



The HuT

Minutes from I-DRRnF workshops n.2

Deliverable D5.7

DEVELOPED WITHIN

WP5 Transferability and scalability, T5.2 International DRR Nexus Forum

LEAD AUTHORS

Elias Huland (UNIGE); Anna Scolobig (UNIGE)

OTHER AUTHORS

Jogscha Abderhalden (UNIGE/HVL); Julia Aguilera Rodriguez (UNIGE); Michele Calvello (UNISA); Katy Freeborough (BGS); Brian Golding (MET); JoAnne Linnerooth-Bayer (IIASA); Juliette Martin (IIASA); Gaetano Pecoraro (UNISA); Guido Rianna (CMCC); Joanne Robbins (MET); Maryam Rokhideh (UCL); Adria Rubio Martin (UPV)

Version 1.0

(30 January 2025)



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101073957

1. Technical references

Project Acronym	The HuT
Project Title	The Human-Tech Nexus - Building a Safe Haven to cope with Climate Extremes
Project Coordinator	Michele Calvello UNIVERSITA DEGLI STUDI DI SALERNO mcalvello@unisa.it
Project Duration	October 2022 – September 2026 (48 months)

Deliverable No.	D5.7
Dissemination level*	PU
Work Package	WP5 – Transferability and scalability
Task	T5.2 – International DRR Nexus Forum
Lead beneficiary	UNIGE
Contributing beneficiary/ies	GWP CEE, UCL, HEREON, CMCC, UNISA, UPV, CNR, GFZ, IIASA, UPC, NGI, HY, IMO, VU, ARANTEC, KOTIVIZIG, ICONS, LEITHA, SOR, CONF-NO, NIP, MA, MET, BGS, GNDR

- * PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)



1.1. Document history

Version	Date	Lead contributor	Description
0.1	17.01.2025	Elias Huland (UNIGE), Anna Scolobig (UNIGE)	First draft
0.2	24.01.2025	Luca Piciullo (NGI), Farrokh Nadim (NGI)	Review
0.3	29.01.2025	Elias Huland (UNIGE)	Final draft
1.0	30.01.2025	Michele Calvello (UNISA)	Proofreading, final version



2. Table of contents

1. Technical references	2
1.1. Document history	3
2. Table of contents	4
2.1. List of Tables	5
2.2. List of Figures	5
2.3. List of Abbreviations.....	5
3. Summary.....	7
4. Introduction	8
5. International DRR nexus Forum: Minutes from the second meeting.....	10
5.1. Expert presentations	10
5.1.1. MHEWS Introduction and overview (Brian Golding)	11
5.1.2. MHEWS practice example I: The NHP in the UK (Joanne Robbins & Katy Freeborough) - Insights from The HuT demonstrators: DEM 9, Dorset	12
5.1.3. MHEWS practice example II: Valencia floods of 2024 (Adria Martin Rubio) - Insights from The HuT demonstrators: DEM 1, Valencia.....	13
5.1.4. NbS Introduction and overview (Juliette Martin) - Insights from The HuT demonstrators: DEM 10, Bern.....	16
5.1.5. NbS practice example: Protection forests in Grisons (Marco Vanoni) - Insights from The HuT demonstrators: DEM 10, Bern	18
5.2. World Café.....	19
5.2.1. MHEWS barriers, group 1 (Moderator: Guido Rianna, Note taker: Maryam Rokideh)	21
5.2.2. MHEWS barriers, group 2 (Moderator: Michele Calvello, Note taker: Gaetano Pecoraro, Jogscha Abderhalden)	23
5.2.3. NbS barriers, group 1 (Moderator: Juliette Martin, note taker: Elias Huland)	25
5.2.4. NbS barriers, group 2 (Moderator: JoAnne Bayer, Note taker: Julia Aguilera Rodriguez)	28
5.3. Synthesis	30
5.3.1. Limited expertise and knowledge	30
5.3.2. Sectoral/administrative or institutional silos (and ineffective communication)	31
5.3.3. Limited evidence on benefits derived by the adoption of multi- (vs. single) hazard approach.....	31
5.3.4. Limited political will to implement multi-hazard approaches.....	32
5.3.5. Limited Data.....	33
5.3.6. Limited multi-risk management tools	34
5.3.7. Limited policy instruments explicitly addressing multi-risk issues	34
5.3.8. Path dependency	35



6. Conclusions 36

7. References..... 38

8. Appendix 43

8.1. Preparatory survey with The HuT Demonstrators..... 43

8.2. Preparatory analysis of key barriers from relevant literature 46

8.2.1. Early warning systems and NbS for multi-hazard management..... 46

8.2.2. Experiences in The HuT DEMs confronted with MHEWS and NbS barriers 48

8.3. Workshop agenda..... 52

8.4. List of Participants..... 53

2.1. List of Tables

Table 1: Reported losses and damages during the 2024 Valancia floods 5

Table 2: Timeline of events and warnings issued on 29 October 2024..... 15

Table 3: List of barriers discussed during the World Café 20

Table 4: MHEWS barriers, group 1 21

Table 5: MHEWS barriers, group 2 23

Table 6: NbS barriers, group 1 25

Table 7: NbS barriers, group 2 28

Table 8: Summary of key barriers identified by The HuT demonstrators. 49

2.2. List of Figures

Figure 1: Institutions responsible for flood risk planning and flood warning in Valencia region. 15

Figure 2: Main barriers that hinder multi-risk management in DEMs 44

Figure 3: Main enablers that can contribute to effective multi-risk management in DEMs 44

Figure 4: Aspects of multi-risk management most interesting for future work in DEMs..... 45

2.3. List of Abbreviations

Abbreviation	Meaning
BGS	British Geological Society
CHF	Swiss Francs
DEM	The HuT Demonstrator
DHA	Daily Hazard Assessment



DRR	Disaster Risk Reduction
EbA	Ecosystem-based adaptation
Eco-DRR	Ecosystem-based disaster risk reduction
EU	European Union
EWS	Early warning system
HIWeather	The High Impact Weather project
HuT	The Human-Tech Nexus - Building a Safe Haven to cope with Climate Extremes
I-DRRnF	International Disaster Risk Reduction Nexus Forum
JMA	Japan Meteorological Agency
MHEWS	Multi-hazard early warning systems
NbS	Nature-based solutions
NCA	Nature's contributions to adaptation
NGO	Non-governmental organization
NHP	Natural Hazard Partnership
NRSA	National Security Risk Assessments
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
UK	United Kingdom
UNDRR	United Nations Office for Disaster Risk Reduction
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme



3. Summary

This report provides the minutes of the second International Disaster Risk Reduction Nexus Forum (I-DRRnF) which is part of The HuT project and took place on the 21 November 2024 in Gerzensee, Switzerland. The report consists of an introduction (chapter 4), the forum minutes, which include summaries of the expert presentations and the world café discussions (chapter 5) as well as a synthesis that links the various findings with the preparatory work. A detailed insight into the preparatory work is provided in the appendix (chapter 8, appendix).

The HuT project addresses the growing challenges posed by climate change-induced extreme events like forest fires, droughts, heatwaves, landslides, floods and storms in Europe by testing innovative DRR solutions. The I-DRRnF brings together The HuT partners and stakeholders to discuss DRR strategies, challenges and experiences, governance and policy mechanisms supporting DRR, and the transfer and upscaling of good practices and DRR solutions. The second I-DRRnF focused on two multi-risk management approaches: multi-hazard early warning systems (MHEWS), and nature-based solutions (NbS).

Preparatory work (chapter 8, appendix) consisted of analysing a survey (8.1) on multi-risk management, administered to all The HuT demonstrators and a literature review (8.2) about early warning systems and nature-based solutions in multi-hazard management as well as specific barriers to their implementation. The preparatory survey showed that both topics are relevant in the demonstrators but many barriers to their implementation remain. The literature review contributed specific information on the four barriers most relevant to the demonstrators, namely, lack of expertise and knowledge, limited policy instruments, sectoral/administrative or institutional silos and limited evidence on benefits derived by the adoption of multi-risk approaches.

The forum itself featured expert presentations (5.1) and a world café (5.2) in which all The HuT partners contributed to four thematic group discussions, each focussing on either MHEWS or NbS. The findings were then analysed in a joint synthesis (5.3). The presentations and discussions during the forum confirmed that multi-hazard management faces many challenges and that all previously identified barriers were relevant for both MHEWS and NbS implementation. A comparison of the two approaches shows that some of the barriers and ways to overcome them were nearly identical, indicating that the underlying challenges are shared and likely inherent to multi-hazard management in general or to novel risk management approaches. For example, sectoral/administrative silos were equally impeding both approaches and the ways to overcome them were largely aligned. Other barriers for which we could identify clear similarities included limited expertise and knowledge, limited evidence on benefits and limited multi-risk management tools. Overall, we conclude that reflecting jointly on different multi-hazard approaches can contribute to identifying general learnings, better understanding the challenges in responding to multiple hazards and developing approaches for more effective multi-hazard governance.



4. Introduction

This deliverable reports on the second International Disaster Risk Reduction Nexus Forum (I-DRRnF) entitled “Enhancing multi-hazard DRR efforts through nature-based solutions and multi-hazard early warning systems”. The workshop was held in Gerzensee, Switzerland, on November 21, 2024 at the annual meeting of the The HuT¹ project.

The concept of multi-risk or multi-hazard refers to the simultaneous presence or cumulative occurrence of various hazards and their interconnected impacts within a given geographical area or community (Gill et al., 2022; UNDRR, 2024). Such occurrences of multiple hazards can be caused by one trigger event (cyclone causing wind, rainfall, and landslides) or by several separate trigger events occurring at the same time. The occurrence of one hazard or risk can amplify others by further weakening protective infrastructure, jeopardizing warning chains and response mechanisms, or triggering cascading effects. It is increasingly recognized that different hazards undergo complex interactions. However, many risk assessments do not consider these interactions and the management efforts related to it (Thaler et al., 2023).

While hazards are strongly dependent on the regional setting, a large share of the European territory is affected by multiple hazards. A study that analysed the exposure to risks of landslide, coastal flood, river flood, earthquake, wildfire and drought found that almost 20% of the European population lives in regions prone to multiple hazards (Antofie et al., 2024). Other hazards like storms and heatwaves were not assessed as part of that study, but their inclusion would undoubtedly increase the area and population at (multi-)risk.

It is in this context that The HuT project addresses the growing challenges posed by climate change-induced extreme events like forest fires, droughts, heatwaves, landslides, floods and storms in Europe. The ten demonstrator sites in The HuT implement different disaster risk reduction (DRR) measures for different types of hazards, and at least eight demonstrators are faced with multiple (i.e. two or more) of the above-mentioned hazards. They are testing and applying novel approaches, use solutions and integrate best practices. The demonstrators reflect a vast regional diversity with case studies from eight countries, namely Germany, Hungary, Lithuania, Iceland, Italy, Spain, Switzerland, and the United Kingdom.

As part of The HuT process, the I-DRRnF aims at fostering reciprocal learning across hazards, the project demonstration cases and domains of expertise, and at improving the transferability of DRR solutions. The I-DRRnF members include The HuT partners and stakeholders. During the forum, they deliberate on improvement of DRR strategies, challenges and experiences from The HuT demonstrators, new ideas for governance and policy mechanisms supporting DRR, and the transfer and upscaling of good practices and DRR solutions. The first I-DRRnF was held in 2023 and focused on effective stakeholder engagement for the co-creation of DRR solutions and respective barriers and enablers. It provided valuable insights and considerations for dealing with multiple risks. The minutes and summary of key findings are available in The HuT deliverable 5.3².

The second I-DRRnF focused on the implementation of two specific multi-risk management approaches that play important roles in mitigating and adapting to multi-risks in the demonstrators: (1) Multi-hazard early warning systems (MHEWS), which deliver warnings to multi-hazard events and (2) Nature-based solutions (NbS), which contribute to making landscapes more resilient and providing co-benefits and ecosystem services that stabilize the natural system.

