**Contribution to the Mid-term Review of the Sendai Framework for Disaster Risk Reduction**

by

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1 Introduction and key messages

In 2020, the United Nations General Assembly called for a Mid-Term Review of the Sendai Framework for Disaster Risk Reduction. The United Nations University - Institute for Environment and Human Security (UNU-EHS) welcomes the opportunity to submit an institute contribution to the Mid-Term Review on both retrospective and prospective elements. The United Nations University (UNU) is the academic arm of the United Nations and acts as a global think tank. The Institute for Environment and Human Security (UNU-EHS) works on risks, adaptation and transformation related to environmental hazards and global change.

With this submission, UNU-EHS contributes to Mid-Term Review process on selected topics within its area of expertise: the Systemic and interconnected nature of risk (Chapter 2), Disaster risk finance and risk analytics (Chapter 3), Disaster-related losses of ecosystems and ecosystem services, including digitalization (Chapter 4), Sendai implementation in mountains (Chapter 5), and Building back better in recovery (Chapter 6).

Following the guidance from the Voluntary National Reporting template, each thematic section of this document is structured as: i) Retrospective review, ii) Context shifts / new and emerging issues and challenges, iii) Recommendations.

1.1 Key messages

Retrospective review

A key factor in achieving the Sendai Framework Priorities for Action concerns understanding, analysing and managing the systemic and interconnected nature of risk. Seemingly isolated events have overlapping shared drivers, root causes and impacts. Hazards can be both exogenous (i.e. emerge from outside the system) and endogenous (i.e. emerge from within the system), exposure can be indirect (i.e. effects can be felt in places that are not directly approximated to a hazard), and the vulnerability of one system can also turn into a hazard for other interdependent systems.

Ecosystems and ecosystem services make an important contribution to disaster risk reduction. However, the Sendai Framework Monitoring system has very limited options to capture disaster-related losses of ecosystems and their services. Of the options that relate to green and blue infrastructure, there is not a link to ecosystem services. Currently, no country has reported on green infrastructure in the Sendai Framework Monitoring system, despite the possibility of doing so under Targets C, D and in the custom indicators. This emphasizes that the established Targets and Indicators of the Sendai Framework poorly represent ecosystem services. Similarly, we observe a misalignment between the priorities defined in the Sendai Framework and the indicators on the Sendai Monitoring system with respect to disaster risk finance and risk understanding. The level of aggregation in indicators G5 and E1 conceals the progress in funding mechanisms and the investments in analytics, discouraging the integration of Priorities 1 and 3 on risk reduction strategies.

Strengthening disaster risk governance in mountains is especially important as communities are located in remote areas with, at times, poor access to services and thus often need to be autonomous in case of a hazard event. Investments have been made in establishing early warning systems (EWS) for hazards with potentially large impacts, which has been made possible by technological advances and ad hoc overseas development assistance. However, there is still a huge need for capacity building to establish local disaster risk reduction plans.

Priority 4 of the Sendai Framework is enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction. Examples of building back better are still scarce. As communities recover from disasters, we observe the tendency to rebuild without learning. Barriers for ‘building back better’ are such factors as insecurity, polarization, regulations that discourage change, and lack of understanding of recovery process with relief organizations. Drivers for ‘building back better’ include cooperation and trust building in new alliances between citizens and government actors, platforms that enable self-mobilization, and long-term vision for change.
**Context shifts / new and emerging issues and challenges**

There is appetite for guidance and actionable management options for systemic risk, but communication on the concept is highly difficult. This is challenging in the policy domain, where policies most often target specific goals and sectors. A key challenge for systemic risk analysis is to couple the complexity of social ecological systems with human agency to understand how systems perform under stress. These emerging issues require attention to make progress on the Priorities for Action.

Lines of progress are improving risk understanding, which the Sendai Framework can leverage to increase reporting and provide a more comprehensive picture of disaster risks around the globe. These are: i) Advancement in information technology, including data collection, ii) Socioeconomic factors of vulnerability and exposure and challenges for data and analytics needs, iii) Stakeholder engagement and, iv) Investing in disaster risk reduction for resilience.

In mountain areas, the world’s water towers are rapidly drying up and may no longer have the same capacity to provide the essential ecosystem services upon which 1 billion people depend. The rapid change in mountains is leading to cascading and complex interactions, including rapid changes in habitat, increased occurrence of extreme hazard events and the rapid spread of invasive species.

Increases in climate related extremes, in conjunction with compounding and cascading effects from other hazards (including COVID-19), raise the importance of recovery. Recovery is still poorly understood and typically a lower-priority aspect of risk management policy and practice. Supporting ‘building-back-better’ is an emerging challenge for the Sendai Framework. Nature-based solutions can be effective options for managing multi-and-systemic risks, and should be considered in Sendai Framework Priority 4.

**Recommendations**

Systemic risk management must be able to address the multifaceted and complex nature of disaster risk. System interconnectivity can be used to our advantage to address multiple problems at once by designing integrated solutions. When assessing risk, is it important to map interconnections, identify critical system components and understand risk perspectives and perceptions. When designing risk interventions, the cascading effects and trade-offs of policies must be understood, all hazard and multi-risk approaches should be taken where possible and clear, actionable and open communication is important to build trust.

Disaster-related losses of ecosystems and ecosystem services need to be better included and reported in the Sendai Framework monitoring system. For example, the reporting of an area of damaged or destroyed green (and blue) infrastructure would be more meaningful than the sole number of items affected (Target D, indicator D-4). The majority of ecosystem services can be considered as basic services needed for society to function. Against this background, ecosystem services should be integrated into indicator D-8 (disrupted services) and reported in reference to ecosystem losses under green (and blue) infrastructure as monitored by indicator D-4 (Target D, indicator D-8). Ecosystems which are recognized for their disaster risk reduction benefits should be considered as critical infrastructure.

