effective and efficient disaster risk management and timely EWS. These services encompass the systematic observation, collection, analysis and interpretation of data and information related to hazards and environmental conditions. Consequently, they provide key contributions to the EWS and connect the disaster risk knowledge with the operational phases of warning dissemination, comprehensive preparedness and response. 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). From the Western Balkans, only Albania reported on indicators G1 and G2 from Target G on the existence of MHEWS and monitoring and forecasting systems for MHEWS in the Sendai Monitor. Additionally, 53 percent of meteorological and hydrological services report limited capacities to provide 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 the Western Balkans, monitoring and forecasting systems are well established, covering a palette of hazards impacting the countries and territories with essentially suited equipment and knowledgeable and trained personnel. Additionally, data from regional networks and international sources are readily accessible, processed in real time or near-real time, routinely archived for verification and research, and regularly shared with neighbouring countries and territories to enhance collaborative risk management efforts. While policy and regulatory frameworks exist, vertical standard operating procedures are needed to clarify roles and enhance intrasectoral cooperation, coordination, and the timeliness of forecasts. Consistent data and information exchange, forecasts and warnings are facilitated through mutual agreements, but additional protocols are necessary for more streamlined early warning communication and transitioning to actionable forecasts.

In that sense, following the floods in 2014, the NMHS improved its monitoring and forecasting capabilities for floods by issuing timely meteorological and hydrological warnings. However, early warning capacities for earthquakes remain limited due to the inherent nature of the hazard as well as in **Serbia**, where these challenges are further compounded by a lack of equipment and human resources in the Institute of Seismology (European Union Civil Protection, 2019: 12). Seismological and geological entities in the region can monitor seismic activities in real time but cannot issue forecasts and warnings. On the other side, the role of the NMHS is becoming increasingly important due to the increasing trend of frequency, intensity and magnitude of the hydrometeorological hazards as a consequence of climate change. A good practice is identified in **Serbia** with the development of a flood EWS in the Kolubara River Basin to protect the population and infrastructure in the basin, which is more vulnerable since 2014.

In general, even though the forecasts are primarily related to weather information with a low degree of localization, they regularly inform the population of weather-related threats and duration, and the scope of this information might trigger operational reactions (e.g. sheltering and evacuation). However, there are many other challenges among the individual countries and territories, including the profile of the generated forecast (e.g. the format is general and not suitable for all users), the NMHS does not have stipulated responsibilities for disaster risk reduction, forecasts are issued by different departments rather than from a single issuing service, information is not impact-based prediction, etc. Usually, the information from these services is delivered to the key government entities and ministries, disaster management agencies and media and is published over various communication channels (radio, television, social media, etc.) to reach the population and communities. Nevertheless, this forecast information is general and in a format not customized to the needs of various users, requiring disaster management agencies to translate the information into actionable warnings.

Meteorological warnings are partially distributed through the Meteo alarm system developed as part of the European Meteo alarm, such as meteoalarm.rs in **Serbia**, which displays information on expected meteorological or hydrological events through a colour-coded pictogram representing the expected hazard level. Some of the countries in the region (**Bosnia and Herzegovina, Montenegro, North Macedonia** and **Serbia**) are presented on the website of MeteoAlarm, an early warning dissemination system that visualizes, aggregates and accessibly provides awareness information from 38 European NMHSs.[100]

There are several practices to be noted for advancing monitoring and forecasting services coordinated and implemented by competent **regional and central institutions**. Regional cooperation is functional and supported by bilateral and regional agreements or memoranda of cooperation among countries/territories, such as among Albania, Kosovo, Montenegro and North Macedonia for cooperation and data exchange for flood warning in the Drin/Drim—Buna/Bojana River Basin[101] and the exchange of seismic information between neighbouring countries and territories. Also, all countries and territories in the Western Balkans are active members of the European-Mediterranean Seismological Centre,[102] an international non-profit association dedicated to the rapid collection and dissemination of earthquake information and the promotion of seismological research. The centre gathers data from seismological agencies, individual observers and social media analysis, disseminating information for the public through websites and the LastQuake app[103] and for scientists via accessible interfaces. Cooperation with international organizations is active and facilitated by various agreements, including WMO,[104] the European Organisation for the Exploitation of Meteorological Satellites[105] and the European Centre for Medium-Range Weather Forecasts,[106] establishing an effective early warning network. In addition, the NMHS collaborates with the European Flood Awareness System and the European Forest Fire Information System regularly and receives awareness information and alert notifications.

The Southeast European Multi-Hazard Early Warning Advisory System[107] is an initiative aimed at improving EWS for natural hazards in Southeastern Europe. It focuses on enhancing the capabilities of meteorological and hydrological services to provide timely and accurate warnings for various hazards, such as floods, storms and heat waves. The Flood Forecasting and Warning System in the Sava River Basin[108] enhances preparedness and response to flooding by integrating advanced meteorological and hydrological data for timely forecasts and alerts to at-risk communities. Key features include the real-time monitoring of river levels and rainfall and collaboration among domestic and regional agencies to ensure effective communication, ultimately aiming to minimize flood impacts and protect lives and infrastructure.

Prevailing gaps and challenges are evident in this thematic area across the Western Balkans, as summarized below:

The NMHS and seismological, geological and similar services are not sufficiently integrated into the disaster risk management of countries and territories, often being viewed primarily as service providers rather than as essential contributors to community resilience and societal preparedness.

Existing normative and procedural gaps hinder a comprehensive understanding of risks and limit coordination and cooperation in forecasting, ultimately affecting the delivery of actionable warnings and timely, effective responses.

The existing observation and monitoring network across the region is insufficient to respond to the increased demand for data collection and analysis and inadequately addresses challenging environments (e.g. topography, cascading multi-hazard profiles, complex climate dynamics, etc.), resulting in lower data resolution accuracy and limited localization of weather information and services.

The limited number and profiles of monitoring stations necessitate their expansion and automation, impacting the effectiveness of sector-specific monitoring and observation, such as the agrometeorological network or the integration of biological hazards.

The delivery of sector-specific services is ineffective, impeding the ability of sector entities to make well-informed decisions.

Not every critical infrastructure asset is covered with earthquake sensors; in Kosovo, for example, none of the hydroelectric dams has this kind of installation (World Bank, 2021a).

Crowdsourced data from various platforms, including social media, is not included in hazard data analyses as a secondary data source regarding possible events.

The still-restricted availability of hydrometeorological data impedes comprehensive analysis, research and forecasting, limiting the effectiveness of EWS.

The centralization of hydrometeorological data restricts access for other ministries and stakeholders, including academia and research and development entities, hindering innovative applications and the effective coordination of responses across agencies.

Weather radar coverage and remote-sensing applications require enhancement with new equipment and information and communications technology solutions to address the deficiencies in existing radar and satellite monitoring systems.

The challenging topography of the region requires specific solutions, such as radar coverage or cellular networks, to overcome technological limitations, and this may lead to occasional data flow gaps or delays.

Challenges in monitoring and forecasting can be identified in limited technical capabilities, the availability of equipment and software, insufficient automation and digital solutions, limited real-time data collection, etc.

As with forecasts, there is no systematic validation process in place for warnings.

Resource-related constraints—including those related to people (lack of sufficient educated and trained personnel), finances (lack of stable and sufficient financing, which impedes proper and regular maintenance and investments in systems and human resources), and equipment—pose obstacles to effective monitoring and forecasting.

Forecasting information often uses technical language, posing comprehension challenges for non-specialists and the general population.

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 often delayed or incomplete, particularly among local authorities and communities.

Impact-based forecasting is not streamlined due to population distribution and the absence of know-how, expertise, resources and infrastructure.

Feedback mechanisms for enhancing forecasting services are either lacking or insufficient.

THEMATIC AREA

Warning dissemination and communication

Timely warnings and communication emphasize the critical channel attributes that enhance the timeliness, effectiveness and efficiency of EWS. Equipping individuals and businesses with practical and actionable information can support decision-making informed by early warnings and enhance responsiveness in emergencies. 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) of the Early Warnings for All framework stands out, with 89 countries (46 percent of the world) reporting positive scores, indicating that the population is covered by early warning information (UNDRR and WMO, 2023: 39). Only Albania reported on Indicator G-5[109] through the Sendai Monitor.

In the Western Balkans, timely and effective warning dissemination depends on relevant policy and regulatory frameworks, institutional architecture and empowered authorities and communities. Disaster management agencies are predominantly responsible for warning and alerting, whereas specialized services (e.g. NMHSs or geological services/seismic observatories) initiate the warning dissemination process. In that sense, challenges remain in the delineation of roles and responsibilities, the localization of warning and alerting dissemination, the establishment of reliable feedback mechanisms for verification, and the management of warning communication for all. The main channels for warning information dissemination in the Western Balkans are still the traditional ones (television, radio, disaster management agency web pages, social media and public alert systems), while text messages, public loudspeakers, word of mouth and volunteers are underused, except for individual cases or some remote areas.