¹ See also: <https://thehut-nexus.eu/>

² https://thehut-nexus.eu/wp-content/uploads/2024/03/The-HuT_D5.3_v1.0.pdf



As preparatory work for the second I-DRRnF, we distributed a survey (8.1) to all ten of The HuT demonstrators to collect information on those aspects of multi-risk management that are present and relevant in their work. Based on the experiences of the demonstrators, we then conducted a literature review (8.2) on the most mentioned barriers to multi-hazard management in DRR. Particularly, we focused on four key barriers to the implementation of MHEWS and Nature-based Solutions: 1) limited expertise and knowledge, 2) limited policy instruments, 3) sectoral/administrative and institutional silos, and 4) limited evidence on benefits. The detailed contents of our preparatory work, the workshop agenda and a list of participants are presented in the appendix.

We incorporated this information into the design of the second I-DRRnF, which took place as a half-day workshop on 21 November 2024 (see agenda in appendix, 8.3). During the forum, expert presentations were given and discussion groups formed among the participants. The forum minutes together with information from the preparatory work form the basis of this deliverable.



5. International DRR nexus Forum: Minutes from the second meeting

This section provides a summary of the second The HuT I-DRRnF workshop, held on 21 November 2024 in Gerzensee, Switzerland during the annual meeting of The HuT consortium, back-to-back with The HuT Annual Meeting.

Based on the information collected through the literature review and survey, we structured and planned the second I-DRRnF (see agenda in appendix, 8.3). The half-day workshop lasted 4 hours and was divided into two sections:

The first section featured an introduction on the survey and literature review that were conducted as part of this deliverable (see appendix, 8.1 and 8.2). Moreover, five presentations helped participants to familiarize with the state of art of the two focus topics and provided insights into practical applications: These were a general introduction and one good practice example on each of the two focus topics MHEWS and NbS and, a presentation on the recent floodings in one of The HuT demonstrators, the Valencia region (October 2024), that was added because of its currentness and relevance.

In the second section, we stimulated discussions among the participants by dividing them into four groups and by fostering discussions using a world café format. Each group had an in-depth discussion on either MHEWS or NbS and each focused on a set of four barriers and ways to overcome them. Each discussion was facilitated by a host and lasted about one hour. At the end of the discussion, the hosts of each group reported the key insights and innovative approaches back to the plenary.

Overall, 54 participants attended the workshop, including working group moderators and note-takers. The participants' background spanned across different scientific disciplines (e.g. meteorology, forestry, political sciences, engineering, economics, environmental sciences). Participants included both researchers and practitioners from the public and private sectors. The list of participants, as well as the workshop agenda, are provided in the appendix. At the start of the session, all participants were informed that the data would be used for this deliverable.

5.1. Expert presentations

The forum started with five presentations on the forum's topics, delivered by experts in the respective fields, introducing both a background and concrete examples of MHEWS and NbS. This chapter provides an overview of the presentations.

The MHEWS presentations comprised an introduction on early warning systems, opportunities and challenges related to MHEWS held by Brian Golding (UK Met Office), a good practice example of how MHEWS have been implemented and institutionalized in the UK, presented by Joanne Robbins (UK Met Office) and a presentation about the recent flooding event in East Spain and the role of the warning system, held by Adria Rubio Martin (Universitat Politècnica de València).

The second set of opening lectures focused on Nature-based Solutions. Juliette Martin (International Institute for Applied Systems Analysis, IIASA) started with an overview of NbS for multi-hazard DRR. This was followed by a presentation on the implementation of protection forests in Switzerland, given by an invited guest speaker, Marco Vanoni (Canton of Grisons, Forest and Natural Hazards Office).



5.1.1. MHEWS Introduction and overview (Brian Golding)

The first presentation by Brian Golding started with an introduction of the building pillars, key elements and the importance of early warning systems. It walked through:

- (1) Introduction to EWS** (see also Golding, 2022) **and governance of EWS** for creating an environment for successful implementation, e.g. through the national risk management strategies, connecting information producers, communicators and responders together and overcoming legal or funding obstacles.
- (2) How EWS support disaster mitigation at several levels**, e.g. through effective gathering, processing and forwarding of information, directing response resources to where they are needed by the safest routes, enabling professional responders to take mitigating actions (e.g. to pre-position resources for early response, and to engage with stakeholders who can facilitate local response), and providing the public with the information needed, followed by an introduction of **what makes a warning effective** and explanation of the early warning value chain. An effective warning enables protective action to be taken if: (1) A mitigating action exists and is taken, (2) a warning is received and understood, (3) information in the warning is sufficiently complete and accurate. Achieving this requires everyone involved in designing and delivering the warning to work in partnership.
- (3) Keys to communication that will promote protective responses:** (1) Understand the decisions individuals face and their needs, (2) Use multiple media to reach those at risk; prepare the receiver; build trust in the information source, (3) Communicate hazard, impact and action; location, time and source. (4) Communicate uncertainty and take into account legal, political, scientific uncertainties, as well as uncertainties in behavioral & psychological responses, (5) Tailor to audience – use local impact to promote response, and (6) Evaluate with trusted partners and public.
- (4) Keys to producing the necessary information on hazards and impacts:** (1) The small scale of many hazards demands the highest resolution coupled weather and hazard models and a probabilistic approach to prediction, (2) the expertise for impact prediction lies in a wide range of disciplines, including engineering, epidemiology, economics and sociology, (3) access to the required dynamic exposure and vulnerability data raises ethical issues and requires development of partnerships with data owners.
- (5) Additional challenges when addressing MHEWS:**
 - a. MHEWS may be built from scratch, it may be an extension of an existing warning system; or a combination of existing warning systems. It should be extendable to additional hazards.
 - b. There are cost efficiencies in using the same platform, formatting, communication, evaluation, channels and facilities. However, it is important that each warning represents the authoritative voice for that hazard. Also, multi-hazard is more complex, requiring more rigorous testing/upgrade procedures – which may reduce agility.
 - c. Consistent terminology, look & feel simplifies the user interface and builds recognition which increases trust. However, people may prefer to trust hazard-specific organizations, limited trust in one hazard may affect trust in other hazards and a common format may not be optimal for all hazards.
 - d. Using common platforms for dissemination ensures users get information for all hazards they are exposed to. However, different levels of tailoring may be needed for different hazards, some people, businesses and infrastructure operators may be vulnerable to only a subset of hazards and those not connected to those platforms miss everything.
 - e. A risk-based approach will naturally result in more predictable hazards being escalated earlier, but multi-hazard warnings may give the impression that the less predictable events are also the less important and some hazards may reach

maximum risk levels frequently, diminishing the level of attention for events characterized by low probability and high magnitude/severity.

(6) How MHEWS should be employed in different situations:

- a. Factoring the specific kind of multi-hazard events into the hazard warning, important differences are: (1) Compound multi-hazards (simultaneous distinct hazards), (2) cascading multi-hazards (hazards triggered by other hazards, both natural and technological), and (3) amplifying multi-hazards (hazards made more impactful by precursors).
- b. Adapting education & recognition: (1) Precursors may be factored into the hazard forecast and warning script, (2) compound names (e.g. thunderstorm) help communication, but may only tell part of the story, (3) compounds without names are difficult to convey and may be better treated as distinct warning and (4) communicating cascades is challenging (how far down should the warning go?).

(7) Evaluation of MHEWS, which should focus on (1) a continuous evaluation of all steps of the chain, (2) logging and analysing operation & timeliness of system components, (3) measuring accuracy of information sources and warnings, (4) surveying warning receipt & responses, (5) estimating avoided losses and losses attributable to warnings, (6) gathering and publishing post-event evaluations (7) and initiating stakeholder-led reviews that consider the value that the MHEWS is delivering and how it could be improved.

(8) Conclusion

- a. It is the response that matters!
- b. Understanding of personal risk and capability underlies response.
- c. Warnings must reach and be understood by everyone who needs to respond.
- d. Information in the warning must be good enough to stimulate an effective response.
- e. Warnings of all relevant hazards should be available to everyone.
- f. A good integrated hazard warning system is better than multiple systems, but a bad one could be confusing, unreliable, expensive and mistrusted.

5.1.2. MHEWS practice example I: The NHP in the UK (Joanne Robbins & Katy Freeborough) - Insights from The HuT demonstrators: DEM 9, Dorset

The UK Met Office has recognized the need for effective MHEWS and has implemented strategies around four key elements of good practice: (1) cross-organizational collaboration, (2) data, knowledge and information exchange (3) recognition of expertise and skills, and (4) development of processes to leverage diversity effectively. The presentation followed these elements and elaborated them in detail:

- (1) Cross-organizational collaboration:** It is necessary to bring together the interdisciplinary science and practitioner community, create a common language and establish partnerships because stakeholders from different sectors often do not use the same terminology and operate separately. In the UK, cross-organizational collaboration has improved readiness and response through scientific advancement and better coordination. It delivers coordinated natural hazards science, research and advice to Governments, Civil Contingency responders and other hazard resilience groups across the UK. The cross-organizational collaboration was institutionalized in the Natural Hazard Partnership (NHP) in 2011. It consists of 22 members from different government levels, research, emergency response organizations and NGOs and different sectors (e.g. meteorology, environment, public health, and infrastructure). Outputs include: Daily Hazard Assessment (DHA), DHA Colour State Matrix, Hazard Impact Modelling and Monitoring Frameworks, scientific input into National Security Risk Assessments (NRSA), hazard overviews for 11 hazards, infographics for 24 hazards.



- (2) **Data, knowledge and information exchange:** It's important to bring together complex datasets to inform decision making (What, Where, When, Why & How). The NHP has agreed on standard approaches for research to operations (R2O) development to improve efficiency and adaptability. Also, knowledge and data sharing agreements were set up to improve data access. Lastly, it is important to identify suitable methodological approaches, which might be different from approaches taken for individual hazards.
- (3) **Recognition of expertise and skills:** Evaluating the whole early warning process, from observations to decisions, is crucial in a multi-hazards early warning system with many actors. The evaluation identifies how value is lost and gained throughout the process, what impact this has on usability and opportunities for improvement. The EWS-Value Chain (as introduced in the previous presentation) helps to identify the different expertise needed. Each step of the warning chain is linked to different tasks that can be assigned to different institutions, respective of their expertise and skills:
- a. **Observations:** Weather observations [MO], Slope monitoring/Internet of Things [BGS], Crowdsourcing [BGS/MO], Soil Moisture [BGS/MO]
 - b. **Weather Forecasting:** Rainfall forecasts [MO], Temperature forecasts [MO], Humidity forecasts [MO], Heatwave forecasts [MO],
 - c. **Hazard Forecasting:** Susceptibility mapping [BGS], Water balance modelling [BGS], Landslide forecasts [BGS],
 - d. **Impact Forecasting:** Research in progress [BGS/MO],
 - e. **Guidance:** Daily Hazard Assessment [BGS/MO],
 - f. **Decisions:** Category 1 and 2 Responders
- (4) **Processes to leverage diversity effectively:** To make best use of the diversity in MHEWS governance, a few questions should be considered: Is there shared goal and purpose for the early warning system being developed (is there a shared understanding of success)? What mechanisms will enable synthesis of expertise within necessary operational timescale (are there Standard Operating Procedures (SOPs))? Have roles and responsibilities been clearly assigned? What procedures are in place for continual review, evaluation, monitoring and life cycling? Only if these can be sufficiently answered, the diversity is best employed for better hazard management.

Questions focused on the one hand on governance structures and the comparison to other fields, e.g. NbS, where similar challenges and approaches are discussed. On the other hand, questions addressed the public trust in the warning system that is needed to obtain the optimal responses but that often differs between societal groups. An example was mentioned, in which a religious group had limited access to or trust in public media and government agencies. In response, a partnership with specific news channels trusted by members of the religious group was established and utilized to extend warnings to them.

5.1.3. MHEWS practice example II: Valencia floods of 2024 (Adria Martin Rubio) - Insights from The HuT demonstrators: DEM 1, Valencia

The first two inputs showed what needs to be considered for designing good MHEWS and how they can be implemented in practice. The final presentation on warning systems was held by Adria Martin Rubio from the University of Valencia. This presentation was added to the agenda on short notice, after devastating floods had hit the Valencia region on the 29th of October 2024, 4 weeks prior to the forum.