Mountain regions are overlooked in disaster risk reduction. More investment is needed in disaster resilient infrastructure in mountains, including for basic services, such as improved communications and access to water and transportation corridors. These recommendations can be interlinked through transformational pathways planning to address underlying conditions that lead to mountain risks, investing more in bridging information and knowledge gaps, supporting adaptation and informing a just future for all mountain communities that resonates with the Sendai Framework, the Glasgow Pact and the Sustainable Development Goals.

The committee of the Mid-term review is recommended to discuss pathways for countries to increase reporting within the Sendai Framework on risk understanding and disaster risk finance as a way to steer national and global efforts. Linkages should also be explored with the global goal on adaptation and global stocktake, as the Sendai Framework can inspire governments to invest in analytics and reporting.
Finally, Building-Back-Better in recovery deserves more attention in disaster risk management. We recommend sharing recovery experiences, and using this experience to shift the focus from reconstruction to proactive adaptation and recovery pathways.

2 The systemic and interconnected nature of risk

2.1 Retrospective review

A key factor in achieving the Sendai Framework Priorities for Action concerns understanding, analysing and managing the systemic nature of risk. While research on systemic risk is not new, much of the existing work prior to 2015 had largely focused on financial systems. More recently, increasing work has been undertaken across different research domains to understand the systemic nature of disaster risk. Much of this work engages with the conceptualization and emergence of systemic risk in social-ecological systems. In attempts to further progress work on systemic disaster risk, UNU-EHS has developed tools and methodologies that engage with understanding, analysing, managing and communicating the concept from an empirical perspective.

2.1.1 Lessons from COVID-19

In collaboration with UNDRR, UNU-EHS has undertaken a project named CARICO which draws on lessons from the COVID-19 pandemic to better understand and manage systemic risk (UNDRR & UNU-EHS, 2022). We have developed an analytical tool named ‘Impact Webs’ (building on impact chains methodologies (GIZ, EURAC & UNU-EHS, 2018) which starts from observed interconnected impacts to map the cascading interplay of hazard(s), vulnerabilities and risk management/policy interventions and possible shock propagation across sectors and systems. Lessons include seven key characteristics that determine systemic risk. While these were developed in the context of the pandemic, these characteristics are observable in risk associated with other disaster events (i.e. in the context of climate change, conflict or humanitarian crises). The seven characteristics are:

I. Interdependence, interconnectedness and cascading effects
II. Non-linear relationships
III. Feedback loops
IV. Tipping points
V. Being unnoticed
VI. Uncertainty
VII. Dynamic

Additionally, this work has expanded our understanding of risk by drawing attention to (i) hazards can be both exogenous (i.e. emerge from outside the system) and endogenous (i.e. emerge from within the system), (ii) exposure can also be indirect (i.e. effects can be felt in places that are not directly approximated to a hazard) as a result of interconnectedness, and (iii) vulnerability of one system (i.e. an underprepared health system) can also turn into a hazard for other interdependent systems.

Building on case studies, Figure 1 shows a conceptual model for the ‘systemic nature of COVID-19 risks and impacts’. The model, which focuses action on Priority 1 of Sendai, advances existing conceptual models of systemic risk in showing direct and cascading effects of COVID-19 on interconnected systems. It illustrates how these effects, coupled with decision-making processes (e.g. interventions to contain the spread of the disease) and other factors (i.e. pre-existing vulnerabilities, system dependencies, tipping points and feedback loops), have contributed to making vulnerable communities, sectors and systems more at-risk.
2.1.2 Lessons from interconnected disaster risks

We observe that disasters are primarily perceived as isolated, random incidents rather than as socially constructed systemic failures. Critical reflection is needed as to why disasters have happened, and how their effects emerge and cascade across systems. Through this lens, UNU-EHS analysed 10 disaster events between 2020/2021 and between 2021/2022. This work, which contributes actionable knowledge to Priorities for Action 1 and 2, has been published in the Interconnected Disaster Risks report (UNU-EHS, 2022). The report looks at how seemingly isolated events have overlapping shared drivers (e.g. atmospheric warming, insufficient early warning systems, and deforestation), share root causes (e.g. undervaluing environmental costs (see section 4 below), inequality of development opportunities, and a legacy of colonialism) and shared impacts (e.g. ecosystem damage and biodiversity loss, migration/ displacement, food insecurity). This work highlights that, through interconnected systems, disasters influence one another. This can occur where one disaster directly contributes to the hazard of another, or where one disaster increases the exposure or vulnerability of people or places. Additionally, impacts shared among different disasters overlap to create future risks that will only be revealed over time, emphasizing the dynamic and uncertain nature of systemic disaster risk.

This work emphasizes that understanding disaster risks (Priority 1) requires a systems perspective. Only then we can understand how disturbances and shocks cause ripple effects that transgress from seemingly disconnected sectors or systems and extend into economic, social, and political domains causing a complex array of impacts and new risks. By better understanding these connections, pre-existing vulnerabilities, as well as their root causes and drivers can be better addressed through risk management (see 2.3).
2.2 Context shifts / new and emerging issues and challenges

In May 2022, UNU-EHS brought together over forty experts from across a range of domains for an expert workshop on new frontiers in understanding systemic risk. Here, we synthesize outcomes to highlight emerging issues that fall under; i) Systemic risk analysis and ii) Systemic risk/ policy integration.

2.2.1 Challenges for systemic risk analysis

Quantitative and qualitative tools for analysing systemic risk emerge, often relying on network mapping and analysis approaches (e.g. ecological network analysis, Bayesian network analysis, impact chain approaches, agent based modelling) that provide focused simplifications of systems, thereby helping to identify relationships between interconnected system components and spatial-temporal patterns. A key challenge for these approaches is to couple the complexity of social ecological systems with human agency to understand how systems perform under stress. This is particularly the case in response to ‘black swan’ events (unpredictable events with severe impacts, such as COVID-19), as new sets of rules emerge. Additionally, it is important to look at natural and social tipping points. However, analysing gradual changes and non-linear relationships to identify tipping points is difficult and needs more attention, particularly in consideration of climate tipping points in natural systems, which can themselves trigger ‘black swan’ events.