At the community level, church bells and mosque sound systems also are used to alert the public in cases of emergencies, such as in Kosovo, for example. In many countries and territories in the region, domestic public alert systems (i.e. sirens, a legacy alerting system from the former Yugoslavia) are not fully functional, such as in North Macedonia (European Union Civil Protection, 2018). They also might be insufficiently spatially distributed (i.e. they only exist in the bigger cities) or need to be completed (European Union Civil Protection, 2019: 5). The main reasons for this might be a lack of finances for maintenance and updating equipment or a lack of acoustic studies or plans to transition to mobile telephony as a more reliable system. Examples exist of hydroaccumulation systems, hydro and thermal power plants, and major industrial complexes having individual siren systems for alert notifications, but no regular activities for sharing information and raising awareness in communities have been implemented in reality. The 1-1-2 emergency number and associated call centres have been established in Albania (only in Tirana, out of 12 regions), **Kosovo, Montenegro** and **North Macedonia**; it is under development in **Bosnia and Herzegovina** and **Serbia**.

Photo: UNDP Serbia / Momira Marković

The EWS value chain, particularly regarding warning dissemination and communication, often faces disruptions that hinder the effective transmission of crucial information to affected communities and businesses. These disruptions can stem from various factors, such as warning information ending at the local level without reaching everyone in the communities, the lack of a precise definition of the "last mile"[110] in warning communication, challenging cooperation between agencies to ensure consistent and complementary warnings, the absence of warning message tracking (World Bank, 2022a), and the absence of feedback mechanisms. Warning and alerting communication and dissemination systems are not sufficiently tailored to the needs of at-risk communities, especially populations in remote areas and vulnerable groups (such as the elderly, youth, women, persons with disabilities, non-native speakers and others). Existing warning dissemination and communication systems often fail to meet specific needs in several ways, including issues regarding generality, reaching remote communities, visual and auditory accessibility, language barriers, cultural relevance, technology accessibility, digital literacy, community engagement, timeliness and clarity. Warning messages often lack clarity and consistency, are not gender sensitive and do not effectively convey essential information about risks and impacts. There is a pressing need for these messages to be actionable and to link threat levels directly to appropriate emergency preparedness and response actions, ensuring that everyone understands the necessary steps to take in a crisis.

The existing warning and alerting systems in the Western Balkans do not adhere to the Common Alerting Protocol, meaning that they do not follow a standardized digital format for exchanging emergency alerts and public warnings to allow for the consistent and simultaneous dissemination of alert messages across multiple communication channels, such as radio, television, mobile phones and internet services. Impact-based early warning notification is still a non-existent practice, and risk communication does not provide advice on actions that need to be taken. The time needed to transfer hazard information is very often insufficient, causing delays between forecasts and warnings ranging from minutes to hours.

Private-sector resources for warning and alerting dissemination and communication are insufficiently regulated. In most cases, there are no legislative frameworks or they are too general, e.g. the Law on Crisis Management in North Macedonia. A good example of this point is **Serbia**, where in the Law on Disaster Risk Management and Emergency Situations Management (Article 98),[111] broadcasting and television stations, mobile telephony operators and mobile telecommunications entities are obliged to provide urgent transmissions of relevant information and notifications and the location of incoming calls. In **North Macedonia**, memoranda of understanding are signed with the regulator body and the A1 mobile operator, but still, the mobile telephony warning system has not been established. On the other hand, even if solid agreements with television and radio stations are in place, the sharing of warnings might be difficult, such as regarding flooding in **Kosovo** (World Bank, 2021a: 34).

In **Albania**, while procedures for issuing public warnings exist, there is currently no reliable warning message system, and the integration of GIS-generated data and EWS data is lacking for effective situational awareness. The alarm signals used for public alerts are outdated and largely nonfunctional. Although the National Civil Protection Agency, prefects and mayors have protocols in place for issuing warnings under Article 50 of Law No. 45/2019, the transmission of warning messages typically flows from the central level to local authorities, such as mayors and village heads, before reaching neighbourhoods and individuals. In emergencies, according to Article 49 of Law No.45/2-19, media outlets are required to interrupt their programming to relay important civil protection messages (World Bank, 2021b). Currently, **Bosnia and Herzegovina** lacks a reliable public warning message system. While critical infrastructure facilities receive notifications from EWS and are mapped on the Next-Generation Incident Command System platform, warning messages are disseminated to the public via radio and television stations with which various organizations maintain strong relationships.

Additionally, institutions issue daily bulletins, and municipal civil protection operations centres activate sirens to transmit alerts when imminent threats or accidents are detected (World Bank, 2021c). In **Montenegro**, the PRD is responsible for distributing warning messages to at-risk populations, while local municipalities oversee public siren systems. However, a clear mechanism for relaying messages from authorities to the public is lacking. National television serves as the primary alert channel, effectively broadcasting orange-coded weather warnings. Collaboration with telecommunications companies is being developed to improve communication. Currently, early warning data are not integrated into a unified information management system but are shared with the 1-1-2 Operational Communication Centre (World Bank, 2021d).

In **Kosovo**, alerts are disseminated to the public through various media channels, including social media, with the Ministry of Environment and Spatial Planning managing media coverage for floods and the Emergency Management Agency handling others. Both use a colour-coded system (red, yellow, green) to indicate urgency, and emergencies may prompt interruptions in television and radio programming to issue warnings (World Bank, 2021a). In **North Macedonia**, public alerting procedures are in place, but overlapping responsibilities hinder their consistency and effectiveness. The Crisis Management Centre is tasked with alerting the population via traditional channels, although public sirens are nonfunctional. Efforts are underway to establish text message warning dissemination through A1 mobile services (World Bank, 2021e). In **Serbia**, the Sector for Emergency Management is responsible for warning and informing the public in an emergency, and local authorities have competencies in establishing and maintaining the warning and alerting system, i.e. public services (World Bank, 2022a). Current good practice is the establishment of an effective electronic platform for transmitting urgent information to the population during natural disasters or technological accidents. This system uses the Short Message Service (SMS) to send text alerts about dangers and necessary safety measures, helping to minimize negative consequences. It covers the entire country, with the ability to target specific areas as needed (Ministry of Information and Telecommunication of Serbia, 2024).

Consequently, thematic gaps and challenges are prevalent across the Western Balkan countries and territories, as outlined below:

Warning dissemination and communication are not fully integrated across the EWS value chain, as the disaster management agencies primarily hold the responsibility for issuing and disseminating alerts.

Regulations and standard operating procedures are insufficient, often lacking clarity and leading to confusion among key stakeholders on roles and responsibilities, with issues related to the timeliness and effectiveness of the warning communication. This ambiguity stems from vague and non-standardized messaging and insufficient methods and communication channels to reach all members of the communities.

There are no feedback mechanisms or tracking systems in place for alert messages.

Current warning dissemination and communication mechanisms do not cover all hazards or cascading impacts of various hazards and do not cover all segments of the population. Consequently, this does not lead to a hazard-specific response with prioritization of actions, communication equipment, required procedures, emergency shelters and procedures, etc.

Insufficient cooperation exists in data sharing, system digitalization/automation and stakeholder engagement for early warning and alerting dissemination and communication.

Beyond their current insufficient functioning, public alert systems may not be functional due to topographical challenges, the obsoleteness of the system design, and low awareness among the population, especially younger people.

The lack of application of the Common Alert Protocol leads to messages that are not standardized across hazard and threat domains, resulting in communications that are unclear and often fail to provide actionable guidance for those affected. Also, the interoperability and consistency of disseminating the warnings and alerts through various platforms and channels are affected.

Cell broadcasting has not been implemented, and it is not integrated into warning dissemination schemes.

There are no standardized processes for warning dissemination and communication via social media or for the utilization of crowdsourced data for warning and alerting.

The current warning dissemination and communication mechanisms do not ensure that the "last mile" of communication reaches those most at risk, resulting in gaps in awareness and preparedness among affected at-risk communities.

Gender and disability considerations are not sufficiently integrated into early warning and alerting processes.

The limited engagement of the private sector undermines timely, effective and efficient warning and alerting efforts, highlighting the need for greater participation to enhance responsiveness.

The absence of an impact-based warning leads to delayed and inefficient communication, a lack of actionable information, reduced preparedness, and ineffective response mechanisms among communities, individuals and businesses, leading to a lack of action or increased pressure on emergency response services.

Automated EWS are notably absent, especially in industrial enterprises and social facilities.

Insufficient public awareness and education hinder timely early responses, highlighting the need for comprehensive initiatives to improve understanding and encourage proactive measures.