The presentation started with some numbers to show the dimensions of the disaster, including a list of reported damages (see: Table 1). The gravity of the situation was caused by three factors coming together: (1) the physical characteristics of the basin, (2) the unprecedented magnitude of precipitation, and (3) the early warning system (and its failure).

(1) Physical characteristics of the basin of the rivers Rio Turia and Rambla de Poyo was one of the key factors leading to the flooding event.

Characteristics include that on reaching the town of Chiva, the riverbed of Poyo reduces its width from 60 metres to only 12 metres in the urban centre, accumulating water upstream and increasing the speed. A similar effect happens a few kilometres downstream, where the river flows through fields and the basin quickly narrows from 128 metres to 43 metres. A little later, the water reaches a crucial bottleneck where the riverbed practically disappears between two roads and only 6 metres remain for the river. This causes the water to expand, creating a large flood. In the town of Torrent, the Poyo joins the La Horteta ravine. The sum of both watercourses, 84 metres, is twice as much as the space behind it (41 metres). In Paiporta, again, a new narrowing of the channel to only 36 metres exacerbated the flood.

Table 1: Reported losses and damages during the 2024 Valencia floods (as of 21 November 2024).

Affected area	530 km ²
Affected municipalities	84
Fatalities	219
Missing persons	12
Directly affected people	190.000
Houses	48.003
Shops and warehouses	8.787
Offices	670
Industrial facilities	2.658
Civil infrastructure	30
Vehicles	83.437

(2) Magnitude of precipitation: It is in this challenging setting, in terms of flood resilience, that an unprecedented magnitude of precipitation, occurred on 29th October 2024. The phenomenon called “DANA” is rather typical in Spain, it occurs when a cold air bubble is isolated between areas of warmer air, becomes stationary and releases a large amount of precipitation in a short time. This often causes heavy storms and torrential rainfall events. The nearby weather station of Turis Mas de Calabarra recorded a total of 771.8 l/m² in one day with peaks of up to 184.6 l/m² in one hour or 102.8 l/m² in 30 minutes. The highest amount of precipitation was recorded between 17:00 and 18:00. The measured water flow in la rambla des Poyo quickly exceeded the water flow rates of 25-year flood events (430m³/s), 100 year flood events (530 m³/s) and 500 year flood events (1200 m³/s, around 18:10), and jumped to more than 2000 m³/s, at which point the flow meter was destroyed – while the water kept rising. Estimations show a maximum water flow of between 2800 m³/s and up to 4000 m³/s further downstream. This corresponds to a return period of 2000 - 3000 years and far exceeds the water flow rate of Danube River in Vienna. Correspondingly, large areas were flooded beyond 500-year flood event areas, which is the maximum value considered in the planning.

(3) Early warning system:

During this extraordinary flood event, the early warning system failed to warn people effectively. Since the people in the region are not strange to this type of phenomena, most people reacted as usual, even though the situation was everything but usual. Therefore, some people were left trapped inside their homes, underground parking lots, or other buildings. The failure of the warning system is particularly visible in the fact that no general alert was sent to the public until 20:12, a time at which the intensity of the precipitation was known for hours and water levels had already surpassed crucial thresholds (see above). The presentation first looked at the general organization of the warning system in Spain (see Figure 1) for an overview of relevant institutions: When no warning level is active (or warning level 0), state intervention is concentrated in the warning and alert systems available for each type of risk in the different ministerial departments. Warning level 1 is generally a municipal situation, in which it can be reinforced, if necessary, with the resources of the affected Autonomous Community and, if necessary, those of the State. Warning level 2 is perhaps the most complex of all due to the different interpretations that occur in the regional emergency plans and lastly warning level 3 involves the declaration of national interest by the Minister of the Interior, either at the request of the affected Autonomous Community, the Government Delegate or by his own decision. The presentation then walked through the afternoon when the disaster took place and explained the different internal warnings issued at certain points in time (see Table 2).

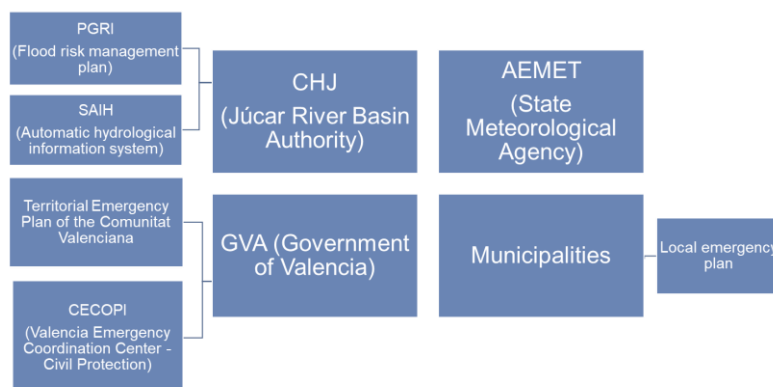


Figure 1: Overview of institutions responsible for flood risk planning and flood warning in Valencia region.

Table 2: Timeline of events and warnings issued on 29 October 2024

Morning	During the morning, AEMET had issued a red alert, warning of high precipitation. Some floodings along the Magro River and high water levels in the Forata reservoir, both a little south of Valencia, were reported.
17:00	A verbal notification was made about the general increase in water levels, especially in the Magre and Xúquer rivers, and the imminent declaration of scenario 2 for the Forata dam according to its emergency plan. This scenario occurs when there is a danger of dam breakage or serious malfunction, and it cannot be assured with certainty that it can be controlled with the available measures and means. Scenario 2 was notified at 18:05. Earlier, at 17:30, the first military personnel were dispatched to help address the effects in the Plana Utiel-Requena region.
18:00	Civil protection authorities were informed of a flow rate in the Poyo ravine of 1,686 m ³ /s via email. At 14:35 (according to CHJ), it was 55.86 m ³ /s. The Generalitat claims that there was a CHJ member at CECOPI, and it wasn't until 18:45 that they informed the Valencian government that the forecast and situation had changed. Discrepancies remain. In the following days, Mazón criticized the Confederation's management, accusing them of deactivating the alert three times. In response to the accusations, the Ministry of Ecological Transition stated that neither AEMET nor the confederations had all the information and therefore were not competent to declare alerts.

19:00	Around 19:00 videos of floodings appeared on social media. As admitted by the Generalitat, "after 7:00 PM," the head of the Consell, "once informed of the risk of the Forata dam breaking and the drastic change in the situation, with the danger that it entailed," moved to the command center in l'Eliana, where CECOPI was meeting "to monitor the situation on-site." At 6:54 PM, Paiporta, the epicenter of the devastation, informed on social media that the ravine had overflowed, that the bridges were closed, and asked residents to stay indoors. At 7:21 PM, Picanya sent out the same message. In the meantime, the water force destroyed the gauging station, registering a flow of 2,282 m ³ /s at 6:55 PM. An increase of almost 600 m ³ /s in just 12 minutes explains the tsunami of mud and water that devastated up to eight districts of Valencia.
20:00	At 20:12 a public warning message was sent to cell phones. However, the message was rather technical and mainly told residents to stay inside. During the critical moments, several important calls were made. According to Teresa Ribera's statement to Cadena Ser, she had to make "up to four calls to locate Mazón." The Valencian president countered these words by showing a text message from the minister at 8:20 PM. The Consell clarified that Ribera's first call was at 8:17 PM, after the alert had already been issued, and at 8:20 PM, the text message mentioned by the Valencian president. There is agreement that at 8:00 PM, the Secretary of State for the Environment, Hugo Morán, called Pradas to warn about the Forata dam. The counselor mentioned that the Poyo ravine, already overflowed, was not discussed and that it was at that moment when she learned about the possibility of sending an alert using a system she was unfamiliar with.

Questions evolved around the issue of trust in warning authorities, which has on the one hand decreased because the government was not able to protect people from the disaster. On the other hand, it was emphasized that the absence of alerts was caused by human / institutional errors and that the necessary information and knowledge had actually been available. Additionally, the disaster increased the awareness for extreme weather events and associated risks, therefore it might be easier to bring warnings across in the future. Other questions stimulated a discussion about where the necessary information got lost, how citizens responded to the warning message that was sent out, how this message could be improved, how people can be effectively warned, even if they don't visually see the risk (e.g. because it is not raining at the location where the flood wave will hit, as in the Valencia case), which message a "red warning" without further discrimination conveys, etc. – thus touching on many topics that would later be discussed in the world café groups. Another remark concerned the urban development in the region as an important factor: After the previous disastrous floods in Valencia (1957), the Spanish government rerouted rivers around Valencia which allowed further urban developments. In consequence, many of the small towns that were affected by the 2024 floods had grown significantly over the following decades.

5.1.4. NbS Introduction and overview (Juliette Martin) - Insights from The HuT demonstrators: DEM 10, Bern

The first presentation on NbS was given by Juliette Martin and included an introduction and overview of NbS, (1) their definition, (2) their relevance in environmental policy, (3) NbS application in DRR and for multiple hazards and (4) ways to overcome NbS governance barriers.

- (1) Definition - What are nature-based solutions?** The internationally recognized definition was adopted by the fifth United Nations Environment Assembly (UNEA-5) in 2022. It defines NbS as "Actions to protect, conserve, restore, sustainably use and manage natural or modified [ecosystems], which address social, economic and environmental challenges



effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits". Typical applications of NbS are therefore, among others, urban forests, creation of terraces and slopes, rivers and stream renaturation, (green) building solutions, open green spaces, green corridors, urban farming, bioretention areas, natural or constructed inland wetlands, river floodplains, mangrove forests, salt marshes, sandy shores, or, in the case of Switzerland, protection forests.

- (2) Why do NbS matter?** NbS are considered a suitable solution to tackle the multiple planetary crises, in particular loss of biodiversity and climate change. NbS are considered a key component for achieving biodiversity targets (EU Biodiversity Strategy, Global Biodiversity Framework), climate targets (Paris Agreement, to which NbS can provide 37% of the mitigation needed between 2017 and 2030 (Griscom et al., 2017), Nationally Determined Contributions, EU Green Deal) and DRR targets (Sendai Framework).
- (3) NbS for DRR and multi-risk:** Among the different co-benefits of NbS, their contribution to DRR is particularly recognized, making them a viable alternative to traditional/"grey" engineering measures, such as levees, retention dams, metal netting. These measures are often costly (especially in maintenance), consume a lot of space and may have negative impacts on ecosystems. Achieving the same DRR impact through NbS can be worthwhile, as shown by recent literature reviews. For example, in Vicarelli et al. (2024), 80% of studies show that NbS are more cost-effective for DRR than conventional infrastructure. Ruangpan et al., (2020) found that NbS are also more effective in attenuating hazards compared to traditional infrastructure in 65% of the analysed publications. This means that in many contexts, NbS are an efficient and cost-effective alternative to grey infrastructure.

Besides, NbS provide multiple co-benefits and can address multiple societal challenges, such as biodiversity loss and climate change adaptation. NbS therefore have the potential to mitigate a wide range of hazards, including all those represented in The HuT demonstrators (forest fires, droughts, heatwaves, landslides, storms, floods) and can therefore reduce multiple risks at the same time and can be considered as multi-risk management tools. Three The HuT demonstrators are already considering NbS in their work and are working on a joint deliverable as part of work package 3: Valencia, Ogliastro and Bern.

Examples of NbS in multi-risk contexts include: (1) Urban green spaces that reduce the risk of urban flooding, mitigate heat waves by reducing the urban heat island effect and reducing air pollution. In this case, co-benefits are enhanced air quality, urban cooling, increased biodiversity, and improved mental health, recreational spaces for urban populations. (2) Wetland restoration, reducing the risk of floods, droughts and water scarcity by providing co-benefits such as water filtration, biodiversity conservation, recreation, support for fisheries and agriculture.

- (4) NbS Governance:** However, NbS governance comes with complexities: NbS governance goes beyond 'government' and the legal, institutional and policy arrangements it encompasses. It includes a network of state and non-state actors (e.g., businesses, civil society, NGOs and expert communities) in the process of deciding on, financing and implementing NbS (Lemos & Agrawal, 2006; Steurer, 2013).