2.2.2 Challenges for policy integration

Experts report an appetite for clarity and guidance on actionable management options for systemic risk in the policy domain, however, challenges are evident. Engagement with regional organizations, as well as communicating systemic risk in appropriate language was flagged as key, particularly given the cross-border nature of impacts. A challenge in engagement with policy is its sectoral nature, which conflicts with systems and interconnectivity thinking.

2.3 Recommendations

2.3.1 Lessons from COVID-19

Our empirical work on systemic risk in the context of COVID-19 has provided lessons in (i) risk assessment, (ii) risk interventions, and (iii) monitoring and evaluation. For risk assessment; it is important to map interconnections (that exist in systems by design or are emergent), as well as identify critical system components (that can lead to devastating cascading effects) and understand risk perspectives and perceptions (paying attention to trust and the perceived fairness of distributed benefits and losses of management decisions). For risk interventions; the cascading effects and trade-offs of policies must be understood, multi-risk approaches should be taken, there needs to be preparedness for ‘black swan’ events and clear, actionable and open communication is important to build trust in risk reduction measures (especially in times of disaster). For monitoring and evaluation; more investment is needed to collect, manage and interpret data. Where possible, results should be made open access and key decision-making indicators should be regularly re-evaluated to assess their relevance in dynamic situations.

2.3.2 Lessons from interconnected disaster risks

System interconnectivity can also be used to our advantage to address multiple problems at once by designing integrated solutions. Through analysing the shared drivers, root causes and impacts across the disaster events of the Interconnected Disaster Risks report (UNU-EHS, 2022), eight potential interconnected and cross-cutting solutions have been identified (Figure 2). Solutions may address drivers behind multiple types of disasters. For example, green infrastructure in cities can reduce the risk from both flood and heatwave events. Such co-benefits should be accounted for when valuing solutions along with potential trade-offs. When developing risk management options, it is critical to acknowledge that solutions can also have cascading effects. Here too, attention should be paid to trade-offs, co-benefits and potential positive cascades. We acknowledge that many values are non-monetary, with challenges for integration into cost-benefit comparisons.
3 Risk Analytics and Disaster Risk Finance

While the Sendai Framework offers a comprehensive mechanism for countries to showcase, benchmark, and strategize their progress on disaster risk reduction, there is a misalignment between the Priorities for Action defined in the Sendai Framework and the indicators on the Sendai Monitor system. The current indicator structure focuses on impact reduction and collaboration and planning, whereas directly tracking progress on the Priorities would require more detail. In this Chapter we focus on Risk Analytics and Disaster Risk Finance for Priority 1 and Priority 3.

3.1 Retrospective review

3.1.1 Priority for Action 1

There is a stark contrast between the importance that the Sendai Framework gives to risk understanding and its related reporting requirements. With the current indicator structure, countries report their progress on risk understanding mostly under Global target G (specifically, under indicator G-5: Number of countries that have accessible, understandable, usable, and relevant disaster risk information and assessment available to the people at the national and local levels). In our opinion, the degree of aggregation of this indicator reduces the value of the information it provides, missing the complexities and interactions of the components, scales, and timeframes of risk, as discussed in the Section 2 of this report. Moreover, it fails to reflect the capacity of governments to undergo the appropriate assessments and monitor progress from investments in data or analytics.

Priority 1 states that: Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard
characteristics, and the environment, disaggregating the required factors for such understanding into 15 points (such as data collection, capacity building, investments in innovation, integration of indigenous knowledge). In contrast, under indicator G-5 member states report whether there is accessible, understandable, usable, and relevant disaster risk information and assessment, using a binary (i.e., yes or no, 1 or 0) for each of the major hazard types the country faces, calculating the score as the arithmetic average of all of the hazard-specific scores (UNISDR, 2017). According to the Sendai Monitoring website, even under this low requirement, less than 15% of the 195 countries reported it for 2019. From the data available on the G-5, three considerations emerge: i) out of the 20 countries that reported, 4 have a value of 0, implying that risk assessments are either non-existent or don't meet minimum requirements, ii) the low level of reporting is not regionally determined. Even though more countries report in the Americas and Europe than in Africa, Oceania, and Asia, the data available is not significantly higher, iii) most countries do not consistently report their annual progress. These three considerations suggest that capacities for risk assessments are limited in many regions of the world, underlining the need to monitor the progress in these capacities under Priority 1.

The following challenges faced by countries in reporting risk understanding are worth noting; i) Disaster data is often not centralized, and there is no overview of the existing data and where to find it (Khoza et al., 2022; Kohler et al., 2020), ii) Data aggregation is complicated, given the inconsistencies in data collection across different agencies and levels of government (Kohler et al., 2020), iii) Some countries are reluctant to report on the Sendai Framework Monitoring system to avoid cross-country comparisons of data collected using different methods (Kohler et al., 2020), and iv) National and local institutions lack the technical capacities and infrastructure to process and consolidate data to appropriately inform risk management (Khoza et al. 2022; Mizutori, 2020).

3.1.2 Priority for Action 3

The Sendai Framework recognizes the importance of Disaster Risk Finance as part of Priority 3, highlighting that in order to increase investments in disaster risk reduction for resilience, states should: “30 (b) … promote mechanisms for disaster risk transfer and insurance, risk-sharing and retention, and financial protection...”. Priority 3 also mentions risk analytics as an important element for finance, noting that states shall: “30 (g) … promote the mainstreaming of disaster risk assessment, mapping, and management into rural development planning and management...”. The importance of risk analytics and disaster risk finance and insurance for disaster risk reduction is also recognised by other organizations. For example the OECD DAC integrated reporting on disaster risk financing into its Creditor Reporting System.

Despite this background, reporting disaster risk financing activities is not facilitated by the current indicator structure of the Sendai Framework. Moreover, while singular disaster risk financing actions and initiatives are valuable, they must be combined in a risk-layering approach and be part of comprehensive risk management strategies, which are also not part of the Sendai Framework. Few countries report on disaster risk reduction programs, plans, or strategies under Indicator E-1 (Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030) and disaster risk finance, in particular, under E-1 a #7. However, the overall E-1 indicator is calculated as the average quality of ten elements of disaster risk reduction strategies based on a self-assessed criterion (UNISDR 2017), which further reduces the visibility and influence of finance in the Sendai Framework.