Photo: Kosovo / Arben Llapashtica

Preparedness and response capabilities

To be effective, MHEWS must result in appropriate action being taken to avoid or minimize negative impacts on lives, livelihoods and assets, especially critical infrastructure. To be able to act when required, not only is it necessary to identify risk (Thematic Area 1), monitor and predict the potential impact of a hazard (Thematic Area 2), and disseminate and understand warning messages (Thematic Area 3), but it also is essential to understand risk (Thematic Area 1) to underpin the actions required to prepare and respond to warnings (Thematic Area 4) (UNDRR and WMO, 2023: 65). This final step in the EWS value chain requires emergency responders, businesses and communities to be prepared and ready for timely, effective and efficient response. Less than one-third of countries globally have reported the existence of local government plans to act on early warnings, indicating the potential lack of such plans for more than two-thirds of the world's local governments (UNDRR and WMO, 2023). Among Western Balkans countries and territories, only **Albania** has reported the existence of local government plans for early warning (Target G – Indicator G.4),[112] with growth from 18.2 percent coverage in 2018 (five out of 61 municipalities) to 39.3 percent in 2023 (24 out of 61 municipalities).

Countries and territories in the Western Balkans emphasize preparedness and response in their disaster risk management strategies and plans as part of the wider narrative for building readiness. They are comprehensively elaborating on these aspects of the EWS. In all countries and territories, central and local preparedness and response plans are adopted at all levels, following the multi-hazard, multi-risk and multisector approach. Nevertheless, there are outstanding issues related to their regular updating and availability for the broader public (and at-risk communities specifically).

For instance, in **North Macedonia**, the Protection and Rescue Plan has been outdated for more than a decade, and the municipal plans have different dynamics of updating beyond the regular one. A good practice in this context is the National Civil Emergencies Plan of Albania (2023),[113] which institutionalizes the country's overall preparedness and response planning. Early warning is part of this document and aims to contribute to a better understanding of the overall EWS, including roles and responsibilities, information processing and the raising of awareness among the population.

Despite significant investments in disaster readiness planning and resource allocation, systematic community involvement—especially among vulnerable groups—remains a challenge. Education and training for at-risk communities are insufficient, vulnerability groups are not regularly included in these activities, and the roles of key stakeholders, such as hydrometeorological services, lack clarity. While regular drills for various hazard scenarios are conducted, community participation varies considerably. Community-based disaster preparedness activities that include the needs of vulnerable groups are primarily project-driven due to the lack of institutionalization within existing policies and regulations. While municipalities have adopted operational preparedness and response plans, local education programmes often are absent, leading to numerous ad hoc projects in at-risk areas. Volunteerism, crucial to fostering a culture of preparedness, is still in its early stage, with volunteers participating in emergency services, search and rescue organizations, firefighting associations and some NGOs. It is good to emphasize that the Red Cross societies have extensive volunteer networks that can contribute to the building of disaster resilience. **Kosovo**, for example, has more than 3,000 volunteers (World Bank, 2021a), while **Montenegro** has approximately 2,000 (World Bank, 2021d) and **North Macedonia** between 4,000 and 5,000 (World Bank, 2021e).

Exercises and drills are regularly conducted at regional, central and local levels to test preparedness and response mechanisms, including EWS during simulated disasters. These can include simulations/tabletop exercises, e.g. the flash flood simulation in the Polog Region of **North Macedonia**,[114] and field drills, such as Silver Sabre 2019 in **Kosovo**,[115] System 2021 in **Serbia**,[116] Balance 2022 in **Montenegro**,[117] a 2024 coordination and response civil and military exercise in **Bosnia and Herzegovina**[118] and the Flood North Alb event in **Albania**.[119] However, there is no feedback system to inform decision-making for updating emergency plans, and engagement with at-risk communities is lacking. This disconnect limits the effectiveness of drills, as valuable insights are not integrated into future strategies. Also, vulnerable population groups are not regularly included in the development and implementation of these activities. For instance, in **Serbia**, NGOs dealing with disability inclusion are usually involved in training programmes but rarely in drills and scenarios (World Bank, 2022a).

In terms of financial preparedness, the situation varies across the region, but the main actions are directed towards supporting the immediate response, rather than preparedness. For instance, in **North Macedonia**, the legislation foresees specific budgets for emergency-related aspects, but in reality, financial preparedness is insufficient and not consistent at central and municipal levels across the country (World Bank, 2021e: 12). Disaster risk anticipatory measures also are not widely implemented across the region, though there have been some initial project activities. In general, they refer to ex post preparedness, e.g. state reserve or contingency funds, disaster relief stockpiles, etc.

A key aspect of modern preparedness is business continuity planning for essential government and critical infrastructure services. While some sectors have established plans, many government entities in the region still lack them. Following the 2019 earthquake, **Albania** began developing continuity of operations and government plans to maintain essential functions during disasters. In **North Macedonia**, contingency and business continuity planning are recommended for central institutions and municipalities to enhance disaster risk reduction and climate change adaptation (Popovski, 2022: 45). Some local units, such as the Municipality of Veles,[120] have incorporated these plans into their strategic disaster risk reduction planning efforts.[121]

Additionally, progress has been made in strengthening the continuity of water management facilities[122] across Albania, Kosovo, North Macedonia and Serbia; however, this remains a fragmented, project-based approach rather than a fully integrated system.

The Western Balkans showcase several effective practices for enhancing preparedness and response capabilities at both national and regional levels, as well as fostering broader cooperation. The **Disaster Preparedness and Prevention Initiative for South Eastern Europe** plays an important role in promoting regional collaboration for effective preparedness and response. This is evident from its various activities, which include education and knowledge sharing, professional training, disaster management education (e.g. host nation support),[123] simulation (e.g. DPPI Flex 2023)[124] and field training exercises. The **European Union** plays a key role in strengthening the preparedness and response capabilities of countries and territories in the Western Balkans by fostering cooperation with European Union Member States and the Civil Protection Mechanism. Its efforts focus on enhancing protection against cross-border disasters, supporting the European Union Disaster Resilience Goals[125] via risk management tools and knowledge exchange, the building of civil protection competencies, and the fostering of partnerships and community awareness. This resilience-building contribution is channelled through several initiatives, including projects funded by the Directorate-General for European Civil Protection and Humanitarian Aid Operations,[126] national IPA projects (e.g. EU for Civil Protection and Disaster Resilience Strengthening[127] and EU for Healthcare[128] in **Serbia**), regional projects such as ongoing IPA CARE (e.g. increasing medical response surge capacities, the development of urban search and rescue, civil protection volunteerism, inter-institutional coordination or regional cooperation, etc.) or past projects, such as IPA Floods and Fires (e.g. EWS procedures and agreements in local/central emergency response plans, forest fighting modules, border crossing and hazardous and noxious substance protocols, and regional tabletop and field exercise), or various cross-border project initiatives that include the strengthening of EWS as part of project actions. In **North Macedonia** in 2017, for the first time, the EU MODEX exercise was organized outside the territory of the European Union (European Union Civil Protection, 2017).

Additionally, other donors and organizations present in the region contribute to the enhancement of domestic preparedness and response capabilities, with a focus on the most profiled hazards (e.g. floods, wildfires, earthquakes, etc). The United States Agency for International Development Bureau for Humanitarian Assistance continued support for Catholic Relief Services for **Bosnia and Herzegovina** and **Serbia**, for example. A good practice for strengthening the preparedness and response capabilities of critical infrastructure is the Get the Airport Ready (GARD) initiative,[129] a partnership among UNDP, the DHL Group and Airport Council International. GARD enhances airport preparedness by assessing their capacities to handle humanitarian aid, training staff and assisting authorities in developing action plans. In the region, Skopje International Airport in **North Macedonia** held a GARD workshop in 2015 (UNDP North Macedonia, 2015), and Sarajevo International Airport in **Bosnia and Herzegovina** hosted a GARD workshop in 2018 (DHL Group, 2025), followed by a GARD Plus Training in 2023 to prepare for a disaster simulation exercise (DPPI SEE, 2023).

At the regional level, also, the role of **The North Atlantic Treaty Organization** (NATO)[130] in civil emergency preparedness and response is channelled through the Euro-Atlantic Disaster Response Coordination Centre,[131] which is NATO's principal civil emergency response mechanism available to all allies and partner countries, supporting them with both response and preparedness for natural and human-made disasters and other emergencies. NATO helped **North Macedonia** and **Montenegro** respond to the COVID-19 pandemic by providing necessary health supplies, and the NATO Communications and Information Agency has helped **Bosnia and Herzegovina, Montenegro** and **North Macedonia** adopt the Next-Generation Incident Command System to manage information during emergencies and disasters (NATO, 2022). For testing the preparedness and response systems, the Euro-Atlantic Disaster Response Coordination Centre organized disaster exercises in **Montenegro** (2016), **Bosnia and Herzegovina** (2017) and **Serbia** (2018) to practice responding to these types of requests in the event of natural or human-caused hazards (European Western Balkans, 2020).

Prevailing gaps and challenges are evident in this thematic area across the countries and territories of the Western Balkans, as summarized below:

- Existing policy and regulatory frameworks related to disaster preparedness and response need to closer align with international and regional standards, such as the European Union Civil Protection Mechanism.

- Standard operating procedures may not adequately encompass the diverse needs of all communities and stakeholders; current protocols often overlook specific local contexts and the needs and perspectives of various groups, especially vulnerable ones, and this can hinder effective preparedness and response efforts.