The most common barriers to NbS implementation were included in the multi-risk survey that was sent to the 10 The HuT demonstrators before the forum (see appendix, 8.1). Two of the key barriers identified in the survey were explained in more detail: limited policy instruments and sectoral/administrative or institutional silos). Policy instruments that support the

implementation of NbS include holistic policies addressing NbS or related issues, regulations, standards and liability guidelines, novel institutional arrangements or targets and indicators. In Norway, for example, a recent guideline "National guidelines for climate and energy planning and climate adaptation, 2023 - 2027" explicitly mentions NbS as an adaptation solution that should be assessed for landscape planning. If NbS are not selected, the regulation states that this decision needs to be justified, however, the guidelines are supportive and not legally binding.

A second practical example shows how the sectoral, administrative or institutional silos that hamper many NbS projects can be overcome. The issues associated with this barrier usually evolve around Lacking coordination mechanisms, lacking transferable standards, missing communication mechanisms, single sector decision-making and a lack of polycentric governance arrangements. In the case study of the Isar restoration in Munich, Germany, the "Isar Plan" was implemented (1995-2011), a river restoration project over 8 km stretch for flood protection. NbS that were applied included riverbank restoration, levee removal, riverbed widening and an enhanced river connectivity – green measures were complemented by grey infrastructure. To overcome the abovementioned challenges, the Isar Working Group was established, a polycentric arrangement that brought together representatives from various sectors and scales and allowed to streamline previously dispersed decision-making processes across multiple organizations that included flood protection, nature conservation, urban planning, water quality, waste management, and recreation, among others, leading to a successful implementation of the project.

5.1.5. NbS practice example: Protection forests in Grisons (Marco Vanoni) - Insights from The HuT demonstrators: DEM 10, Bern

After the general introduction of NbS for multi-risk management, a good practice example was introduced by Dr Marco Vanoni, responsible for protection forests and forest ecology in the Swiss canton of Grisons. He introduced (1) an example of a forest collapse and reforestation in Grisons, (2) the general case of Grisons, (3) forest management practices, (4) impacts of climate change and other management challenges and (5) political measures to manage the challenges.

- (1) Example:** The presentation started with the example of a protection forest in Surselva near Sedrun, which was severely damaged by storm Vivian in February 1990. Due to secondary damage caused by bark beetles, large parts of the slope were unwooded, which posed a major threat to the railway line and cantonal road below. However, thanks to extensive reforestation and intensive measures over three decades, the forest has now been restored to a condition that enables it to fulfil its intended function as protection against avalanches. Reforestation, however, needs to be well managed. E.g. clearances help to establish a sustainable structure in tree age in size, helping to maintain the protective function of the forest in the long term. Compared to artificial protective structures, the lifespan of this protection forest is virtually unlimited, because with regular interventions, younger trees grow back and the forest provides permanent protection.
- (2) State of forests in Grisons:** In the canton of Grisons, more than half of the forest area and about 17% of total area is protection forest (122,000 ha), two thirds is Norway spruce. Forest condition is mostly stable and there have been only few major collapses in the past, but regeneration is partly insufficient, mainly due to the presence of ungulates. Sustainable rejuvenation of forests requires management. Forests are categorized according to their status and the associated risks / possible impacts.



(3) Forest management: Every 12 years, all forests are recorded and their condition and protective function is assessed. Necessary interventions are 80% financed by the federal government with the remaining costs being covered by the landowners – in most cases the municipalities. Next to the planned interventions, which remain relatively constant across years (ca. 12 -16 million CHF per year), unplanned interventions, such as clearing of damaged trees after storm events, become necessary. They are highly variable in costs (ca. 4 – 14 million CHF per year), depending on the year's weather conditions.

(4) Climate change: With increasing temperatures and changes in the precipitation regime, the natural composition of forest types changes. Generally, tree species see an upward shift in altitude. Certain risks, e.g. drought, bark beetle, storms become more likely and pose a risk to the protective function of the forest or require active management and adaptation to climate change. To meet these challenges, a new strategy for silviculture and climate change was developed in 2022. Its main principles for adaptation are tree species diversity, structural diversity, genetic diversity and resistance to disturbance. E.g. maps of the expected distribution of certain species in the future were developed to guide tree planting already today. E.g. areas in which the spruce will not be able to survive in 2075 under climate change projections should already start to promote different species.

As described previously, forest regeneration has emerged as a problem, partly due to the presence of ungulates. More than 1.2 million CHF are spent annually on passive damage prevention (e.g. building fences). However, the impact varies greatly by region and finding a long-term sustainable solution remains a challenge.

(5) Political measures: The need to adapt has been part of the political process for some time. The first step was taken with the cantonal climate strategy in 2015, which was followed by various measures and a partial revision of the Cantonal Forest Act in 2019. In each case, the focus is on establishing the legal framework in such a way that we can implement and finance measures to make the best possible use of the diverse services provided by forests for our benefit.

The presentation was followed by **questions** which evolved around biodiversity issues (e.g. leaving dead trees in the forest which is favourable under certain circumstances whereas it is also sometimes needed to take out dead trees of certain species, e.g. to prevent the spread of bark beetles or to avoid driftwood in rivers), trade-offs between different risks (e.g. avalanche protection vs. risk of wildfires (which are a lower risk in Grisons)) and forestry priorities outside of protection forests where either economic or biodiversity factors play a bigger role.

5.2. World Café

The second section of the I-DRRnF started with a short introduction including a summary of the survey results and literature review and an explanation why each discussion topic had been selected. Also, the process of the world café was described to participants.

The participants were divided into four groups in a world café format. The group division was based on participants' expertise and aimed to ensure that all groups were of roughly equal size. Each group had an in-depth discussion on either MHEWS or NbS and focused on a set of four barriers and ways to overcome them. Each discussion was facilitated by a host. The discussions were captured on sticky notes and flip chart paper and in each group key points were also noted down by a note-taker. While the initial plan had involved participants switching groups after 45 minutes, we decided to have each group discuss for 60 minutes without interruption. At the end of the



discussion, the hosts of each group reported the key insights and proposals to overcome barriers back to the plenary.

Each group was equipped with a set of barriers that came out of the pre-forum survey. Examples were provided so that even participants less familiar with a specific topic could engage in the discussions. Based on these barriers, the participants were asked to discuss if and how the barriers can be overcome. They were invited to share experiences and innovative approaches from case studies they have been involved in. Before the discussion started, participants were granted some time to reflect and write down their most relevant thoughts. During the discussion, the moderators collected the points brought in by the participants and guided the discussion so that each contribution could be linked to one or more of the barriers. The list of barriers included in the World Café is provided in Table 3:

Table 3: List of barriers discussed during the World Café

MHEWS barriers	NbS barriers	Discussion groups:
Limited expertise and knowledge (e.g. know-how for the implementation and management of MHEWS is missing, multi-hazard dynamics are not well understood)	Limited expertise and knowledge (e.g. know-how for the implementation of NbS)	1 & 3
Ineffective communication and sectoral/administrative or institutional silos (e.g. different hazards are dealt with by different administrative divisions (horizontal or vertical); warnings are inconsistent, e.g. because communicated differently by public and private sector actors; text or visual warning messages are not clear/understood by users)	Sectoral/administrative or institutional silos (e.g. NbS affect different policy sectors/administrative divisions, such as civil protection, forestry and tourism, and due to a lack of cooperation each sector favors conventional solutions over a novel joint NbS).	1 & 3
Limited evidence on benefits derived by the adoption of multi-(vs. single) hazard approach (e.g. lack of cost-benefit analysis comparing single and multi-hazard EWS)	Limited evidence on benefits derived by the adoption of multi-risk responses (e.g. the DRR-benefits and/or co-benefits are not sufficiently quantified in comparison to benefits derived from grey solutions)	1 & 3
Limited political will to implement MHEWS (e.g. authorities see no need in upgrading current warning systems; they do not see the benefits, or they do not have funding)	Limited political will (e.g. authorities see no need in daring new approaches or aim for a grey “quick fix” instead of a long-term NbS)	1 & 3
Limited Data (e.g. meteorological, climatological, demographic or other data that would be essential for the design and implementation of MHEWS is missing/not sufficiently available or accessible).	Limited data (e.g. meteorological, topographical, demographic or other data that would be essential for the design and implementation of NbS is missing/not sufficiently available or accessible)	2 & 4
Limited multi-risk management tools (e.g., agencies not willing to take over	Limited multi-risk management tools (e.g., agencies not willing to take over	2 & 4

responsibility for multi-risk assessment or MHEWS; multi risk forecasts are not really operational)	responsibility for multi-risk assessment, the multi-risk benefits of NbS cannot be account for)	
Limited policy instruments explicitly addressing multi-risk issues (e.g. guidelines, frameworks, funding schemes, etc. are mostly focused on single hazard warning systems)	Limited policy instruments (e.g., on urban planning) explicitly addressing multi-risk issues	2 & 4
Path dependency (e.g. MHEWS would require different/new knowledge, infrastructure and other resources compared to existing single risk centred early warning systems that are entrenched and resistant to change).	Path dependency (from single risk centred management systems, e.g. grey solutions are already in place, and it is less to replace / upgrade them than planning NbS that function differently).	2 & 4

The following sections provide a summary of the discussions in the four groups.

5.2.1. MHEWS barriers, group 1 (Moderator: Guido Rianna, Note taker: Maryam Rokideh)

Table 4: MHEWS barriers, group 1

Barriers	Ways to overcome them & examples
Limited expertise & knowledge	→ Different orgs. have different sensors and thus not joined up, there needs to be a common system (shared platform) → The first step towards a new MHEWS is the installation of relevant sensors in the right sites. → Use existing knowledge in a better way. Expertise is often present but issues arise with different communication, politics, and cultural aspects → Amplify success stories - policymakers usually don't have knowledge about how effective systems work and evidence of good practices or what has worked well, so using success stories from other contexts could motivate action (local town councils also don't want to spend their budgets if they are not certain) -> Distribute policy briefs or success stories to increase awareness of the effective use of these solutions → Need focused training and testing to integrate the knowledge of technical experts with response authorities → Separate institutions need cooperation, integration and perhaps multi-risk institutions → Regular information sharing between stakeholders is necessary
Ineffective communication & Sectoral/institutional silos	→ Need of continuity: When administration changes (e.g. elections), there is the risk that the new one will not consider previous decisions. Instead, implement protocols independent of who is in charge. → Make a clear action plan when communicating alert for events and conduct trainings and simulation exercises regularly, ex. Italy → More co-production and collaboration is needed: Single voice for highest warning levels → Invest in interdisciplinary collaborations; develop joint governance structures between organizations and public-private partnership agreements. Use MHEWS planning and learning from other hazards

	where many institutions and countries work together, e.g. Volcanos and Tsunamis → Limited communication and interactions with the public: Integrate the '1st mile', co-production of warning in communities: Emergency measures need to be adopted within organizations, schools, etc. not just at the government level—needs to be embedded in all domains of daily life → People are not connected with EWS channels or communication: Centralized warnings systems (floods, droughts, fires, etc.) Good examples: Volcanoes and tsunamis → Focus on failures and improve from there? (Can early warning work at all for events which never happened before?) → Communication channels that are used for warnings and alerts are not the same that people use in their everyday lives: Identify what people use and use those channels for communicating warnings
Limited evidence on benefits	→ Expert judgement from all sectors, other people should be involved in decision-making → Highlight other values, not just monetary benefits. Direct and indirect impact assessment (Direct: Response, Indirect: damage mitigation, restoration) → Socio-economic benefit analysis: Learn from economists for example Socio-economic modelling and benefit analysis – efficiency savings to operationalize MHEWS → Learning from good practices and explain to decision-makers and schools/Dissemination of study cases and successful projects. Working with stakeholders like students, politicians → Limited evidence of benefits, but know consequences and impacts so use this to create urgency
Limited political will	→ Memory - when we have a long time without any events, politicians stop thinking about necessity of dealing with these issues — so must remind and have a memory of disaster events → Incentivize the adoption of MHEWS by creating narratives and provide awareness in different ways → Develop better long-term DRR policy – that goes beyond the time horizon of political terms. Needs to be enforced & supported by all parties, implemented e.g. through a technical directorate → Leverage learning from high impact events that trigger a political response → Local politics consider risk management as an abstract requirement from the central government. National frameworks need to be harmonized with daily work/issues to be relevant. → Participatory workshops involving municipalities and citizens on risk management, involving them in decision-making