3.2 Context shifts/ new and emerging issues and challenges

There are several lines of progress in risk analytics and finance, which the Sendai Framework can leverage to strengthen reporting and provide a more comprehensive picture of disaster risks around the globe.

3.2.1 Advancement in information technology and risk analytics

The rapid advancement in information technology in the past few years has resulted in unprecedented access to risk-related data and tools (see also Box 1, digitalization). These advancements include remote sensing,
geographical information systems (GIS), and drones, as well as fast data collection using social media, in-situ streams (cell phone data), and crowd-sourcing (Ruckelshaus et al., 2020; Izumi et al., 2019). Combining advances in information technology with methodological approaches that help to build conceptual understanding of risk interaction, underlying drivers, root causes and cascading effects (see also 2.1 lessons) can be highly promising for future risk assessment. Disaster risk reduction practitioners and researchers leverage these technologies and data to further develop tools, such as the geospatial model that is used to monitor Sendai Framework indicator B (Walz et al., 2020; Urrutia et al., 2022) and the modelling platform CLIMADA that UNU-EHS uses for risk and adaptation assessment (UNU-EHS & Frankfurt School of Finance and Management, 2021).

Challenges remain around the appraisal and monitoring of socioeconomic factors, such as poverty, underdevelopment, marginalization, and inequality, which are drivers of both increased disaster vulnerability and maladaptation (Schipper, 2020; Chmutina et al., 2021). Similarly, the scope of what was understood as direct impacts of disasters has expanded to include non-monetary impacts, like reduced access to education, health services, and transportation, which adds to our data and analytics needs (Sett et al., 2022).

3.2.2 Assessing Disaster Risk Finance and Insurance needs

In recent years, understanding has moved away from singular disaster risk reduction plans towards approaches that integrate with climate change adaptation and other sectors. This is also reported to facilitate convergence of public budgets and resources (UNDRR, 2022b). This integration creates challenges to capture the different needs which disaster risk financing has to cover for effective risk management. For example, to minimize protection gaps, investments in social protection and affordable insurance solutions through premium and capital support, have to be combined with micro-finance and forecast-based financing (UNDRR, 2022b). Opportunities arise from synergies between initiatives. For example, the InsuResilience Global Partnership for Climate and Disaster Risk Finance and Insurance Solutions (IGP) shares the commitment to close the protection gaps, which is reflected in indicator 3 of the IGP Vision 2025 "ilii Number of countries adopting risk-finance and insurance solutions integrated within the prevention, preparedness, response and recovery plans that are anchored in a country's systems" (InsuResilience Global Partnership, 2019). Similarly, the Risk-informed Early Action Partnership (REAP)'s targets that by 2025 "50 countries [will] have reviewed and integrated their crisis/disaster risk management and climate adaptation laws, policies and/or plans to ensure that they reduce climate change impacts and exposure on people and the environment" (REAP, 2019).

3.3 Recommendations

3.3.1 Economics of Climate Adaptation

Open-source data and tools can significantly increase governments’ understanding of their disaster risks, which translates to enhancing the Sendai Framework Monitor system. UNU-EHS developed an open-source tool named the Economics of Climate Adaptation (ECA) framework. Applied in more than 20 countries, ECA provides access to state-of-the-art modelling (CLIMADA) and stakeholder engagement methods and is linked to a community of practice that shares lessons learned and success stories that can guide risk managers worldwide. This framework allows for the flexible identification of cost-effective climate change adaptation measures (including risk transfer). It ensures a fully integrated process, from climate-risk assessment to the feasibility of concrete adaptation measures and decision-making on climate investment. Moreover, ECA can help quantify the protection gap for selected countries or regions by estimating expected annual damages (UNU-EHS & Frankfurt School of Finance and Management, 2021).

3.3.2 Sendai Framework reporting

UNU-EHS recommends that the committee of the Mid-term review discusses pathways to increase the reporting options for countries on disaster risk, in particular, risk understanding, analytics and finance. In section 3.1, we focused on Priority 1 and 3, which countries can report on through indicators G-5 and E-1, respectively, and we describe why we believe they are not sufficient to represent the complexity of the topics...
they addressed. We stress the urgency of elevating the progress of countries in these fields within the Sendai Framework as a way to steer national and global efforts in the same direction.

3.3.3 Linkages with the Global Goal on Adaptation and Global Stocktake

The lessons learned from the MTR process and the many successes of the Sendai Framework are more relevant today than ever. Implementing and reporting on the Sendai Framework has a high potential to leverage synergies with initiatives under the UNFCCC, in particular the Global Goal on Adaptation and to global stocktake. This momentum can motivate governments to invest in analytics and reporting and increase disaster risk finance.

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**Box 1: Digitalization and risk management**

**Opportunity and need**

The way we experience the world we live in and how we interact has changed drastically in the last decades. Millions of people are now connected in real time to their community and the wider world through the internet and interactive devices such as the smartphone. We have better access to data, information and entertainment, as well as an unprecedented window to provide feedback and two-way communication. This presents opportunities to effectively engage with different stakeholders in the process of informed, collaborative risk management (see Section 3.2). While certain actors have been more successful in understanding individual needs and even influencing them through tools such as big data, machine learning and AI, these tools can enable many more stakeholders to engage efficiently and effectively with each other. The MRT SF presents an opportunity to integrate such tools in national, regional and global disaster risk reduction and management practices.

**Usage of digitalization in managing risks from COVID-19**

COVID-19 pandemic spotlighted the potential of digital means to augment effective disaster risk reduction and management practices. Various countries relied on nascent digital platforms for real time and efficient COVID-19 management. Digital apparatus meant for other governance purposes, such as the ‘command and control centers’ of the Indian smart cities, proved efficient in assisting COVID-19 management through real time data collection, processing and monitoring. The usage of contact tracing apps in minimizing the spread of COVID-19 infection and later the usage of QR codes-based vaccination certificates underline the immense potential that digitalization has as means of risk management. Important to note here, is the recommendation in section 2.3, concerning decision-making indicators, which should be regularly re-evaluated to assess their relevance in dynamic situations.