- The institutional preparedness and response capacities of key sectoral stakeholders in disaster risk management systems remain insufficient.

- Key sectoral policy and regulatory frameworks often view preparedness and response as solely the responsibility of disaster management agencies, failing to integrate these aspects into broader sectoral resilience-building efforts. Consequently, there are existent gaps in key sectoral readiness. In the agriculture sector, for example, there has been a failure to identify evacuation routes for livestock during floods and to implement measures to prevent and mitigate plant pests and diseases during and after such events.

- Existing subnational coordination needs enhancement through intersectoral agreements to more effectively integrate preparedness and response services.

- Regular education and training efforts face challenges related to resource constraints and sustaining long-term engagement that impact the effectiveness of preparedness initiatives. Addressing these issues is essential for ensuring that communities remain well equipped to respond to disasters.

There remains a weak culture of preparedness with an all-of-society approach due to the low awareness or lack of inclusiveness, participation or incentives to encourage the broader community to take an active role in building readiness.

In many cases, existing professional training curricula and programmes are not adapted to climate and disaster risk challenges, current developments and the latest technologies and equipment. Additionally, there is a lack of systematic education and training of key policymakers and decision-makers and, more broadly, practitioners in participating institutions.

Training centres are missing or are inefficiently organized in some of the countries and territories, and this contributes to a lack of multi-agency, multi-hazard and multi-risk readiness programmes and training.

The local culture of preparedness is hampered by a lack of systematic education programmes aimed specifically at community leaders and a lack of regional information-sharing fora. Establishing these initiatives is essential for building awareness and resilience within communities, ensuring that leaders are equipped to guide their populations effectively during emergencies.

Some key ministries, such as health and environment ministries, have their own preparedness and response plans. However, closer integration among these plans is necessary to enhance coordination and ensure the continuity of operations and services during emergencies. This collaboration would facilitate a more comprehensive approach to disaster management and improve overall resilience.

Comprehensive programmes and plans for the preparedness and response of critical infrastructure facilities and assets are lacking. The absence of these initiatives hinders effective disaster management and increases vulnerabilities in essential services during emergencies. Developing such plans is crucial for enhancing resilience and ensuring the continued operation of critical infrastructure in times of crisis.

Simulation exercises and drills are not conducted consistently, underscoring the need to establish clear guidelines on their frequency, scope and scale to enhance overall preparedness.

Early warning mechanisms, as part of preparedness, are not sufficiently integrated into the existing school curriculum beyond the basic recognition of alert sounds.

Limited funding restricts the upgrading of tools, technology development and specialist training, which in turn hampers disaster preparedness and response capabilities.

The insufficient involvement of other stakeholders—e.g. NGOs, academia and the private sector—in building societal and community readiness hampers anticipatory actions, effective response and service continuity.

The absence of anticipatory actions, such as forecast-based financing mechanisms, results in resource gaps that undermine community preparedness and response efforts.

Evaluations of past disaster responses are not conducted regularly, and lessons learned are often not codified or incorporated into updated planning documents. This oversight hinders the adoption of a transformative approach necessary for building societal and community resilience. Regular assessments and the integration of findings into planning are essential for improving future disaster preparedness and response efforts.

EARLY WARNING SYSTEMS BEST PRACTICES IN THE WESTERN BALKANS

The establishment of National Forest Fire Information Systems and implementation of Eco-DRR solutions has been supported by JICA.[132] Following the initial success of the establishment of the Macedonian Forest Fire Information System (MKFFIS)[133] and the piloting of Eco-DRR solutions for risk mitigation in North Macedonia,[134] JICA disseminated the results across the Western Balkans and initiated similar projects to be implemented in Montenegro[135] and Kosovo.[136] This initiative supports socio-economic reforms across the Western Balkans towards European Union accession and fosters regional cooperation. The National Forest Fire Information System (NFFIS) is an integrated web–GIS platform that combines satellite and weather data with topographic maps to monitor fire risks, predict spread and assess dryness. This enables effective fire prevention, early warning and information sharing among relevant agencies. The forest fire early warning and prevention efforts align with Eco-DRR interventions aimed at increasing disaster risk mitigation, such as reducing risks in coastal forests in Montenegro and reforesting avalanche-prone areas in Kosovo.

The Southeast European Multi-Hazard Early Warning Advisory System[137] is an initiative aimed at improving the forecasting and warning systems for meteorological and hydrological hazards across 18 countries in Southeastern Europe.[138] By facilitating the exchange of data, forecasts and warnings, the initiative improves predictions and responses to these hazards. Key objectives include harmonizing forecasts and warnings among NMHSs in transboundary areas, enhancing regional cooperation for better forecasting and resource sharing, providing impact-based forecasts to support informed decision-making, and strengthening domestic MHEWS through shared regional tools and data (World Meteorological Organization, 2024).

The Flood Forecasting and Warning System of the Sava River Basin[139] is a collaborative effort to enhance flood preparedness and response across the Sava River Basin—which includes Slovenia, Croatia, Bosnia and Herzegovina, Serbia and Montenegro—following the devastating 2014 floods. This system enables informed decision-making and implementation of flood- and drought-prevention measures based on accurate and long-term flow and discharge forecasts. It relies on close cooperation with stakeholders and effective data management, utilizing observed data from gauges and Numerical Weather Predictions. The system employs hydrological and hydraulic models to calculate runoff, river flows and water levels, operating on the Delft-FEWS platform[140] developed by Deltares for integrated water management and forecasting.

The Disaster Prevention and Preparedness Initiative for South Eastern Europe[141] contributes to the development of a cohesive regional strategy for disaster preparedness and prevention for its ten Member States (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, North Macedonia, Montenegro, Romania, Serbia, Slovenia and Türkiye). The initiative aims to strengthen disaster management capabilities for natural and human-made hazards through enhanced regional cooperation, with a focus on European Union and Euro-Atlantic integration. The initiative supports the Sendai Framework by assisting Member States in developing effective disaster legislation, environmental regulations and specialized emergency training.

The Drought Management Centre of South-East Europe[142] aims to enhance drought preparedness by undertaking vulnerability and risk assessments and by establishing an EWS to reduce the impacts of droughts.

The Integrated climate-resilient transboundary flood risk management in the Drin River basin in the Western Balkans project,[143] implemented by UNDP, assists the Drin River riparian states (Albania, Montenegro and North Macedonia) in the implementation of an integrated, climate-resilient, basin-wide flood risk management approach, aiming to improve their capacities to manage flood risks at regional, central and local levels and to enhance the resilience of vulnerable communities to climate-induced floods.

The completed Adaptation to Climate Change through Transboundary Flood Risk Management in the Western Balkans project,[144] commissioned by GIZ and implemented in Albania, Kosovo, Montenegro and North Macedonia, aimed at strengthening transboundary flood risk management concerning climate change. The project resulted in the improvement of flood hazard and risk mapping in line with the European Union Floods Directive, the enhancement of early warning in selected pilot areas on building capacities for delivering effective and timely "end-to-end" early warnings, and the institutional development of key institutions to better coordinate flood risk management.

The Balkan Regional Early Warning System Programme,[145] launched in collaboration with the United States Forest Service, the Albania National Civil Protection Agency and the Pacific Disaster Centre from Hawaii in the United States of America, leverages the Disaster-AWARE platform[146] for multi-hazard early warning coverage. This program strengthens coordination by disseminating critical information to at-risk communities and highlights the value of collaboration in building resilience to natural hazards (PDC, 2023).

UNDRR supports building urban resilience in Western Balkans cities through the global Make Cities Resilient 2030 initiative,[147] fostering local resilience through advocacy, knowledge sharing, city-to-city learning networks, technical expertise, multilevel government collaboration and intersectoral partnerships. The following cities and municipalities in the region have joined the initiative:

Albania: Roskovec, Dibër, Shkodëra, Peshkopeja

Bosnia and Herzegovina: Gornji Vakuf – Uskoplje, Jajce, Vitez, Kiseljak, Travnik, Busovaca, Gradacac, Olovo, Bijeljina, Bihac

Montenegro: Zabljak, Podgorica, Ulcinj, Kotor

North Macedonia: Gjorche Petrov, Gazi Baba, Ohrid, Strumica, Centar

Serbia: Priboj, Ljubovija, Novi Pazar, Tutin, Pozega, Kosjeric, Cajetina, Aleksandrovac, Arilje, Knic, Uzice, Trstenik, Ivanjica, Gornji Milanovac, Bac, Lucani, Pancevo, Pirot, Loznica, Vracar, Obrenovac, Kragujevac, Ub, Krusevac, Zrenjanin, Cacak, Kraljevo, Vrnjacka Banja

MeteoAlarm is an early warning dissemination system that visualizes, aggregates and accessibly provides awareness information from 38 European NMHSs, including from Bosnia and Herzegovina, Montenegro, North Macedonia and Serbia. MeteoAlarm aggregates warnings from its members, making awareness information accessible to national and international redistributors and empowering individuals to take timely action.