5.2.2. MHEWS barriers, group 2 (Moderator: Michele Calvello, Note taker: Gaetano Pecoraro, Jogscha Abderhalden)



Table 5: MHEWS barriers, group 2

Barriers	Ways to overcome them & examples
Limited Data	➔ There is a need to identify vulnerable points (elements at risk): if there is something happening what is the impact? In general, we are good in the hazard part but there is less focus on vulnerability ➔ It is the responsibility of central institutions to make data available ➔ There is a matter of cost and workload (data storage and handling can be costly). Dedicated funding could mitigate this issue ➔ There is a need for a structure to share data. It must be clear which data needs to be open and shared with whom and why, just making everything openly available in raw formats etc. can be too much and confusing. ➔ Data sharing between neighbouring countries is sometimes a problem where important data for cross-border activities is not shared across but would be very central to have. Example: The Pyrenees are a cross-border region and data sharing is very complex. ➔ Collaboration between different organizations (e.g., road authority and national government in Norway) should be fostered/improved ➔ Obtaining data: Making better use of global data that is already freely available (e.g. open street map provides a lot of information and huge amount of data which is freely available) ➔ Obtaining data: Consider citizen science + low-cost sensor networks

	→ Data consistency: Local data systems are often set up for specific issues. Local communities result in getting their own purpose-built system. However, the data might be useful/of interest for others as well. Discussions among all interested actors are central to explore synergies and collect data in a way that is consistent with the systems of other stakeholders/national agencies.
Limited multi-risk management tools	→ Prioritizing is essential: Do not try to do everything at once but identify and focus on combinations of the most relevant single hazards. To achieve this, easy-to-use tools to overlap single hazard maps would be essential. → There is no way that one institution can produce everything for each hazard, but one channel/one institution should take on the coordinating role and be responsible for distribution of information and rules, and make sure information is produced and collected. → Learn the needs of decision-makers to be able to offer them the support, data or infrastructure they need. Climate counsellors and councils are a concrete idea to foster exchange and provide citizen support. → Responsibilities need to be clear and, in the case of new types of disasters, they need to be clarified first. Roles of key actors in the multi-risk decision-making process need to be very clear, but also adaptable. → One institution must take the coordination lead. In 2005 the UK defined responsibilities for all DRR-relevant actions. This process was initiated in the aftermath of three disasters and spans across the whole range of hazards, except public health. → For better governance practice, tools for collaboration need to be established. They are only working and sufficiently implemented, if they are imposed (or at least proposed and backed) top-down. → It remains a delicate balance for the government to hand down responsibility but also to step in at the right time if needed. → Adaptability of processes is especially important with multi-risks because several critical incidents may be happening at the same time. Processes are very complex, and it is impossible to foresee the exact evolution of an event/several events or cascading effects. → The case of natural hazard triggering technological disasters must not be forgotten: If there is a natural hazard you should be aware that there could be an impact on industry. Thus, also the private sector has to be prepared and partnerships must be built. → Conduct good uncertainty analysis (also for data) and send a clear message to the responders.
Limited policy instruments explicitly addressing multi-hazard	→ Clear procedures / guidelines: What to do (e.g. in cascading disasters). Guidelines and hazard maps. Hazard maps should be legally linked with guidelines, otherwise they are useless. → There should be clearer procedures linked to different scenarios and frameworks/paths to follow in the case of different events. (It was not discussed here how to do it – so the way to achieve this solution is not clear) → The concept of impact chain should be addressed more systematically: What to do if a main hazard is coming. E.g.: heavy rainfall has a link with landslides, floods, etc.

Path dependency	➔ Need to change our thinking: (1) Start with schools to raise awareness, (2) increase our understanding of multi-risk, (3) emergency managers need to understand cascades as well. ➔ Cascading hazards: Cascading events are the most common multi-hazard situations, and we need to focus more on that (e.g. no warning about the possibility of a power system to collapse)
------------------------	---



5.2.3. NbS barriers, group 1 (Moderator: Juliette Martin, note taker: Elias Huland)

The first NbS group included several NbS experts from multiple countries.

Table 6: NbS barriers, group 1

Barriers	Ways to overcome them & examples
Limited expertise & knowledge	➤ Funding for dedicated position to work on NbS. Preferably long-term, as limited positions risk loss of progress and hinder long-term planning. ➤ Cross-cutting boards /councils across different authorities (“sustainability board”) where NbS options and knowledge are brought to the table and discussed across stakeholder groups. ➤ Research collaboration, beginning in The HuT: Shared folder with NbS best practice examples from The HuT partners. However, it was mentioned that NbS are not easily transferable to other contexts, e.g. landslides are an issue in Iceland but as there are few natural forests, protective forests are not a relevant strategy.

	➤ Harness local expertise and knowledge by raising awareness at the local level, e.g. through NbS campaigns and engagement with stakeholders. The transfer of knowledge can go in either direction: site-specific/regional approaches can become available to researchers and planners and a general understanding of NbS becomes understood by citizens. ➤ Capacity building for local authorities ➤ Protect the anthropological identity of rural communities, ensure that new residents are familiarized with local traditions and knowledge and landscape management. E.g. in the case of wildfire prevention in Italy. ➤ An example from Hungary highlighted that the priority in DRR planning is safety with a lot of established standards for water infrastructure. When considering NbS, it is unclear whether NbS will be able to meet the conventional safety standards. Thus, more expertise on the safety of NbS is needed (see also barrier: limited evidence on benefits).
Sectoral, administrative and institutional silos	➤ University degree and professional training which connects disciplines and encourages reaching out to others. E.g. engineering for international development or global health and development. Could be a dedicated Master program bringing technical and social sciences together. ➤ Legislation mandating a governance structure such as medicines “multi-disciplinary teams” for diagnosis and treatment ➤ Establish structured communication, permanent communication channels. ➤ Preserve and integrate traditional knowledge in landscape management. A concrete approach could be a certification scheme for local communities for traditional wildfire management. ➤ Create Public-private partnerships. Find ways to motivate private landowners who do not manage their land properly and create “private hazard spots”.
Limited evidence on benefits	➤ Offer insurance cost reduction if evidence of benefits is brought up. This creates an incentive to assess benefits. ➤ Policy briefs with best practices, e.g. in cooperation with high-trust actors such as UNDRR. Also consider The HuT policy briefs. ➤ If NbS can help yielding incomes, this would make them more acceptable solutions where their benefits can be seen ➤ Consider case studies and pilot actions that integrate e.g. forest fires, droughts, heat waves together and show benefits for mitigation, adaptation, etc. and from which lessons learnt can be transferred ➤ We don't need to reinvent the wheel. More research which systematically compiles and compares what we know already and makes it accessible. New data is always welcome, but we have so much evidence already to promote. ➤ Evidence from longitudinal studies is missing. Some can be done ex post. These will deliver evidence to justify future NbS projects. ➤ Many NbS have been used/implemented for a long time but haven't been called as such. Including them in the evidence base would contribute a large chunk of evidence (e.g. protection forests, etc.)
Limited political will	➤ Further legislation supporting NbS. There should be standards, methods and guidelines that practitioners can apply.

	➤ In projects there should be specific targets for how many NbS should be implemented ➤ Recognition works even better than financial incentives, e.g. national competition for best NbS implementation on local level or prize for most effective sustainability board. ➤ Cost-benefits finance evidence, proof of efficiency will convince political stakeholders. Politicians will only allocate money, if there is reasonable proof of cost-effectiveness. ➤ Tender specifications/Public procurement process always has principles (cheapest wins, most effective one wins, most sustainable one, lowest carbon footprint, etc. (or at least weigh different factors)): Either make NbS prerequisite for everyone. Then it is something to fulfil and to tick the box OR make it something to compete for. E.g. The proposal with most NbS wins. Then implementers try to maximize NbS proportion in projects. E.g. from a public building process in Hamburg where architects competed for the greenest option and all proposals fulfilled the Green Building Standard. ➤ Remind political entities about them being signatory to global frameworks, e.g. show how NbS contribute to SDGs, SFDRR, how they are recommended by UNDRR, etc. ➤ Create a community resilience fund that covers additional costs/risks of NbS
--	--

Insights from The HuT demonstrators:

- DEM 5, Schleswig-Holstein State, mentioned a best practice approach for creating political will on a local level. They made the experience that recognition works very well and that offering prizes for successful NbS can activate local politicians. They also had good experiences with including NbS in public tenders which resulted in bidders competing for the greenest urban development plans.
- DEM 8, Italy, mentioned that to overcome the lack of expertise and knowledge, better community involvement could help to obtain traditional knowledge and sustainable management practices that work with nature to prevent wildfires. This knowledge could be acknowledged in policies, shared and upscaled.





5.2.4. NbS barriers, group 2 (Moderator: JoAnne Bayer, Note taker: Julia Aguilera Rodriguez)

Table 7: NbS barriers, group 2

Barriers	Ways to overcome them & examples
Limited Data	➤ We have data, but the impact of measures is often in the long term, and we don't have enough data to properly understand the long-term impact of decisions. ➤ Talking to policy makers in Valencia - they see most benefits of NbS related to health and not necessarily to safety. But they need tools for measuring such health benefits and support investments so that they are not regarded as an expenditure. Health benefits of NbS are very difficult to include in a cost-benefit analysis.
Limited multi-risk management tools	➤ Using a diversity of solutions is needed (not to put all eggs in one basket) ➤ In Switzerland, the cantonal government works as the umbrella that brings together departments that relate to multiple hazards. ➤ When issues emerge at the local and regional level, for example due to different political parties, having a figure of authority such as the European Union, helps. ➤ In Portugal, civil protection managers address multi-risk by having weekly debriefs. Everyone dealing with DRR works in the same building and is in close communication. The weekly debriefs keep them informed even if risks are not related.

	➤ “Control rooms for breaking silos” - Periodical meetings among relevant stakeholders at the local level ➤ We can try to overcome many of the barriers by organizing round tables including ministers and policy makers at the local level. Periodical meetings. One important aspect is that it becomes easier to put different stakeholders together, when they feel obliged to participate in discussions. At regional level, “control rooms” for specific risks could be created so that the relevant actors design measures in collaboration.
Limited policy instruments explicitly addressing multi-hazard	➤ Insurance for those measures with higher risks, perhaps provided with low premium by a public mechanism ➤ NbS implementation needs “buffers” that have to be accounted for because of uncertainties – this includes funding for those buffers. ➤ When complications arise at the local level, top-down decisions to make actions mandatory can help
Path dependency	➤ Local perception is another barrier: infrastructures are getting older and there is the idea that all that is getting old needs to be fixed (path dependency). There is an urgent need to raise awareness.

Insights from The HuT demonstrators:

- DEM 1, Spain, said that specific sectoral data for NbS is missing. In their case, data on the health effects of NbS would be most important to local policy makers.
- DEM 8, Italy, reported from successful round table events that included high political representation and helped to involve stakeholder and various organizations effectively.
- DEM 10, Switzerland, mentioned a best practice approach for coordinating stakeholders for better multi-risk management: The regional (cantonal) governments function as an umbrella and bring together departments that relate to multiple hazards.



5.3. Synthesis

The topics MHEWS and NbS were selected for this forum because of their common relevance in multi-hazard management. The presentations and discussions aimed to approach the complex issue of multi-hazard DRR from different perspectives to identify fundamental multi-hazard management barriers and ways to overcome them. Both topics that were discussed show some different characteristics, both in terms of their complexity, timeliness and corresponding governance structures, yet, at root, both issues are governance issues of multi-hazard management, and therefore several similarities emerged during the closing session of the forum, when all groups reported back to the plenary. We aim to distill these characteristics of barriers and solutions to overcome them. We focus on the barriers that were mentioned for both topics. We argue that MHEWS and NbS can serve as proxies for multi-hazard DRR in general and that therefore our findings may also be applicable for other multi-hazard DRR approaches and the wider DRR debate. In this synthesis section, we walk through the barriers to multi-risk management and discuss the suggestions collected in presentations and discussions. As discussed earlier, some barriers are closely linked with each other, and some approaches to overcome them apply to multiple barriers.