**Emerging challenges**

This rapid change also presents certain threats that were not earlier foreseen. The concerns regarding privacy and misuse of data collected and processed for example, underlines the need for a global set of guiding principles and rulebooks for the digital world. The questions of cybersecurity, fraud and manipulation of individuals or communities have fundamental consequences for ‘informed decision making’. Proactive and succinct outreach through the digital means are needed to contain the risks of misinformation, as witnessed during the COVID-19 pandemic.

While we are embarking on the digital era, the success of disaster risk reduction and management practices in the near and long term depends on people having affordable and reliable access to digital means. The MRT SF presents the opportunity to establish and foster frameworks that support sustainable, inclusive and just digitalization.
4 Disaster-related losses of ecosystems and ecosystem services

In this section, we include inputs to the Mid-term review covering the topics of green and blue infrastructure in Sendai Framework Monitoring, disaster related losses of ecosystems and their services and Nature-based solutions for disaster risk reduction. These inputs have also been submitted to the Mid-term review in a document from the PEDRR network, which includes UNU-EHS.

4.1 Retrospective review

4.1.1 Green (and blue) infrastructure in Sendai Framework Monitoring

The Sendai Framework Monitor system has very limited options to capture disaster-related losses of ecosystems and their services. One entry point for the consideration of ecosystem losses are the indicators for infrastructure damage and loss, where “green infrastructure should be included where relevant” (UNDRR, 2017, p. 39). Green infrastructure can be understood as natural or semi-natural areas that deliver ecosystem services. Still, this opportunity is not straightforward considering that the terminology, conceptualization, and valuation of green infrastructure, ecosystems and their services are not widely shared among academia and practitioners (Sebesvari et al., 2019). Within the Sendai Framework Monitor system, the pre-programmed categories related to green infrastructure that can be accounted for are: coastal defences, mangroves, parks and green space, green infrastructure, urban tree canopy, regional storm water reservoirs, rain gardens, rainwater harvesting, ground reinforcement for landslide prevention, and underground water infiltration trenches and storage systems. These examples are helpful, but it is not clear exactly as to how they could relate to ecosystems. For example, a regional stormwater reservoir could be interpreted as a wetland, but more likely than not, it is viewed as a hard infrastructure. Currently, no country has reported on green infrastructure in the Sendai Framework Monitor, despite the possibility of doing so under Targets C and D and in the custom indicators. Siloed planning and limited collaboration across institutions leading Nature-based solutions (NbS) versus disaster risk reduction-related mandates are one reason for under-reporting. Another reason is the challenge of acquiring data on national ecosystem loss and calculating these for Targets C & D. Ways forward to gathering data for ecosystem loss for Targets C & D have been suggested in UNDRR (2021).

4.1.2 Disaster-related losses of ecosystems and ecosystem services

The degradation and destruction of ecosystems has had cascading effects contributing to the emergence of zoonotic diseases such as COVID-19, to increasing climate change impacts and decreasing adaptive capacities of systems and communities (Pörtner et al., 2021). Additionally, it contributes to increased disaster risk from natural hazards by undermining regulating ecosystem services that stabilize soils, regulate water flow and quality and buffer the impacts of natural hazards (Renaud et al., 2013; Walz et al., 2021). Ecosystem loss and deterioration has lasting impacts on human well-being. Furthermore, combined with the impacts of climate change, these impacts are felt disproportionately by the poor and vulnerable, increasing human insecurity and conflict (Wetlands International, 2017). With increasing implementation of NbS measures it is increasingly vital to monitor the risk reduction services provided by these measures. This includes the monitoring of damages and losses to ecosystems and ecosystem services as these are also impacted by climate related hazards such as droughts, floods and storms. Without monitoring ecosystem loss and damage, understanding and reducing risk will be challenged further and achievements limited as a result (Walz et al., 2021). Ecosystems which can be recognized for their disaster risk reduction benefits should be considered as critical infrastructure. The Sendai Framework Monitor allows the possibility to report on critical green infrastructure under Targets C and D. A systematic review on disaster related losses of ecosystems and their services provides the scientific evidence for concluding on the recommendations as mentioned below (Walz et al., 2021). In short, ecosystems and ecosystem services are neglected and poorly represented by the established Targets and Indicators of
the Sendai Framework Monitor system. We identified entry points for considering ecosystems and their services in the given structure of the framework as outlined above and in Walz et al. (2022).

The use of custom indicators within the Sendai Framework Monitor is another inroad for monitoring and evaluation of NbS projects themselves. Several of the Resilient Cities Indicators can be used for this purpose. However, lack of knowledge on the efficacy parameters (i.e. under what intensity of a hazard does NbS no longer work) and key performance indicators can be challenging (UNDRR, 2021). Nevertheless, for some NbS, these are now relatively well known, especially when it comes to slope stabilization (e.g. ADPC, 2020).

Monitoring systems for these ecosystems and services are also of interest in other international frameworks, most notably the Convention on Biological Diversity (CBD). Ecosystems and biodiversity have traditionally received least funding and focus at national, regional and global levels. This is slowly changing. Furthermore, some countries have pledged funds for biodiversity conservation, not only to achieve the goals of the CBD but also of the UNFCCC. Thus, stronger links need to be tied between the agendas of biodiversity conservation, climate change mitigation and adaptation and disaster risk reduction.

4.1.3 Nature-based Solutions for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction outlines the critical role of ecosystems in disaster risk assessments (Priority 1), in strengthening risk governance (Priority 2), and in disaster resilience investments (Priority 3). Highlighting poor land management, unsustainable use of natural resources and degrading ecosystems as underlying drivers of disaster risk, the Sendai Framework urges countries to strengthen the sustainable use and management of ecosystems for building resilience to disasters. The Sendai Framework also calls for greater collaboration between institutions and stakeholders from other sectors and calls for ecosystem-based approaches to be implemented in transboundary cooperation for shared resources, such as within river basins and shared coastlines. At the sixth session of the Global Platform in 2019, the role of Green and Blue Infrastructure (falling under the umbrella of NbS) was discussed as natural assets that enable and support disaster risk reduction. It has become even more evident that working with nature is crucial to addressing many of the global crises today. Post-COVID, there is a need for a green recovery and to build back better and greener after a disaster occurs.