CONCLUDING REMARKS AND THE WAY FORWARD

Overall conclusions and recommendations

This stakeholder mapping exercise of EWS in the Western Balkans assessed the disaster risk management landscape and early warning contexts in participating countries and territories. It identified key stakeholders across the entire EWS value chain, highlighted gaps and challenges in four thematic areas, showcased best practices and proposed actionable recommendations to achieve inclusive EWS for all communities.

The identified EWS stakeholders possess competencies across all thematic areas, and their active engagement fosters enhanced cooperation and coordination among sectors. This collaboration is crucial for the timely and effective implementation of EWS. By sharing expertise, stakeholders build trust within the community, helping ensure that the population feels informed, educated and supported during emergencies. Their diverse perspectives enable a comprehensive approach to disaster risk management, resulting in timely, efficient and tailored solutions for local needs. This collaborative framework not only strengthens EWS but also empowers communities to take proactive measures, enhancing their resilience against potential threats. In summary, stakeholder involvement is essential for cultivating a culture of preparedness and promoting sustainable practices across the Western Balkans. Consequently, a strong potential for enhancing the EWS value chain has been identified, laying the foundation for the improvement of overall risk management and climate change adaptation. Various advancements across the thematic pillars, as well as the results of past and ongoing interventions and established best practices, can lead to significant improvements in EWS. These developments enhance the overall effectiveness and resilience of disaster risk management efforts to help ensure that communities are better prepared for and able to respond to potential hazards. By integrating successful strategies and lessons learned, the countries and territories in the Western Balkans can foster a more robust framework that supports proactive measures, encourages collaboration and ultimately contributes to a safer and more resilient environment for all.

This exercise fosters a transformative shift in how EWS are perceived and integrated into broader resilience-building efforts. It emphasizes EWS as proactive disaster risk management tools and key climate adaptation measures, encouraging a holistic understanding of resilience. This shift paves the way for stronger collaboration among stakeholders—governments, technical agencies, academia, the private sector, NGOs and local communities—and promotes a unified approach to disaster prevention, preparedness and response. As stakeholders recognize the value of EWS for community empowerment and resilient development, their commitment to investing in these systems grows, aligning early warning and disaster risk reduction with central and local priorities for more risk-informed policies and decisions.

The forward-looking and actionable recommendations derived from this assessment aim to expand the Early Warnings for All initiative across the Western Balkans. These recommendations lay the groundwork for effective and inclusive early warning processes at regional, central and local levels, ensuring that no one is left behind. General recommendations are outlined to guide regional and central efforts towards achieving EWS standards across the Western Balkans, as follows:

- Promote a shift from reactive to proactive disaster risk management, prioritizing resilience and sustainability over risk concentration. Adopt comprehensive approaches that address all hazards, engage all sectors of society, encompass the entire disaster life cycle, include early warning and emphasize forward-thinking policies and risk reduction actions.

- Participate in the Early Warnings for All initiative and replicate and scale up global best practices.

- Strengthen the entire EWS value chain through continuous stakeholder mapping and by enhancing competencies across the four thematic pillars. This approach aims to make the EWS more robust and effective in mitigating risks and protecting communities.

- Improve policy and regulatory frameworks, integrating the EWS value chain, to ensure coherence, timely and effective implementation, and seamless coordination and collaboration across all thematic areas, from risk understanding and anticipation to response.

- Redesign the institutional architecture to reflect EWS value chain stakeholders through greater inclusion and participation in the process, and foster collaborative partnerships by building their capacities and utilizing available knowledge and expertise for the timeliness and effectiveness of these systems.

- Enable the streamlining of EWS in risk-informed policymaking and decision-making as effective tools for building the resilience of the societies and communities.

- Enhance the funding of the EWS value chain by establishing sustainable and stable financial sources by engaging stakeholders, advocating for dedicated budget allocations, diversifying funding sources, developing multi-annual financial strategies and exploring partnerships with the private sector, NGOs, international organizations and institutions for innovative financing mechanisms.

- Invest in a regional cooperation framework for EWS that includes standardized protocols for information sharing, joint training initiatives and a governance structure to facilitate EWS across borders and administrative boundary lines. This framework not only will help avoid the duplication of efforts across the countries and territories but also will help enhance coordination, streamline processes and promote shared capacity development, ultimately improving the effectiveness of these systems across the region.

- Facilitate the evolution of current EWS to adopt impact-based early warning methodologies while prioritizing a proactive strategy to bolster community safety and resilience.

- Continue or scale up regular reporting for the monitoring and evaluation of the alignment of initiatives with the Sendai Framework. This will enhance transparency, improve the understanding of progress in resilience-building efforts, and support the effectiveness of EWS.

Recommendations per EWS thematic area

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

THEMATIC AREA

DISASTER RISK KNOWLEDGE

Enhance risk knowledge focused on systemic risk understanding and the anticipation of new and emerging risks, e.g. threats related to climate change or security.

Incorporate climate change projections and models into risk and hazard assessments to ensure that scenarios accurately reflect future conditions and uncertainties and inform more effective planning and response strategies.

Ensure an inclusive and participatory risk and hazard assessment process that encompasses at-risk communities' perspectives, needs, coping strategies and knowledge and incorporates the knowledge and expertise of other stakeholders into early warning-aligned actions.

Implement a systematic review process for updating risk and hazard assessments at the local level, ensuring that they are conducted and updated regularly and effectively integrated into operational preparedness and response planning documents.

Enhance coordination among disaster risk assessments, strategies and development plans at central and local levels to ensure the integration and consolidation of risk-related information into actionable, risk-informed policies and decisions contributing to timely and effective early warning.

Integrate and consolidate risk-related information across key sectors (e.g. agriculture and health) into strategies, programmes and action plans for making risk-informed decisions and policies.

Improve data availability and quality by establishing comprehensive historical data sets, standardizing data collection methods and enhancing access to and analysis of disaggregated data across various demographics and vulnerabilities (e.g. gender and disability).

Conduct comprehensive assessments of social, economic and environmental vulnerabilities to strengthen EWS, ensuring they effectively enhance community resilience and enable timely and effective early warning actions.

Enhance hazard maps by incorporating comprehensive vulnerability mapping, including critical infrastructure and social vulnerabilities. Ensure that these maps are consistently shared with communities to improve their awareness and preparedness for timely and effective responses.

Facilitate data access and sharing among countries and territories to ensure efficient and rapid early warning capacities.

Develop and implement a standardized approach to provide disaster risk information in accessible formats for persons with disabilities. This should include interpretive language, Braille, simplified language and other relevant formats. Additionally, establish partnerships with organizations representing persons with disabilities to ensure that information dissemination methods effectively reach and meet the needs of these individuals.

Enhance access to disaster risk data at regional, central and local levels for all relevant EWS stakeholders to effectively contribute to early warning processes and decision-making.

Address loss and damage comprehensively by enhancing the normative framework, digitalizing data collection and analysis, and leveraging such global mechanisms as the Warsaw International Mechanism for Loss and Damage associated with climate change impacts.

THEMATIC AREA

MONITORING AND FORECASTING SERVICE

Strengthen the integration of NMHSs and seismological, geological and related agencies into disaster risk management frameworks by establishing formal partnerships, collaborative platforms and regular training programmes that emphasize their essential role in community resilience and disaster response.

Conduct a comprehensive review to identify and address existing normative and procedural gaps in risk management. This will help enhance coordination and cooperation in forecasting and lead to the improved delivery of actionable warnings and timely, effective responses.

Enhance the observation and monitoring network to meet the increased demand for early warning data collection and analysis. Address challenging environments such as complex topography, cascading multi-hazard profiles and dynamic climate conditions to improve data resolution accuracy and the localization of weather information and services to adapt to complex climate dynamics.

Expand and automate monitoring stations to enhance sector-specific monitoring and observation, such as the agrometeorological networks or the integration of biological hazards, to help enable sector entities to make well-informed decisions.

Strengthen the network of monitoring stations to support a regionally standardized EWS, ensuring comprehensive and consistent data collection and analysis across the region.

Install innovative sensors on all critical infrastructure facilities, where they are lacking, to enhance the monitoring, early warning, alerting and response capabilities of critical infrastructure owners and operators.

Integrate crowdsourced data from various platforms, including social media, into hazard data analysis to enhance detection, understanding and early warning and alerting of possible disaster events.

Decentralize and enhance access to hydrometeorological data through the implementation of functional open data platforms that allow for comprehensive analysis, research and forecasting, thereby enhancing the effectiveness of EWS and fostering innovative applications and effective coordination of responses across stakeholders.

Enhance weather radar coverage and remote-sensing applications by investing in new equipment and information and communications technology solutions. This upgrade will help address existing deficiencies in radar and satellite monitoring systems, improving data accuracy and reliability for better forecasting and early warning capabilities.

Implement targeted technological solutions to address the challenges posed by the region's topography, such as enhancing radar coverage and improving cellular network connectivity. This may include deploying mobile monitoring units, using drone technology for data collection, and investing in satellite communication systems to minimize data flow gaps and delays and ensure consistent and reliable information access.