5.3.1. Limited expertise and knowledge

In the discussions about limited expertise and knowledge, one central aspect emerged in both topics: While relevant expertise and knowledge does often exist within stakeholder groups, they are not always present in those groups that are necessary (or have the mandate) for the successful implementation of NbS/MHEWS measures. The workshop results reveal that the stakeholders with decision-making power often lack the necessary knowledge. Different communication, politics, and cultural aspects hamper the flux of expertise and adoption of joint approaches for effective multi-hazard management, such as MHEWS and NbS.

A set of innovative approaches was formulated to ensure that the existing knowledge is shared and integrated into decision-making processes. This includes harnessing local expertise and knowledge by **raising awareness and dialoguing at the local level**, e.g., through campaigns and stakeholder activities. Such activities should, where applicable, encourage the **sharing of local traditions, knowledge and forms of sustainable landscape management**.

Likewise, long-term funding for **dedicated positions to promote NbS** were proposed to encourage dialogue among relevant stakeholders and sharing of expertise to facilitate the development of integrated solutions. Alternatively, cross-cutting boards / council across different authorities ("**sustainability board**") where NbS options and knowledge are brought to the table and discussed across stakeholder groups. The same challenges are also encountered in MHEWS. In her presentation, Joanne Robbins from the UK Met Office shared the example of the **Natural Hazard Partnership (NHP)** that brings together the stakeholders and ensures communication across organisations (see also chapter Sectoral/administrative or institutional silos (and ineffective communication)) and an exchange of expertise.

Amplification of success stories is equally relevant to both topics and all actors. This concerns not just the design of MHEWS and NbS but also expertise on the right policy instruments to foster the implementation of multi-hazard approaches (see appendix, 8.2). Concrete tools include **policy briefs, success stories (articles, radio, video)** to increase awareness and research collaboration, as it is done in The HuT project. In this concrete context, a **shared folder with NbS best practice examples** from The HuT partners could contribute to knowledge exchange among project partners. The issue of sharing expertise, knowledge and data across cases connects closely with the barrier 'Limited Data' and will be further elaborated in chapter 5.3.5.



Both groups also mentioned the need for **capacity building**. While this would look different in each case (e.g. testing warning chains and emergency communication between technical experts and response authorities in the case of MHEWS), training local authorities in multi-hazard approaches seems essential to adapt to emerging challenges.

5.3.2. Sectoral/administrative or institutional silos (and ineffective communication)

The need to tackle sectoral/administrative silos was equally seen as a common key challenge for MHEWS and for NbS. Virtually by definition, multiple hazards affect several institutions or sectors and require integrated responses, more cooperation and joint activities. These challenges are typical for cross-cutting issues that touch upon the responsibilities of different political sectors.

A response mentioned in both groups was the importance of co-production and collaboration, e.g., through the establishment of **permanent or periodical communication channels, joint boards** or “control rooms for breaking silos” as one participant put it in the context of NbS. Regarding the governance of such collaboration tools, both groups mentioned that collaboration is more effective if participants felt obliged to participate. This could also be achieved through **partnership agreements** between organizations or a **legally mandated governance structure** with the oversight and funds to bring together all relevant actors. In practice, the NHP, an **inter-agency partnership** in the UK dealing with MHEWS, as it was introduced in the Good Practice example on MHEWS, is working well. In general, learning from good practices e.g., for specific hazards, such as volcanos and from other countries or international collaborations, such as in tsunami warnings, was mentioned as a helpful strategy to identify ways of effective collaboration.

For MHEWS, the collaboration in emergency situations was specifically addressed. Here, the idea was brought forward to **develop clear action plans** for the case of alerts and regularly practice the implementation in **simulation exercises**. This on the one hand helps all actors to practice the emergency routine and also contributes to tightening contacts between all involved actors.

A number of points regarding communication are mainly relevant for MHEWS and were specifically discussed in the respective groups. This discussion focused on how citizens can be best reached in the case of an emergency: It is important to have a **single trusted voice for high(est) warning levels** and to **identify and use the communication channels that are most frequently used by the target groups** in their everyday life.

Regarding NbS, a side-aspect were the silos between public and private stakeholders. The need to address private stakeholders to prevent “private hazard spots” was stressed, e.g. by creating **public-private partnerships** or incentivising landowners to implement NbS on their land. Irrespective of the concrete issue, **joint university degrees and professional training** which connects disciplines can be a very helpful tool for breaking sectoral silos. Not just will graduates have acquired the skills to understand multiple hazards and various organizations, scientific fields and their respective ‘languages’, but they will also have developed professional personal networks that go beyond specific disciplines and facilitate cooperation. This idea was mentioned regarding NbS but is equally relevant to MHEWS and any other field where multiple hazards require the cooperation of different sectors, administrative units or institutions.

5.3.3. Limited evidence on benefits derived by the adoption of multi- (vs. single) hazard approach

The limited availability of evidence about the benefits of multi-hazard approaches is also an issue inherently related to the nature of multi-hazard. This is because it is always more complex to assess multi-hazards and risks, especially quantitatively. Moreover, difficulties emerge to assess the multiple values of benefits and co-benefits that are derived from multi-hazard management.



Assessing a more limited number of benefits, let alone a single one, is definitely easier. At the same time, a lack of evidence can be a critical liability of a multi-hazard DRR approach. An NbS example from Hungary highlighted that the first priority in DRR planning is always safety and that standards for water infrastructure are well established. In such cases, NbS will not be considered without clear evidence of their effectiveness. Similarly, an MHEWS example highlighted that politicians will only allocate money to MHEWS, if clear evidence of the cost-effectiveness is presented.

For both subjects, most stakeholders agreed that evidence already largely exists but that it needs **to be made more accessible**. Learning from good practices and **systematically compiling and comparing what we already know** could contribute to filling the gap. Concrete actions include the **development of policy briefs** with best practices, e.g. in cooperation with high-trust actors such as UNDRR and/or with very concrete examples from the ground (e.g. experiences gathered in The HuT demonstrators).

Evidence on some co-benefits, however, is missing or not sufficiently highlighted, as was mentioned by both groups. Multi-hazard approaches often deliver **efficiency savings, as several hazards are addressed through one action** (e.g. if NbS are employed to prevent wildfires, they may also have a positive impact on heat waves risks and drought resistance). Valuing of benefits should also **include socio-economic benefits** beyond direct monetary benefits which could include improved responses (in the case of MHEWS), damage mitigation and in the case of NbS even possibilities of yielding **income from co-benefits**. A specific challenge remains that some co-benefits are difficult to assess, e.g. policy makers in Valencia would be very interested in quantifying health benefits of NbS. They, however, are very difficult to quantify and value. To help assess the relevant co-benefits, **expert judgement from all relevant sectors** is needed and a wide array of stakeholders should be consulted to obtain socio-economic approximations of as many co-benefits as possible. Furthermore, a better consideration of existing case studies and pilot actions could deliver additional data by **transferring (estimated) values and benefits** (see also chapter 5.3.1.).

Creating a sense of urgency, e.g. by highlighting the absence of conventional DRR approaches and possible consequences and impacts of unmitigated disasters, can justify multi hazard approaches even when the concrete evidence of benefits remains limited. This applies for both MHEWS (e.g. when there is political pressure regarding multiple hazards) as well as NbS (e.g. in the aftermath of a disaster).

Harnessing **market mechanisms to obtain more evidence** was mentioned as a proposal in one NbS group: This could be achieved through incentives for private actors to assess benefits of NbS or other multi-hazard approaches. Example would be insurance cost reduction if evidence of benefits is brought up or public procurement benefits, if contractors provide evidence that the NbS provides a certain level of co-benefits.

5.3.4. Limited political will to implement multi-hazard approaches

The lack of political will discussed in the groups mainly considers the will to implement actions in local context, i.e., by local decision-makers.

In particular for MHEWS it was mentioned that it is difficult to mobilize political will to prepare for events that have never happened before or a very unlikely to happen. This is true for single hazards that have a low return period but also for (seemingly) unlikely combinations of hazards. For all political actions, a **trigger event is an important opportunity** to shape the political agenda. One way of dealing with this issue is to **keep the memory of past events alive** to bring the issue to people's attention. In return, high impact events provide an opportunity for a quick political response – in any field of DRR but including MHEWS and NbS.



The planning horizons of both MHEWS and NbS far exceed the duration of political term. Therefore, a **long-term DRR strategy** should be developed, and measures should be enforced and supported across parties to ensure consistency. Likewise, the management can be ensured by a technical directorate or fixed protocols that are less dependent on political support.

Political will is often generated through public recognition or stakeholder engagement. One way to achieve that could be through **recognition mechanisms which honour local governments** for outstanding implementations of NbS or warning systems or offer **prizes for innovative sustainability boards**. Apart from this, stakeholder engagement can be stimulated by creating creative narratives or a joint vision, raising awareness, organizing participatory workshops with municipalities and citizens and involving stakeholders in decision-making.

Some discussions evolved around the relation of European/national guidelines, which some local decision-makers may consider as mere requirement that does not always harmonize with daily/local settings. On the other hand, participants agreed that **reminding decision-makers** about how **MHEWS and NbS are endorsed by trusted entities like UNDRR** and how implementing them **contributes to global frameworks and agendas** (2030 Agenda, SFDRR) was identified as a promising opportunity.

Some participants noted a lack of national legislation supporting NbS. **National NbS guidelines** can prescribe specific rules how NbS should be included and include minimal requirements. National guidelines could also include standards and methods that practitioners can adapt to and apply in projects.

5.3.5. Limited Data

Availability of data was a relevant issue for both topics, data requirements and approaches, however, mostly differ. While MHEWS data gaps arose mainly around sensor data collection, storage and sharing, NbS data gaps also include uncertainties about the performance of NbS. These require NbS to plan for buffers and plan very generous interventions, which raise the costs of NbS projects.

For MHEWS a variety of specific gaps exist, such as different sensors requirements, not joined up, relevant sensors system installed in the right sites and right way. Beyond that, it is not only the weather/hazard data that is relevant, but also the identification of vulnerable points to determine the impacts. While consensus was that hazard data is in general relatively good available, the lack of vulnerability data was noted. Solutions to this issue could include making better use of freely available **global data** (e.g. different Open Street Map services) and obtaining data through **citizen science projects and low-cost sensor networks**.

A challenge for data sharing and using decentralized data sources is data consistency: Local users often design data systems for particular issues and develop own purpose-built systems. The data might in principle be useful/of interest for other stakeholders/national agencies as well but these own systems may not be compatible with other users. The solutions that were discussed is bringing stakeholders together **to explore synergies to collect consistent data**. Several other practical and technical issues regarding data sharing were discussed: One **organization needs to be charged with bringing together, handling and storing** the data and determining which data will be available in which format, resolution, where and to whom. This task entails significant costs and workload, which need to be accounted for, e.g. through **funding for data storage and handling**.

Participants saw opportunities to implement MHEWS despite imperfect data, if **good uncertainty analyses are conducted and clear messages** are sent to the responders.

Regarding NbS, the main data gap, next to multiple co-benefits, was long-term data, which is not widely available. This lack is also recognized in literature (Han & Kuhlicke, 2019). As designing case studies to obtain longitudinal data takes time, another approach are **ex post analyses to study already existing NbS** (even if they haven't been called as such, e.g. protection forests) and thereby add to the evidence base of NbS effectiveness.

5.3.6. Limited multi-risk management tools

Fitting tools are essential to multi hazard approaches and were consequently discussed for both subjects: For MHEWS it was mentioned that it is impossible to examine all hazards in all combinations with detailed analyses in one organisation. This concluded in suggestions such as **one channel or institution should be tasked with coordinating** multi hazard assessments and warnings by bringing in expertise from other organisations.

The main issue regarding management tools of multiple hazards was the cooperation of different organizations responsible for different hazards, which was discussed in both groups. In essence, the discussions picked up on many points that were also discussed regarding the sectoral silos (see chapter 5.3.2). For better governance practice, **tools for collaboration of all involved actors need to be established**, such as round tables or “control rooms for breaking silos” which were discussed earlier.