NbS for disaster risk reduction and climate change adaptation (CCA) are being implemented worldwide and commitment to invest in NbS and biodiversity conservation was affirmed in all of the Regional Platforms for Disaster Risk Reduction held in November 2021. The inclusion of NbS in national and local disaster risk reduction and CCA strategies is still rare, however. There are some success stories (see Box 2).

**Box 2: Eco-DRR in India National DRR strategy. Source: UNDRR 2020**

The National Disaster Management Plan of India (2019) provides a comprehensive mechanism to implement ecosystem-based disaster risk reduction. Implementation of ecosystem-based approaches in river basins, mountainous regions and coastlines has been defined as one of the objectives of the Plan. The Plan also promotes Eco-DRR as a key means to integrate disaster risk management and addressing environmental change.

Asserting the role of ecosystems in serving as natural barriers that can moderate the effects of a hazard and protect communities, the plan highlights the role of ecosystems and appropriate land-use in DRR as a key responsibility of both central and state governments towards strengthening DRR governance.
To support implementation of NbS, UNDRR has published Words into Action Guidelines on Nature-based Solutions for Disaster Risk Reduction (UNDRR, 2021). The UN Decade for Ecosystem Restoration (2021-2030) led by FAO and UNEP also provides opportunities for increased use of NbS as a means to enhance ecosystem resilience and disaster risk resilience. NbS can provide multiple benefits simultaneously that are particularly relevant for post-disaster recovery and humanitarian contexts; through improved ecosystem services, NbS can help provide sustainable food and water security alongside health benefits. These benefits are directly tied to the work of key humanitarian clusters, including food security and nutrition; water, sanitation, and hygiene (WASH); and health, as well as other cross-sectoral linkages. The use of NbS in post-disaster recovery and humanitarian contexts can therefore help to enhance the effectiveness and accountability of humanitarian action by addressing social and environmental issues. However, ecosystems and ecosystem management is currently missing from Sendai Framework Priority area 4: “Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction” (PEDRR, 2016) and rarely considered by humanitarian agencies, although there are exceptions.

Further understanding is needed within the humanitarian sector on how best to apply NbS in practice beyond disaster risk reduction, specifically in humanitarian response and recovery operations. For that a paradigm shift is needed from short-term, small-scale humanitarian response operations towards long-term, landscape-scale responses that integrate nature, risk reduction, and affected people into the response strategy (FEBA & PEDRR, 2021). Furthermore, to be effective in reducing further systemic risk, it is necessary to embed ecosystems in building back better and greener.

4.2 Context shifts/ new and emerging issues and challenges

4.2.1 Nature-based Solutions to address systemic risk

NbS needs to be considered as part of a holistic national strategy and not as a separate measure. Careful assessments should consider all options (green-blue, grey and soft measures) and understand their limits and trade-offs. For example, there is a growing body of evidence which shows that by incorporating wetlands as natural infrastructure assets which underpin development, rather than building on and draining them, we can enable cooling, better health and well-being for urban and rural dwellers and resilience to extreme weather events. In addition, global outlooks indicate that instead of continued agricultural expansion driving wetland loss, we need to plan a future of sustainable food production that is supported by healthy wetlands and wise use (Convention on Wetlands, 2021). A paradigm shift will be required towards integrated solutions - where biodiversity and ecosystem services are incentivized and enhanced through connected sectoral policies and investments, rather than ecosystems being the victim of trade-offs between those sectors (See section 2.3). This can best be achieved by addressing goals for biodiversity, climate change, regenerative agriculture and revitalizing communities at a whole landscape scale.

4.2.2 Funding for Nature-Based Solutions

To ensure that the multiple NbS benefits continue to support the reduction of systemic risks in the long-term, innovative approaches are needed - accompanied by the necessary financing. Innovative (blended) financing for NbS for disaster risk reduction and creating linkages to efforts undertaken for the Convention on Biological Diversity, the Paris Agreement and the SDGs more broadly can create win-win funding outcomes. When inclusive and collaborative landscape vision and governance processes are at the heart of landscape planning aimed at connecting natural, social and economic returns, investments in ecosystems can be recognized as being financially attractive. And vice-versa, business cases for ecosystems can help stakeholders to connect their ambitions across landscapes. Benefits can then be shared, including to the people at risk. Cost-benefit analyses (CBA) would be extremely beneficial and helpful to policy makers in establishing priorities for NbS. Several studies of comparative CBA of NbS across the world show that NbS pays off (UNDRR, 2021). Nevertheless, CBAs are underutilized when it comes to NbS (Vicarelli et al., 2016). In the private sector, innovative finance solutions such as parametric insurance for NbS are starting to appear on the market. Insurances for an NbS that reduces risks can be insured so that when extreme events damage them while
they protect people, pay-outs help restore the protecting ecosystem (see UNDRR, 2021). We therefore recommend more CBA to demonstrate the value of Nature-based Solutions and innovative financing modalities.

4.3 Recommendations

Based on the retrospective review and context shifts, UNU-EHS and the PEDRR network make the following six recommendations that should be taken into consideration for the Mid-term review:

I. Green infrastructure needs a more clear and applicable definition in the Sendai Framework Monitor system and to be complemented with blue infrastructure.

II. Ecosystems and ecosystem services make an important contribution to disaster risk reduction and are often impacted by climate-related hazards, such as droughts, floods and storms. Disaster-related losses of ecosystems and ecosystem services need to be reported in the Sendai Framework Monitor system.

III. The reporting of livelihoods lost due to disasters should go beyond crop and livestock and consider other relevant ecosystems and ecosystem services that provide a basis for livelihoods (sub-indicators of Target B, indicator B-5).