Enhance monitoring and forecasting effectiveness by investing in updated equipment, software and automation technologies (e.g. advanced digital solutions for real-time data collection) and improving risk assessment methodologies.

Implement a systematic validation process for warning systems to ensure their accuracy and reliability via regular reviews of warning effectiveness, feedback mechanisms from users and the integration of lessons learned into future warning protocols.

Address resource constraints in monitoring and forecasting by developing a comprehensive resource enhancement plan to address human, equipment and financial constraints.

Develop and implement a strategy to simplify forecasting information through plain language and clear visual aids, creating tailored communication materials such as infographics, videos and community workshops for non-specialists, while engaging community members to identify and address specific language and other barriers, such as for persons with disabilities.

Enhance capacities for data-intensive hazard modelling by utilizing sophisticated data-intensive hazard modelling and risk assessment tools for mudflows, floods, hydrological droughts and landslides as well as the implementation of targeted training for professionals.

Develop and integrate solutions for rapid-onset weather-related events, such as flash floods, to enhance preparedness and response capabilities.

Design and implement clear protocols for the timely dissemination of forecasting information to all stakeholders, focusing on local authorities and communities.

Streamline impact-based forecasting by addressing key gaps in knowledge, expertise, resources, infrastructure and population distribution.

Establish a robust framework for feedback mechanisms for forecasting services that allows users to provide input on forecasting services, ensuring continuous improvement by regularly assessing user satisfaction, identifying gaps, and making necessary adjustments to enhance the effectiveness and reliability of the forecasts.

THEMATIC AREA

WARNING DISSEMINATION AND COMMUNICATION

Enhance the integration of warning dissemination and communication across the EWS value chain by establishing collaborative protocols that involve all relevant stakeholders, ensuring that the disaster management agencies work closely with local authorities, community organizations and other agencies to coordinate and streamline the issuance and dissemination of alerts.

Create and implement clear, standardized regulations and standard operating procedures for warning communication that define the roles and responsibilities of all key stakeholders, ensuring that messaging is consistent and unambiguous. Additionally, establish diverse communication channels and methods tailored to effectively reach all community members, thereby improving the timeliness and effectiveness of warning dissemination.

Establish feedback mechanisms and tracking systems for alert messages to monitor their effectiveness and reception. This should include the development of user-friendly platforms that allow recipients to report their understanding and response to alerts, enabling the continuous improvement of the messaging process and ensuring that alerts reach and resonate with the intended audience.

Enhance current warning dissemination and communication mechanisms to ensure they comprehensively address all hazards and their cascading impacts while reaching all segments of the population. This includes developing hazard-specific response protocols that prioritize actions, identify appropriate communications equipment, outline required procedures and designate emergency shelters, ensuring that all community members are adequately prepared and informed for various potential emergencies.

Foster enhanced cooperation in data sharing, system digitalization/automation, and stakeholder engagement to improve the effectiveness of early warning and alerting dissemination and communication.

Revitalize public alert systems by upgrading their design to overcome topographical challenges and ensure they are equipped with modern technology. Additionally, implement targeted awareness campaigns aimed at educating the population, particularly younger individuals, about the alert systems and their importance in emergency preparedness, thereby enhancing overall community readiness and responsiveness.

Implement the Common Alert Protocol to standardize messages across hazard and threat domains, ensuring clear and actionable guidance and improving the interoperability and consistency of warnings and alerts across various platforms and channels.

Implement and integrate cell broadcasting technology into existing warning dissemination schemes to ensure the timely and direct delivery of emergency alerts to mobile devices across the affected population. This approach will enhance the reach and effectiveness of warnings, allowing for immediate communication during emergencies, especially in areas where traditional communication methods may be unreliable.

Establish standardized processes for warning dissemination and communication that incorporate social media platforms and utilize crowd-sourced data to enhance the effectiveness and reach of alerts and warnings.

Develop targeted strategies to ensure that warning dissemination and communication mechanisms effectively reach the "last mile", focusing on vulnerable and at-risk communities through localized outreach efforts, partnerships with community organizations and the use of accessible communication channels to bridge gaps in awareness and preparedness.

Develop and implement guidelines to ensure that gender and disability considerations are fully integrated into early warning and alerting processes, including the participation of diverse stakeholders in planning, the creation of accessible communication materials, and targeted outreach efforts to address the specific needs of all community members, ensuring equitable access to information and preparedness resources.

Foster private-sector engagement in warning and alerting efforts by establishing partnerships, creating incentives for collaboration and integrating their resources and expertise into EWS. This will enhance the overall responsiveness and effectiveness of communication strategies, ensuring the timely and efficient dissemination of alerts.

Implement impact-based warnings to ensure timely and efficient communication, provide actionable information, enhance preparedness and improve response mechanisms for communities, individuals and businesses, thereby reducing pressure on emergency response services.

Develop and implement automated EWS in industrial enterprises and social facilities to enhance risk detection and response capabilities by investing in technology that enables real-time monitoring and alerts, ensuring the timely communication of potential hazards to protect workers and the surrounding community.

Implement comprehensive public awareness and education initiatives that focus on enhancing understanding of EWS and encouraging proactive measures among community members. This should include workshops, informational campaigns and accessible educational materials to empower individuals and communities to respond effectively to alerts in a timely fashion.

Broaden the scope of EWS stakeholders to include professional networks, volunteer groups, the private sector and civil associations. This diversification will enhance capacities for timely warning dissemination by leveraging the unique strengths and resources of each group, fostering collaboration and ensuring that alerts reach all segments of the community effectively.

Develop hazard-specific reaction models that include clearly defined risk thresholds to guide the notification of communities. These models should support impact-based warnings that trigger early actions, enabling communities to respond proactively based on the severity of the threat and ensuring that timely and effective measures are taken to mitigate potential impacts.

Develop an online risk communication platform that integrates real-time warnings and educational materials, ensuring broad accessibility and understanding through gender-sensitive and disability-inclusive features to enhance the preparedness and responsiveness of all community members.

Establish a fully integrated regional EWS by linking domestic dissemination channels while simultaneously building the required capacities and securing sustainable financing to ensure timely and effective alerts and coordinated response across the region.

THEMATIC AREA

PREPAREDNESS AND RESPONSE CAPABILITIES

Align existing disaster preparedness and response policy and regulatory frameworks with international and regional standards, such as the European Union Civil Protection Mechanism, to enhance consistency, cooperation and effectiveness in managing disasters.

Revise standard operating procedures to incorporate the diverse needs of all communities and stakeholders, ensuring that protocols address specific local contexts and prioritize the inclusion of vulnerable groups, thereby enhancing the effectiveness of preparedness and response efforts.

Strengthen the institutional preparedness and response capacities of key sectoral stakeholders within disaster risk management systems by providing targeted training, resources and coordination mechanisms to ensure more effective and efficient disaster response efforts.

Integrate preparedness and response responsibilities into key sectoral policy and regulatory frameworks, beyond disaster management agencies, by embedding these aspects into broader sectoral resilience efforts, e.g. strengthening sector-specific readiness such as identifying livestock evacuation routes in agriculture during floods or implementing measures to prevent and mitigate plant pests and diseases before, during and after disasters.

Strengthen subnational coordination by establishing intersectoral agreements that enhance collaboration and the integration of readiness across sectors, ensuring a more cohesive and effective reduction of risk at all levels.

Overcome resource constraints and sustain long-term engagement in regular education and training efforts by securing dedicated funding, leveraging partnerships and developing innovative and community-centred programmes, ensuring that preparedness initiatives are effective and that communities remain well equipped to respond to disasters.

Foster a stronger culture of preparedness by promoting an all-of-society approach, increasing awareness, inclusiveness and participation through targeted outreach and education and providing incentives that encourage broader community engagement in readiness-building efforts.

Evaluate at-risk community needs for tailored response strategies that address their unique needs and challenges.

Update professional training curricula and programmes to align with current climate and disaster risk challenges, incorporating the latest technologies and equipment while establishing systematic education and training initiatives for key policymakers, decision-makers and practitioners within participating institutions.

Optimize training centres in countries and territories to facilitate the efficient organization of multi-agency, multi-hazard, and multi-risk readiness programmes and training, ensuring a comprehensive approach to disaster preparedness and response.

Develop systematic education programmes tailored for community leaders and establish regional information-sharing fora to cultivate a local culture of preparedness, enhancing awareness and resilience within communities and ensuring that leaders are well equipped to effectively guide their populations during emergencies.

Enhance coordination and ensure the continuity of operations during emergencies by integrating preparedness and response plans across key ministries, such as health and environment, to facilitate a comprehensive approach to disaster management and improve overall community resilience.

Develop comprehensive programmes and plans for the preparedness and response of critical infrastructure facilities and assets to enhance resilience, reduce vulnerabilities and ensure the continued operation of essential services during emergencies.

Establish clear guidelines on the frequency, scope and scale of regular simulation exercises and drills to ensure consistent implementation, ultimately enhancing overall preparedness for emergencies.