For MHEWS it was mentioned that **adaptability of process and stakeholder collaboration** is especially important. In cases when several critical incidents are happening at the same time, it is impossible to foresee the exact evolution of events, their interdependence or possible cascading effects. Thus, adaptability is key to react appropriately.

5.3.7. Limited policy instruments explicitly addressing multi-risk issues

Policy instruments for MHEWS and NbS have some commonalities but both issues also have characteristics where different instruments are necessary. MHEWS, for example, depends on clear emergency procedures and guidelines in which disaster interactions can be integrated and which can be developed for different scenarios.

The participants agreed that the concept of the **warning value chain** should be more present to **analyse and prepare for multi hazard** scenarios. It can guide decision-makers through the process of analysing different scenarios and overcoming disciplinary silos. E.g. it would clearly indicate how responses to a main hazard (e.g. heavy rain) could be impaired by other hazards (e.g. landslides or floods blocking evacuation routes).

Regarding NbS, a few relatively case specific instruments were named: Firstly, the lever of public procurement and public tenders was emphasized: Such processes always follow certain defined principles (e.g. cheapest offer wins, most effective offer wins). To use this lever, tenders be designed to include **NbS requirements for bidders** or weigh **the amount/quality of NbS as one of the decision criteria**, so that offers with a higher proportion of NbS have a better chance of winning, even if they are more expensive.

If uncertainties about the precise effectiveness of NbS implementation force NbS owners to buy more expensive insurance, **include funding to lower insurance premiums or implementation of buffers is a suggested option** This additional funding to cover costs/risks of NbS could come from other public mechanisms or external sources. A possible tool that was mentioned are **community resilience funds**.

5.3.8. Path dependency

Considering multi-hazard approaches often requires a fundamentally different way of thinking about issues and approaching them. This begins with education, where hazards are often mentioned separately, includes sensors, policy mechanism, stakeholder expectations, administrative know-how, availability of contractors and many other factors that, once established, require additional resources to change and adapt to multi-hazard approaches. All these issues combine into a strong retarding force in risk management that has been widely acknowledged (Šakić Trogrlić et al., 2024; Thaler et al., 2023). The issue of path dependency was also widely agreed upon during the I-DRRnF, however due to the wide scope and to being closely intertwined with the other barriers only few specific approaches could be collected.

One example from Switzerland was mentioned that shows the rigidity of stakeholder expectations: older infrastructure (check dams) that contributed to flood prevention started to become insecure and needed fixing. Many stakeholders had the expectation that similar solutions to the known and trusted check dams would replace the old ones and opposed new strategies to reduce the flood risk by implementing NbS. In this case, **involving the stakeholders and raising awareness** of the benefits of the new approach was necessary to keep this option open.

Also, for MHEWS, it is always complex to manage hazards in a different way than people are used to. Possible entry points for reducing resistance are raising awareness in schools and in the public to **increase the understanding of multi-hazards** and the need to respond to them, **capacity development** of civil servants and emergency managers for them to understand the multiple hazards, and particularly the risks associated to cascading events .



6. Conclusions

This document summarizes the results the second I-DRRnF which took place on the 21 November 2024 in Gerzensee, Switzerland. The forum focused on barriers to multi-hazard management, and ways to overcome them. The two approaches MHEWS and NbS served as cases for which the barriers were discussed. The special strength of the I-DRRnF is the diversity of project partners and participants from across Europe. To make use of this strength, all The HuT demonstrators contributed to a preparatory survey, all project partners of The HuT project were invited to participate in the interactive World Café sessions and some experts, representing different institutions of The HuT consortium and beyond, gave presentations on specific aspects of multi-hazard management and practical experiences. A literature review has supported the organization of the forum and this deliverable in order to provide a substantial foundation for the discussions and compare the project partners' experiences with findings from the literature.

Beyond the joint conclusions for multi-hazard management, the discussions during the forum also revealed insights into both focus topics: Regarding MHEWS a crucial issue for successful implementation was communication, as could be seen during the Valencia floods, when data was available, but warnings were not issued timely and appropriately. Additionally, the discussions indicted a high demand for breaking silos, e.g. tools for making different actors collaborate more effectively. Focusing on the early warning value chain to identify weak spots and areas for action could be a support overcome some of the barriers.

Despite NbS gaining a lot of prominence and traction on an increasing number of political agendas and being subject to massive research efforts, there are still crucial gaps in NbS implementation, in particular when it comes to DRR. When human lives are at stake, there is still a clear reluctance to solely rely on NbS without a fallback grey infrastructure option and even seemingly minor research gaps and uncertainties about the effectiveness of NbS can become crucial pitfalls for NbS projects. A potential expedient to this dilemma could be to consider hybrid more thoroughly and explore how combinations of NbS and grey infrastructure could look like. For example, in Switzerland, this issue has been solved by embracing the fact that protection forests alone sometimes do not provide sufficient protection of human assets, in which case they are complemented by structural measures. Translating this approach into the NbS policy discourse, could contribute to making NbS elements in DRR contexts more feasible and overcoming the crucial barriers.

Overall, the discussions showed that multi-hazard management still faces many challenges and that all of previously identified barriers were relevant for both MHEWS and NbS implementation. A general comparison of the two approaches shows that some of the mentioned barriers and ways to overcome them were nearly identical, indicating that the underlying challenges are shared and likely inherent to multi-hazard management in general or to novel risk management approaches. The challenges connected to sectoral/administrative silos, for example, were almost equal for both topics and the ways to overcome them are largely aligned. Other barriers for which we could identify clear similarities were limited expertise and knowledge, limited evidence on benefits and limited multi-risk management tools. On the other hand, two barriers, namely limited data and political will are both present for both topics but approaches to overcome them were rather different and specific for each approach. Overall, we conclude that reflecting jointly on different multi-hazard approaches can contribute to identifying general learnings, better understanding challenges in responding to multiple hazards and developing approaches for more effective multi-hazard governance.



The format of the I-DRRnF offers a platform for The HuT project partners to share experiences and discuss common issues. It benefits from the diversity of participants who are scientists and practitioners with various academic backgrounds who are engaged in various case studies. It helped participants to connect and to learn from each other, to reflect on issues faced in their projects and to inspire each other with solutions and stories of successful multi-hazard management.



7. References

- Antofie, T., Luoni, S., Tilloy, A., Sibilia, A., Salari, S., Eklund, G., Rodomonti, D., Bountzouklis, C., & Corbane, C. (2024). Spatial identification of regions at risk to multi-hazards at pan European level: An implemented methodological approach. <https://doi.org/10.5194/nhess-2023-220>
- Calliari, E., Castellari, S., Davis, M., Linnerooth-Bayer, J., Martin, J., Mysiak, J., Pastor, T., Ramieri, E., Scolobig, A., Sterk, M., Veerkamp, C., Wendling, L., & Zandersen, M. (2022). Building climate resilience through nature-based solutions in Europe: A review of enabling knowledge, finance and governance frameworks. *Climate Risk Management*, 37, 100450. <https://doi.org/10.1016/j.crm.2022.100450>
- Castellar, J. A. C., Popartan, L. A., Pucher, B., Pineda-Martos, R., Hecht, K., Katsou, E., Nika, C. E., Junge, R., Langergraber, G., Atanasova, N., Comas, J., Monclús, H., & Pueyo-Ros, J. (2024). What does it take to renature cities? An expert-based analysis of barriers and strategies for the implementation of nature-based solutions. *Journal of Environmental Management*, 354, 120385. <https://doi.org/10.1016/j.jenvman.2024.120385>
- Chang, C. H., Erbaugh, J. T., Fajardo, P., Lu, L., Molnár, I., Papp, D., Robinson, B. E., Austin, K. G., Castro, M., Cheng, S. H., Cook-Patton, S., Ellis, P. W., Garg, T., Hochard, J. P., Kroeger, T., McDonald, R. I., Poor, E. E., Smart, L. S., Tilman, A. R., ... Masuda, Y. J. (2024). Global evidence of human well-being and biodiversity impacts of natural climate solutions. *Nature Sustainability*, 1–11. <https://doi.org/10.1038/s41893-024-01454-z>
- Chausson, A., Turner, B., Seddon, D., Chabaneix, N., Girardin, C. A. J., Kapos, V., Key, I., Roe, D., Smith, A., Woroniecki, S., & Seddon, N. (2020). Mapping the effectiveness of nature-based solutions for climate change adaptation. *Global Change Biology*, 26(11), 6134–6155. <https://doi.org/10.1111/gcb.15310>
- Christopher, N., Vachette, A., Horne, A., & Kosovac, A. (2024). Enhancing river floodplain management with nature-based solutions: Overcoming barriers and harnessing enablers. *WIREs Water*, 11(4), e1723. <https://doi.org/10.1002/wat2.1723>
- Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C. R., Renaud, F. G., Welling, R., & Walters, G. (2019). Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, 98, 20–29. <https://doi.org/10.1016/j.envsci.2019.04.014>
- Davies, C., Chen, W. Y., Sanesi, G., & Laforzezza, R. (2021). The European Union roadmap for implementing nature-based solutions: A review. *Environmental Science & Policy*, 121, 49–67. <https://doi.org/10.1016/j.envsci.2021.03.018>
- Davis, M., Cuevas, N. B., & Gvein, M. H. (2024). Transforming ambition into action to catalyse nature-based solutions: Insights from 250 good practice policy instruments. *Nature-Based Solutions*, 6, 100171. <https://doi.org/10.1016/j.nbsj.2024.100171>
- Debele, S. E., Leo, L. S., Kumar, P., Sahani, J., Ommer, J., Bucchignani, E., Vranić, S., Kalas, M., Amirzada, Z., Pavlova, I., Shah, M. A. R., Gonzalez-Ollauri, A., & Di Sabatino, S. (2023). Nature-based solutions can help reduce the impact of natural hazards: A global analysis of NBS case studies. *Science of The Total Environment*, 902, 165824. <https://doi.org/10.1016/j.scitotenv.2023.165824>
- Dorren, L., & Moos, C. (2022). Towards quantitative evidence of Eco-DRR in mountains: A concise review. *Ecological Engineering*, 175, 106485. <https://doi.org/10.1016/j.ecoleng.2021.106485>



- Dorst, H., van der Jagt, A., Toxopeus, H., Tozer, L., Raven, R., & Runhaar, H. (2022). What's behind the barriers? Uncovering structural conditions working against urban nature-based solutions. *Landscape and Urban Planning*, 220, 104335. <https://doi.org/10.1016/j.landurbplan.2021.104335>
- Dunlop, T., Khojasteh, D., Cohen-Shacham, E., Glamore, W., Haghani, M., Bosch, M. V. D., Rizzi, D., Greve, P., & Felder, S. (2023). The Evolution and Future of Research on Nature-based Solutions to Address Societal Challenges. In Review. <https://doi.org/10.21203/rs.3.rs-3312024/v1>
- EEA. (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction. European Environment Agency. <https://www.eea.europa.eu/en/analysis/publications/nature-based-solutions-in-europe>
- Gill, A. J. C., Duncan, M., Ciurean, R., Smale, L., Stuparu, D., Schlumberger, J., de Ruiter, M., Tiggeloven, T., Gottardo, S., Mysiak, J., Harris, R., Petrescu, E.-C., Cipollone, F. B., Torres, C. C., Antolin, I. P., Ferrario, D., Tatman, S., Tijssen, A., Adesiyun, A., ... Ward, P. (2022). Handbook of Multi-Hazard, Multi-Risk Definitions and Concepts. MYRIAD-EU D1.2, H2020 MYRIAD-EU Project, grant agreement number 101003276, pp 75.
- Golding, B. (Ed.). (2022). Towards the "Perfect" Weather Warning: Bridging Disciplinary Gaps through Partnership and Communication. Springer International Publishing. <https://doi.org/10.1007/978-3-030-98989-7>
- Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., Schlesinger, W. H., Shoch, D., Siikamäki, J. V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R. T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M. R., ... Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114(44), 11645–11650. <https://doi.org/10.1073/pnas.1710465114>
- Han, S., & Kuhlicke, C. (2019). Reducing Hydro-Meteorological Risk by Nature-Based Solutions: What Do We Know about People's Perceptions? *Water*, 11(12), Article 12. <https://doi.org/10.3390/w11122599>
- Hermans, T. D. G., Šakić Trogrlić, R., van den Homberg, M. J. C., Bailon, H., Sarku, R., & Mosurska, A. (2022). Exploring the integration of local and scientific knowledge in early warning systems for disaster risk reduction: A review. *Natural Hazards*, 114(2), 1125–1152. <https://doi.org/10.1007/s11069-022-05468-8>
- Higuera Roa, O., Cotti, D., Aste, N., Bustillos-Ardaya, A., Schneiderbauer, S., Tourino Soto, I., Román-Dañobeytia, F., & Walz, Y. (2023). Deriving targeted intervention packages of nature-based solutions for climate change adaptation and disaster risk reduction: A geospatial multi-criteria approach for building resilience in the Puna region, Peru. *Nature-Based Solutions*, 4, 100090. <https://doi.org/10.1016/j.nbsj.2023.100090>
- Joseph, J. K., Akhildev, K., Renjith, V. R., & Pradeepkumar, A. P. (2024). Eco-DRR practices and research: Visualization and analysis of global perspectives. *International Journal of Disaster Risk Reduction*, 102, 104271. <https://doi.org/10.1016/j.ijdr.2024.104271>
- Kumar, P., Debele, S. E., Sahani, J., Aragão, L., Barisani, F., Basu, B., Bucchignani, E., Charizopoulos, N., Di Sabatino, S., Domeneghetti, A., Edo, A. S., Finér, L., Gallotti, G., Juch, S., Leo, L. S., Loupis, M., Mickovski, S. B., Panga, D., Pavlova, I., ... Zieher, T. (2020). Towards an operationalisation of nature-based solutions for natural hazards. *Science of The Total Environment*, 731, 138855. <https://doi.org/10.1016/j.scitotenv.2020.138855>
- Lee, R., White, C. J., Adnan, M. S. G., Douglas, J., Mahecha, M. D., O'Loughlin, F. E., Patelli, E., Ramos, A. M., Roberts, M. J., Martius, O., Tubaldi, E., van den Hurk, B., Ward, P. J., &