IV. Ecosystems which are recognized for their disaster risk reduction benefits should be considered as critical infrastructure. The reporting of an area of damaged or destroyed green (and blue) infrastructure would be more meaningful than the sole number of items affected (Target D, indicator D-4).

V. The majority of ecosystem services can be considered as basic services that are needed for society to function, such as fresh water supply, waste water treatment and services that are relevant for human health and well-being. Against this background, ecosystem services should be integrated into indicator D-8 (disrupted services) and reported in reference to ecosystem losses under green (and blue) infrastructure as monitored by indicator D-4 (Target D, indicator D-8)

VI. Nature-based Solutions for Disaster Risk Reduction to be part of Sendai Framework Priority area 4 and in humanitarian settings

5 Sendai implementation in mountains

The inputs for this section have been developed from a dedicated workshop on gaps and opportunities on the role of mountains in the Sendai Framework, which took place at the International Mountain Conference in Innsbruck in September, 2022. There was a clear consensus among workshop participants that the specific issues of mountains were largely missing in the Framework. Considering the important role of mountains for many of the worlds populations and ecosystems (See also Adaptation at Altitude), the group strongly recommended that more consideration be given to mountains in the Sendai Framework Mid-Term Review.

5.1 Retrospective review

5.1.1 Priority for Action 1

The first priority of the Sendai framework stresses understanding of disaster risk in all its dimensions. Progress has been made on this priority. For example, in the Hindu Kush Himalayan (HKH) region, efforts have been made to better understand the nature and impacts of disaster risks across the region. Different frameworks, tools and approaches for climatic and non-climatic risks and disasters have been developed. Progress has also been made on the collection, dissemination and access to information by governments at the national scale, as well as at the regional scale. In this context, ICIMOD in partnership with the World Meteorological Organization and eight RMCs, developed a regional flood information system (HKH HYCOS) that allows the visualization and extrapolation of real-time data on river water levels and rainfall.
Despite progress on this priority we note three challenges that require special attention in mountain regions; i) Complex hazard interactions occur in mountain areas, where hazard events in the upland/upstream areas can have serious consequences in lower/downstream areas. The compounding effects of hazardous events also require more attention, as evidenced by the compounding impacts of hydro-meteorological or geological extremes during the pandemic, ii) The dynamic nature of risk at different time scale, both long-term (i.e. with increasing vulnerability and trends of extreme rainfall, drought and higher temperatures) and also in the short-term (i.e. after wind storms, where the recovery of roads is rather fast the but the long-term impact of forest degradation will cause changes in impacts over larger time periods), and iii) The emergence of new threats that were not considered before, such as extreme droughts in mountain environments. It is important to develop future scenarios where all risk components (including changes in hazard, exposure, vulnerability and capacity) are considered.

5.1.2 Priority for Action 2
Strengthening disaster risk governance in mountains is especially important considering that many mountain communities are located in remote areas with, at times, poor access to information and transportation and thus often need to be autonomous in case of a hazard event. For example, countries of the HKH region have developed policies and plans at the national and local scales to manage disaster risks. Regional institutions, such as ICIMOD, have been playing an important role through capacity building, advocating mainstream disaster risk reduction and gender in national/local policies and plans. Interdisciplinary collaboration engaging local communities, private sectors (e.g., Nepal Telecommunication Corporation) and other stakeholders for flood early warning systems are also in place.

5.1.3 Priority for Action 3
Investments have certainly been made in establishing early warning systems (EWS) in mountain areas for hazards with potentially large impacts, such as for Global Flood Outburst Floods (GLOFs) in the HKH region. This has been made possible by technological advances and ad hoc overseas development assistance. In HKH, a certain percentage of capital expenditure in disaster risk management has been allocated, and sectoral allocations especially in health, education and agricultural sectors have been initiated. However, there continues to be a huge gap in investments for addressing drivers of risk and establishing locally appropriate EWS which cover a wider range of hazards, notably for landslides and flooding in mountains.

5.1.4 Priority for Action 4
Improvements have been made to enhance disaster preparedness through guidelines, mechanisms and approaches at national and local scales. In HKH, public-private partnerships are emerging for preparedness, while the private sectors are mostly engaged in philanthropic support for disaster-affected communities. Likewise, regional networks such as Koshi Disaster Risks Reduction Knowledge Hub (KDKH) and Upper Indus River Basin Network (UBIN) are effective.

5.2 Context shifts/ new and emerging issues and challenges

5.2.1 Pace of change in mountain regions
The world's water towers are rapidly drying up and may no longer have the same capacity to provide the essential ecosystem services upon which 1 billion people depend. The rapid change in mountains is leading to cascading and complex interactions, including rapid changes in habitat, increased occurrence of extreme hazard events and fire, and the rapid spread of invasive species. These changes are having immediate impacts on mountain and dependent lowland populations.
5.2.2 Institutional capacity

There is a dire lack of institutional capacity to respond to the rapidly changing situation in mountains and mountain-dependent areas. This includes a continued lack of EWS for landslides, flooding and GLOFs as well as capacities to prepare and respond to hazard events. Many countries still lack adequate weather forecasting and the means to communicate extreme weather warnings to remote mountain areas. Importantly, this also includes capacities to reduce long-term exposure of affected populations through risk sensitive land use planning which consider the specificities of mountain spatial planning and risk.

5.2.3 Data and information

There is a continued lack of data and information on all aspects of disaster risk in mountains and mountain-dependent areas, in terms of detail, completeness and quality. Huge steps have been made to generate global datasets on hazard and exposure. However, these are generally not adequate for risk management decisions at municipal level in mountainous areas. Many areas still face severe data scarcity issues, and more efforts are required in local data collection and data sharing, using open data policies.

5.3 Recommendations

5.3.1 Institutional mechanisms for disaster risk management in mountains

There is an urgent need for developing institutional mechanisms to mitigate and manage growing cascading and compounding disasters in mountains. This includes improving capacities for socially and culturally inclusive risk communications, improved access to data with urgently needed bridges between science and decision-making. Integrated Watershed Resources Management (IWRM) institutional mechanisms which bring together stakeholders from land-use planning, disaster management, water management, agriculture, etc. to manage potential trade-offs in land-use and share data for improved risk management outcomes. National education policies can include information on disaster preparedness, response and prevention specific to mountains.