Accordingly, develop a systematic framework for integrating feedback from drills into the decision-making process, ensuring that emergency plans are continuously updated and remain effective in enhancing preparedness.

Integrate early warning mechanisms into school curricula beyond the basic recognition of alert sounds, providing comprehensive education on disaster preparedness and response to foster resilience among youth and strengthen their role as agents of change.

Secure dedicated funding streams to enhance tools, technology development and specialist training, thereby improving disaster preparedness and response capabilities.

Foster the greater involvement of NGOs, academia and the private sector in community readiness initiatives to enhance anticipatory actions and ensure effective responses and business continuity of services during emergencies and disasters.

Design and implement specific anticipatory actions, including forecast-based financing mechanisms, to bridge resource gaps and strengthen community preparedness and response efforts.

Establish regular mechanisms for evaluating past disaster responses and systematically incorporate lessons learned into updated planning documents to foster a transformative approach to enhancing societal and community resilience.

Nurture initiatives and solutions for effective preparedness and prompt response across the region.

Establish regionally standardized frameworks and common structures to enhance community engagement and volunteerism, fostering a collaborative approach to disaster preparedness and response.

Potential resilience building of early warning pathways

The EWS stakeholder mapping and review of the regional context in the Western Balkans have revealed that a transformative shift is necessary in the approach to timely, effective and efficient EWS at regional, central and local levels. As a result, three potential development pathways have been identified by applying a matrix similar to that developed within the EWS Stakeholders Mapping Exercise Across Central Asia in 2024:

The status quo scenario: This scenario posits that the current state of EWS will remain static, operating within existing policies, norms and institutional frameworks. Minimal effort will be made to enhance functionality, which may involve limited stakeholder engagement, insufficient risk awareness and a lack of comprehensive operational plans. Additionally, the expansion of observation networks and improvements in communication and coordination are unlikely to occur. Human, material and technical resources will continue to be utilized according to established procedures, potentially leading to inefficiencies and missed opportunities for improvement.

Advanced scenario: This scenario envisions significant improvements to policies, legislation and institutions, emphasizing the adoption of impact-based warning systems. It includes fostering robust public–private partnerships, increasing investments in EWS, and targeted capacity-building efforts. Additionally, it calls for the expansion of monitoring networks and the implementation of impact-based forecasting to enhance overall resilience and responsiveness.

Altering scenario: This scenario anticipates the comprehensive establishment of a modern EWS. Key components include enacting new legislation, implementing organizational reforms and conducting extensive capacity-building and awareness-raising initiatives. It emphasizes the need for stable resource allocation, full integration of impact-based forecasting and warning systems, location-based warning and alerting, and embedding anticipatory actions into community resilience efforts, along with other transformative measures.

Table 3   Potential early warning system development pathways

SCENARIO	STATUS QUO SCENARIO	ADVANCED SCENARIO	ALTERING SCENARIO
MODEL	Regular	Progress	Towards next-gen EWS
FRAME	Regular and ongoing activities, minimal improvement	Improvement of 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 AND TERRITORIES	Majority of them	Some of them	Few of them

Source: Author's own elaboration as presented in UNDP (2024). Early Warning Systems Stakeholders Mapping Exercise Across Central Asia.
https://www.undp.org/eurasia/publications/early-warning-systems-stakeholders-mapping-exercise-across-central-asia

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Endnotes

[1] The term "Western Balkans" is used in the European Union to refer to six countries and territories in Southern and Eastern Europe that are covered by the European Union enlargement policy (Ministry of Foreign Affairs of Poland, 2025).

[2] References to Kosovo shall be understood to be in the context of the United Nations Security Council Resolution 1244 (1999).

[3] According to UNDP, 180 such sites have been identified, with one-third considered to be of significant environmental and security concern and one-fifth considered to pose transboundary risks (UNDP, 2016: 51).

[4] This document is available online at https://www.undp.org/eurasia/publications/early-warning-systems-stakeholders-mapping-exercise-across-central-asia.

[5] The National Disaster Risk Reduction Strategy (NDRRS 2023–2030) of Albania is available online at https://www.undp.org/sites/g/files/zskgke326/files/2024-01/national_drr_strategy.pdf.

[6] The Kosovo strategy for reducing risk from natural and other disasters is available online at https://ame.rks-gov.net/vleresimiIRrezikshmerise/en-us/.

[7] The draft version of the strategic document was dated February 2024. It is available online at https://ekonsultacije.gov.rs/topicOfDiscussionPage/367/3.

[8] The Montenegro National Strategy for Disaster Risk Reduction for the period 2025–2030 with an Action Plan for 2025–2026 is available online at https://www.gov.me/dokumenta/a9cef7cc-015d-4433-a86c-38bba3357126.

[9] The Law on Disaster Risk Management and Emergency Situation Management (2018) of Serbia is available online at https://www.fao.org/faolex/results/details/en/c/LEX-FAOC192028/.

[10] The Albanian Law on Civil Protection (2019) is available online at https://albcold.gov.al/wp-content/uploads/2021/05/Law-No.-45-On-Civil-Protection.pdf.

[11] Kosovo Law No. 04/L-027 for protection against natural and other disasters is available online at https://ame.rks-gov.net/legjislacioni/ligjet/en-us/Law%20No.%2004%20L-027%20FOR%20PROTECTION%20AGAINST%20NATURAL%20AND%20OTHER%20DISASTERS.pdf.

[12] The Montenegro Law on Protection and Rescue is available online at https://me.propisi.net/zakon-o-zastiti-i-spasavanju/.

[13] The Law on the protection and saving of people and materials goods from natural and other accidents is available online at https://www.fucz.gov.ba/download/36281/?tmstv=1726304428.

[14] The law is available at https://ruczrs.org/wp-content/uploads/2019/09/zakonozastitiispasavanjuuvanrednimsituacijama1.pdf.

[15] More information on the Framework Law on the protection and rescue of people and property in the event of natural or other disasters in Bosnia and Herzegovina is available at https://disasterlaw.ifrc.org/sites/default/files/media/disaster_law/2020-08/Framework law on the protection and rescue of people and property in the event of natural or other disasters_BiH.pdf.

[16] The North Macedonia Law on Crisis Management is available online at https://faolex.fao.org/docs/pdf/mac201971.pdf.

[17] Since Kosovo is not a party of the convention, the preparation of these documents is not a mandatory obligation. However, Kosovo makes efforts to align with the global climate change requirements through the development of related strategies, action plans and programmes.

[18] The National Development Strategy (2022–2042) of North Macedonia is available online at https://www.nrs.mk/content/ENG%20Draft%20NDS%20fin.pdf.

[19] The National Strategy for Sustainable Development of Montenegro by 2030 is available online at https://faolex.fao.org/docs/pdf/mne180387.pdf.

[20] The Albania Fourth National Communication on Climate Change (2022) is available online at https://unfccc.int/documents/620929.

[21] The Bosnia and Herzegovina Fourth National Communication under the United Nations Framework Convention on Climate Change (2021) is available at https://unfccc.int/sites/default/files/resource/FNC BiH_ENG fin.pdf.

[22] The Montenegro Third National Communication on Climate Change (2020) is available at https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/8596012_Montenegro-NC3-1-TNC - MNE.pdf.

[23] The Fourth National Climate Change Communication (2023) from North Macedonia is available online at https://api.klimatskipromeni.mk/data/rest/file/download/15644574e26d61c276c5899e7ccfca8c191f7207b5393d352d6ca2ba51e91406.pdf.

[24] National Adaptation Planning (NAP) to Climate Change in Albania: Framework for the Country Process (2021) from Albania is available online at https://unfccc.int/documents/307740.

[25] The National Adaptation Plan (2021) from Bosnia and Herzegovina is available online at https://unfccc.int/sites/default/files/resource/NAP-Bosnia-and-Herzegovina.pdf.

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[30] The Kosovo Water Strategy (2023–2027) is available online at https://mmphi.rks-gov.net/MMPHIFolder/OtherDocuments/REVIEW OF THE STATE WATER STRATEGY 2023 - 2027 AND ACTION PLAN 2023 - 2025_ENG (1).pdf.

[31] The Montenegro National Drought Monitoring Plan (2020) is available online at https://www.unccd.int/sites/default/files/country_profile_documents/Montenegro national drought plan_0.pdf.

[32] Visit the platform online at http://www.platformabh.ba/.

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[37] For more information, please visit https://www.savacommission.org/flood-forecasting-and-warning-system/579.

[38] For more information, please visit https://www.icpdr.org/sites/default/files/nodes/documents/080310_efas_pr_final_icpdr.pdf.

[39] For more information, please visit https://www.un.org/en/climatechange/early-warnings-for-all.

[40] For more information, please visit https://www.pdc.org/disasteraware/.

[41] For more information, please visit https://vlada.mk/node/26063.

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https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/eu-civil-protection-mechanism_en.

43 For more information on the European Flood Awareness System, please visit
https://www.copernicus.eu/en/european-flood-awareness-system.

44 For more information on the European Forest Fire Information System, please visit
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45 For more information on the Emergency Response Coordination Centre, please visit
https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/emergency-response-coordination-centre-ercc_en.

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47 Information on the Programme for Disaster Risk Assessment and Mapping is online at http://www.ipadram.eu/.

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49 For more information on the IPA CARE Programme on the capacity for risk management of earthquakes and health
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50 For more information, please visit
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51 For more information, please visit
http://www.ipacbc-bgrs.eu/projects-funded/setting-system-prevention-and-early-warning-floods.

52 For more information, please visit https://www.floodshield.eu/floodshield/.

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https://sendaiframework-mtr.undrr.org/media/84438/download?startDownload=20240917.

57 For more information, please visit https://www.preventionweb.net/sendai-framework/sendai-framework-indicators.

58 For more information, please visit https://sendaimonitor.undrr.org/.

59 For more information, please visit https://www.gov.me/dokumenta/9ba11199-ce1c-42bd-9590-08e9ef59e503.

60 For more information, please visit
https://www.mchamber.mk/Upload/Documents/%D0%A3%D1%80%D0%B5%D0%B4%D0%B1%D0%B0_%D0%B7%D0%B0_%D
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0%BF%D1%80%D0%BE%D1%86%D0%B5%D0%BD%D0%B0%D1%82%D0%B0_%D0%BD%D0%B0_%D0%B7%D0%B0%D0%B3
%D1%80%D0%BE%D0%B7%D0%B5%D0%BD%D0%BE%D1%81%D1%82_%D0%BD%D0%B0_%D0%B1%D0%B5%D0%B7%D0%
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62 For more information, please visit https://qbz.gov.al/.

63 For more information, please visit http://www.msb.gov.ba/PDF/13072022.pdf.

64 For more information, please visit https://ruczrs.org/wp-content/uploads/2019/09/purs.pdf.

65 For more information, please visit

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66 For more information, please visit

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67 For more information, please visit http://prezentacije.mup.gov.rs/svs/HTML/licence/Procena rizika od katastrofa u RS.pdf.

68 For more information, please visit http://procena.cuk.gov.mk/Login.aspx?ReturnUrl=%2f.

69 This web page is online at http://civilnazastitakraljevo.rs/the-process-of-creating-a-disaster-risk-assessment/.

70 The INSPIRE Directive (2007) aims to establish an infrastructure for spatial information in Europe to support community environmental policies and policies or activities that may impact the environment. For more information, please visit https://knowledge-base.inspire.ec.europa.eu/legislation/inspire-directive_en.

71 For more information, please visit https://nipp2.katastar.gov.mk:5003/geonipp/#mapPanel.

72 For more information, please visit https://www.undp.org/serbia/news/serbia-gets-disaster-risk-register.

73 For more information, please visit https://geoliss.mre.gov.rs/beware/?page=project.

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75 For more information, please visit https://drasinfo.org/.

76 For more information, please visit http://vrb.pmfbl.org/.

77 For more information, please visit https://www.crisis-project.org/.

78 For more information, please visit https://mkffis2.cuk.gov.mk/index.php/pocetna?lang=en.

79 For more information, please visit https://www.meffis.me/.

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83 For more information, please visit

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84 Results from these initiatives relevant for other thematic areas are presented in the consequent sections.

85 For more information, please visit http://www.ipadram.eu/.

86 For more information, please visit

https://www.researchgate.net/publication/339508648_ERRA_IPA_DRAM_Manual_and_Guidelines_for_Data_Experts#full-text.

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89 INFORM is a collaboration of the Inter-Agency Standing Committee Reference Group on Risk, Early Warning and Preparedness and the European Commission. For more information, please visit https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Subnational-Risk/South-East-Europe.

90 For more information, please visit https://www.giz.de/en/worldwide/29000.html.

91 For more information, please visit
https://fifspubprd.azureedge.net/afdocuments/project/6534/6534_6215_AF_Regional_Project-Proposal_resubmission_06-Feb-2019-clean-version.pdf.

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https://www.giz.de/en/downloads/Report%20%e2%80%93%20Vulnerability%20Assessment%20and%20Adaptation%20Action%20Plan%20for%20Tirana%20Albania%20(2015).pdf.

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https://www.giz.de/en/downloads/Report%20%e2%80%93%20Vulnerability%20Assessment%20and%20Adaptation%20Action%20Plan%20for%20Podgorica%20Montenegro%20(2015).pdf.

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97 For more information, please visit
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98 For more information, please visit https://www.undrr.org/media/90451/download.

99 For more information, please visit
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100 For more information, please visit https://www.meteoalarm.org/en/live/.

101 For more information, please visit https://ihmk-rks.net/uplds/docs/MoU_Albania_EN.pdf.

102 For more information, please visit https://emsc-csem.org/.

103 For more information, please visit https://www.emsc-csem.org/lastquake/information_channels/lastquake_app/.

104 For more information, please visit https://wmo.int/.

105 For more information, please visit https://www.eumetsat.int/.

106 For more information, please visit https://www.ecmwf.int/.

107 For more information, please visit https://www.see-mhews.org/.

108 For more information, please visit https://www.savacommission.org/flood-forecasting-and-warning-system/579.

109 For more information, please visit
https://sendaimonitor.undrr.org/analytics/country-global-target/18/8?indicator=37&regions=5.

110 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.

111 For more information, please visit https://pravno-informacioni-sistem.rs/eli/rep/sgrs/skupstina/zakon/2018/87/1/reg.

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https://sendaimonitor.undrr.org/analytics/country-global-target/19/8?indicator=36&regions=5.

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123 For more information, please visit
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124 For more information on DPPI Flex 2023, please visit
https://www.dppi.info/dmtp/seminars-workshops-conferences/bosnia-and-herzegovina/brcko/23-10-23/dppi-flex-2023-full-scale.

125 For more information, please visit
https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/european-disaster-risk-management/european-disaster-resilience-goals_en.

126 For more information, please visit
https://civil-protection-humanitarian-aid.ec.europa.eu/funding-evaluations/financing-civil-protection/prevention-and-preparedness-projects-civil-protection_en.

127 For more information, please visit
https://www.undp.org/serbia/projects/eu-civil-protection-and-disaster-risk-resilience-strengthening-republic-serbia.

128 For more information on EU for Healthcare in Serbia, visit https://www.undp.org/serbia/projects/eu-healthcare-serbia.

129 More information on the Get the Airport Ready initiative is available at
https://www.undp.org/geneva/projects/get-airports-ready-disaster-gard.

130 Albania (2009), Montenegro (2017), and North Macedonia (2020) are members of NATO. Bosnia and Herzegovina and Serbia joined the Partnership for Peace programme. Bosnia and Herzegovina entered NATO's Membership Action Plan in 2010, while Serbia signed the Individual Partnership Action Plan in 2015.

131 For more information, please visit https://www.nato.int/cps/en/natohq/topics_117757.htm.

132 For more information, please visit https://ame.rks-gov.net/content/templates/ame/uploads/2020-10/West Balkan NFFIS & Eco-DRR Newsletter.pdf.

133 For more information on the Macedonian Forest Fire Information System, please visit
https://www.jica.go.jp/oda/project/1000100/index.html?wovn=en.

[134] For more information, please visit https://www.jica.go.jp/oda/project/1602223/index.html?wovn=en.

[135] For more information, please visit https://www.jica.go.jp/Resource/project/english/montenegro/001/index.html.

[136] For more information, please visit https://www.jica.go.jp/Resource/project/english/kosovo/005/index.html.

[137] For more information, please visit https://www.see-mhews.org/.

[138] The initiative includes following countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Hungary, Israel, Jordan, Lebanon, Montenegro, North Macedonia, Republic of Moldova, Romania, Serbia, Slovenia, Türkiye and Ukraine.

[139] More information on the Flood Forecasting and Warning System of the Sava River Basin is online at https://www.savacommission.org/flood-forecasting-and-warning-system/579.

[140] Information on the Delft-FEWS platform is available online at https://www.deltares.nl/en/software-and-data/products/delft-fews-platform.

[141] The Disaster Prevention and Preparedness Initiative for South Eastern Europe is online at https://dppi.info/.

[142] The centre was founded by Albania, Bosnia and Herzegovina, Bulgaria, Croatia, North Macedonia, Hungary, Republic of Moldova, Romania, Slovenia and Türkiye, with assistance from the WMO and the UNCCD. For more information, please visit https://www.dmcsee.org/index.php.

[143] For more information, please visit https://www.undpopenplanet.org/projects/Integrated_climate-resilient_transboundary_flood_risk_management_in_the_Drin_ River_basin_in_the_Western_Balkans/.

[144] For more information, please visit https://www.giz.de/en/worldwide/29000.html.

[145] For more information on the Balkan Regional Early Warning System Programme, please visit https://www.pdc.org/balkans-early-warning-kick-off-2022/.

[146] For more information on the DisasterAWARE platform, please visit https://www.pdc.org/disasteraware/.

[147] The Make Cities Resilient 2030 initiative is online at https://mcr2030.undrr.org/.