5.3.2 Resilient mountain infrastructure

There is an urgent need to invest in disaster resilient infrastructure in mountains, including basic services, such as improved communications, access to water and transportation corridors. As roads are especially critical lifelines for access to health care, markets and education, transportation is especially critical. Disaster resilient transportation may include Eco-Safe roads which combine civil engineering structures with Nature-based Solutions for reducing roadside hazards. Mountain forests can offer considerable protection from rock fall, avalanches and landslides as demonstrated by long standing practices in the Alps. Furthermore, pledges for reforestation and land restoration by public and private actors through the Bonn Challenge, the Glasgow Pact and the UN Decade for Restoration need to be channelled toward restoration of mountain ecosystems.

5.3.3 Bridging gaps between science and practice

There is an urgent need to bridge information gaps on mountain hazards and land use between science and practitioners. This includes establishing better links with experts to increase the capacities of decision-makers in mountains to better understand, prevent and manage risks (from the village level up). It is essential to express the likelihood of occurrence of impact in terms of probabilities, and communicate this in an understandable manner to decision makers. More data are also needed on location specific climate-related expected events and anticipated frequencies and intensities. In parallel, data needs to be communicated to all relevant stakeholders including local authorities, first responders and local communities. In many instances, traditional knowledge of hazards and land use can be combined with formal science for more impactful outcomes.
Across Africa there is a gap between the theory and science of climate adaptation and practical advice, guidance and support to implementers, in particular those working with Mountain smallholder farmers, conservationists and pastoralists. Furthermore, another remaining acute challenge that cuts across African mountain regions is the lack of data providing the base for evidence-based decisions – this lack extends from meteorological data, plot-based data on biodiversity, and wildlife to river gauging.

5.3.4 Transformational pathways to resilient mountains

Pathways for transformation need to be established so that the world’s mountain systems can continue to support millions of people. This is a call for new understandings of mountains and the ecosystem services they provide to 1 billion people worldwide. Our recommendations focus on the overlooked topic of disaster risk reduction in mountains with the intention to: address underlying conditions that lead to mountain risks, investing more in bridging information and knowledge gaps, supporting adaptation and informing a just future for all mountain communities that is gender inclusive and resonates with the Sendai Framework, the Glasgow Pact and the Sustainable Development Goals.

6 Building-Back-Better in Recovery

6.1 Retrospective review

Extreme events are intensifying. Impacts on lives, livelihoods and wellbeing are seen to extend through time. Recovery from disasters is an inherently prolonged and uneven process. As communities recover, we observe the tendency to rebuild without learning from the disaster. At the same time, the recovery process holds promise to regain strength, learn, adapt and even transform to reduce future risks in a changing climate. In other words, to ‘Build-Back-Better’, Priority 4 of the United Nations’ Sendai Framework for Disaster Risk Reduction.

In our work at UNU-EHS, we have reviewed how to learn from recovery efforts after major flood events around the world. In particular we looked at examples of ‘building-back-better’ and what were drivers and barriers for climate-resilient recovery. We reviewed opinions on recovery and examples of climate resilient development, which emerged after recent flood events. Examples of building back better are still scarce. This holds true across different cases, ranging from the Ahr and the Erft, in Germany, to Lagos in Nigeria and Northern Pakistan. Often relief organizations drive recovery and direct humanitarian aspects are prioritized. At the same time, cases of sustained change can be found. These include the initiation of sustainable communal heating systems, the collaboration between government and insurers to fully compensate victims and allow for reallocation of funds, and the sustained self-mobilization of communities. Drivers and barriers for ‘building back better’, which we have identified across cases in our work, include:

Drivers:

I. Cooperation and trust building in new alliances between citizens and government actors
II. Available platforms to enable self-mobilization and to act in change
III. Long-term vision for change
IV. Government addressing barriers that affected people run into
V. Empowering people, training and advice on ways to build back better
VI. Local resources

Barriers:

I. Psychological factors and insecurity
II. Mistrust and polarization
III. Time needed to see results
IV. Regulation discouraging change, such as insurance and reconstruction funds
V. Lack of understanding of recovery process with relief organizations
6.2 Context shifts/ new emerging issues and challenges

The recent IPCC reports confirm that the frequency and intensity of extreme events will increase at all levels of global warming. With increases in climate-related extremes, in conjunction with compounding and cascading effects from other hazards (including COVID-19) and underlying societal vulnerabilities, communities in exposed regions with limited adaptive capacity find themselves in modes of constant recovery. Recovery is an inherently prolonged and uneven process. Recovery is still poorly understood and typically a lower-priority aspect of adaptation and risk management policy and practice, and should therefore be of increased focus for the Sendai Framework in the coming seven years.

6.3 Recommendations

Recovery deserves more attention in disaster risk management. Recovery calls for taking a step back, and systemically reviewing all hazards and impacts to be expected, drivers of vulnerability and how to recover in an inclusive, equitable and resilient manner. By engaging with recovery, we can give climate-resilient development and transformative adaptation its much-needed impetus and address urgent concerns of vulnerable people. And we can bridge adaptation and risk research, policy, and practice.

Opportunity lies in co-creating climate-resilient recovery pathways, a novel approach which consolidates climate action and development aspirations. Moreover, extreme events disproportionately affect people in vulnerable situations, exacerbate poverty and impact women more so than men. Thus, a key perspective is to integrate social justice, equity, gender, learning across scales, and transformation in climate-resilient recovery.

Relevant knowledge gaps that need Priority for Action are how to learn from recovery efforts around the world, how to build trust for change after extremes and what climate-resilient futures are that people can turn to. We recommend to share recovery experiences, conceptualize recovery, drive action, and use this experience to shift the focus from passive coping to proactive adaptation, innovation and transformative adaptation and recovery pathways.

7 References