- Zscheischler, J. (2024). Reclassifying historical disasters: From single to multi-hazards. *Science of The Total Environment*, 912, 169120. <https://doi.org/10.1016/j.scitotenv.2023.169120>
- Lemos, M. C., & Agrawal, A. (2006). Environmental Governance. *Annual Review of Environment and Resources*, 31(Volume 31, 2006), 297–325. <https://doi.org/10.1146/annurev.energy.31.042605.135621>
- Martin, J. G. C., Irshaid, J., Linnerooth-Bayer, J., Scolobig, A., Aguilera Rodriguez, J., & Fresolone-Caparrós, A. (2023). Opportunities and barriers to NBS at the EU, national, regional and local scales, with suggested reforms and innovations. PHUSICOS-EU D5.2, H2020 PHUSICOS-EU Project, grant agreement number 776681. <https://www.phusicos.eu/globalassets/bilder/eksterne-prosjektsider/phusicos/publications/deliverable-d5-2.pdf>
- Martin, J. G. C., Scolobig, A., Linnerooth-Bayer, J., Liu, W., & Balsiger, J. (2021). Catalyzing Innovation: Governance Enablers of Nature-Based Solutions. *Sustainability*, 13(4), Article 4. <https://doi.org/10.3390/su13041971>
- Mather, A. S., & Fairbairn, J. (2000). From Floods to Reforestation: The Forest Transition in Switzerland. *Environment and History*, 6(4), 399–421. <https://doi.org/10.3197/096734000129342352>
- McVittie, A., Cole, L., Wreford, A., Sgobbi, A., & Yordi, B. (2018). Ecosystem-based solutions for disaster risk reduction: Lessons from European applications of ecosystem-based adaptation measures. *International Journal of Disaster Risk Reduction*, 32, 42–54. <https://doi.org/10.1016/j.ijdrr.2017.12.014>
- Nel, J. L., Le Maitre, D. C., Nel, D. C., Reyers, B., Archibald, S., Van Wilgen, B. W., Forsyth, G. G., Theron, A. K., O'Farrell, P. J., Kahinda, J.-M. M., Engelbrecht, F. A., Kapangaziwiri, E., Van Niekerk, L., & Barwell, L. (2014). Natural Hazards in a Changing World: A Case for Ecosystem-Based Management. *PLoS ONE*, 9(5), e95942. <https://doi.org/10.1371/journal.pone.0095942>
- Nelson, D. R., Bledsoe, B. P., Ferreira, S., & Nibbelink, N. P. (2020). Challenges to realizing the potential of nature-based solutions. *Current Opinion in Environmental Sustainability*, 45, 49–55. <https://doi.org/10.1016/j.cosust.2020.09.001>
- Ommer, J., Bucchignani, E., Leo, L. S., Kalas, M., Vranić, S., Debele, S., Kumar, P., Cloke, H. L., & Di Sabatino, S. (2022). Quantifying co-benefits and disbenefits of Nature-based Solutions targeting Disaster Risk Reduction. *International Journal of Disaster Risk Reduction*, 75, 102966. <https://doi.org/10.1016/j.ijdrr.2022.102966>
- O'Sullivan, F., Mell, I., & Clement, S. (2020). Novel Solutions or Rebranded Approaches: Evaluating the Use of Nature-Based Solutions (NBS) in Europe. *Frontiers in Sustainable Cities*, 2. <https://doi.org/10.3389/frsc.2020.572527>
- Ou, X., Lyu, Y., Liu, Y., Zheng, X., & Li, F. (2022). Integrated multi-hazard risk to social-ecological systems with green infrastructure prioritization: A case study of the Yangtze River Delta, China. *Ecological Indicators*, 136, 108639. <https://doi.org/10.1016/j.ecolind.2022.108639>
- Raška, P., Bezak, N., Ferreira, C. S. S., Kalantari, Z., Banasik, K., Bertola, M., Bourke, M., Cerdà, A., Davids, P., Madruga de Brito, M., Evans, R., Finger, D. C., Halbac-Cotoara-Zamfir, R., Housh, M., Hysa, A., Jakubínský, J., Solomun, M. K., Kaufmann, M., Keesstra, S., ... Hartmann, T. (2022). Identifying barriers for nature-based solutions in flood risk management: An interdisciplinary overview using expert community approach. *Journal of Environmental Management*, 310, 114725. <https://doi.org/10.1016/j.jenvman.2022.114725>



- Ruangpan, L., Vojinovic, Z., Di Sabatino, S., Leo, L. S., Capobianco, V., Oen, A. M. P., McClain, M. E., & Lopez-Gunn, E. (2020). Nature-based solutions for hydro-meteorological risk reduction: A state-of-the-art review of the research area. *Natural Hazards and Earth System Sciences*, 20(1), 243–270. <https://doi.org/10.5194/nhess-20-243-2020>
- Rüegg, J., Moos, C., Gentile, A., Luisier, G., Elsig, A., Prasicek, G., & Otero, I. (2022). An Approach to Evaluate Mountain Forest Protection and Management as a Means for Flood Mitigation. *Frontiers in Forests and Global Change*, 5. <https://doi.org/10.3389/ffgc.2022.785740>
- Šakić Trogrlić, R., Reiter, K., Ciurean, R. L., Gottardo, S., Torresan, S., Daloz, A. S., Ma, L., Padrón Fumero, N., Tatman, S., Hochrainer-Stigler, S., de Ruiter, M. C., Schlumberger, J., Harris, R., Garcia-Gonzalez, S., García-Vaquero, M., Arévalo, T. L. F., Hernandez-Martin, R., Mendoza-Jimenez, J., Ferrario, D. M., ... Ward, P. J. (2024). Challenges in assessing and managing multi-hazard risks: A European stakeholders perspective. *Environmental Science & Policy*, 157, 103774. <https://doi.org/10.1016/j.envsci.2024.103774>
- Sarabi, S., Han, Q., L. Romme, A. G., de Vries, B., & Wendling, L. (2019). Key Enablers of and Barriers to the Uptake and Implementation of Nature-Based Solutions in Urban Settings: A Review. *Resources*, 8(3), Article 3. <https://doi.org/10.3390/resources8030121>
- Sarabi, S., Han, Q., Romme, A. G. L., de Vries, B., Valkenburg, R., & den Ouden, E. (2020). Uptake and implementation of Nature-Based Solutions: An analysis of barriers using Interpretive Structural Modeling. *Journal of Environmental Management*, 270, 110749. <https://doi.org/10.1016/j.jenvman.2020.110749>
- Scolobig, A., Linnerooth-Bayer, J., Pelling, M., Martin, J. G. C., Deubelli, T. M., Liu, W., & Oen, A. (2023). Transformative adaptation through nature-based solutions: A comparative case study analysis in China, Italy, and Germany. *Regional Environmental Change*, 23(2), 69. <https://doi.org/10.1007/s10113-023-02066-7>
- Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 375(1794), 20190120. <https://doi.org/10.1098/rstb.2019.0120>
- Solheim, A., Capobianco, V., Oen, A., Kalsnes, B., Wulff-Knutsen, T., Olsen, M., Del Seppia, N., Arauzo, I., Garcia Balaguer, E., & Strout, J. M. (2021). Implementing Nature-Based Solutions in Rural Landscapes: Barriers Experienced in the PHUSICOS Project. *Sustainability*, 13(3), Article 3. <https://doi.org/10.3390/su13031461>
- Steurer, R. (2013). Disentangling governance: A synoptic view of regulation by government, business and civil society. *Policy Sciences*, 46(4), 387–410. <https://doi.org/10.1007/s11077-013-9177-y>
- Sudmeier-Rieux, K., Arce-Mojica, T., Boehmer, H. J., Doswald, N., Emerton, L., Friess, D. A., Galvin, S., Hagenlocher, M., James, H., Laban, P., Lacambra, C., Lange, W., McAdoo, B. G., Moos, C., Mysiak, J., Narvaez, L., Nehren, U., Peduzzi, P., Renaud, F. G., ... Walz, Y. (2021). Scientific evidence for ecosystem-based disaster risk reduction. *Nature Sustainability*, 4(9), 803–810. <https://doi.org/10.1038/s41893-021-00732-4>
- Thaler, T., Hanger-Kopp, S., Schinko, T., & Nordbeck, R. (2023). Addressing path dependencies in decision-making processes for operationalizing compound climate-risk management. *iScience*, 26(7), 107073. <https://doi.org/10.1016/j.isci.2023.107073>
- Thomas, F., & Knüppe, K. (2016). From Flood Protection to Flood Risk Management: Insights from the Rhine River in North Rhine-Westphalia, Germany. *Water Resources Management*, 30(8), 2785–2800. <https://doi.org/10.1007/s11269-016-1323-9>



- Turner, B., Devisscher, T., Chabaneix, N., Woroniecki, S., Messier, C., & Seddon, N. (2022). The Role of Nature-Based Solutions in Supporting Social-Ecological Resilience for Climate Change Adaptation. *Annual Review of Environment and Resources*, 47(Volume 47, 2022), 123–148. <https://doi.org/10.1146/annurev-environ-012220-010017>
- UNDRR. (2023a). Nature-based solutions for comprehensive disaster and climate risk management: Toolkit for integrated planning and implementation of disaster risk reduction and climate change adaptation. United Nations Office for Disaster Risk Reduction. <https://www.undrr.org/publication/nature-based-solutions-comprehensive-disaster-and-climate-risk-management-toolkit>
- UNDRR. (2023b). Words into Action guidelines Multi-hazard early warning systems. United Nations Office for Disaster Risk Reduction.
- UNDRR. (2024). Strengthening Disaster Risk Reduction in National Biodiversity Strategies and Action Plans: Recommendations and Guidance for Governments. United Nations Office for Disaster Risk Reduction.
- UNDRR & WMO. (2023). Global Status of Multi-Hazard Early Warning Systems. United Nations Office for Disaster Risk Reduction and World Meteorological Organization.
- UNEP. (2023). State of Finance for Nature: The Big Nature Turnaround – Repurposing \$7 trillion to combat nature loss. United Nations Environment Programme. <https://www.unep.org/resources/state-finance-nature-2023>
- UNEP. (2024). Progress on implementation of Integrated Water Resources Management. Mid-term status of SDG indicator 6.5.1 and acceleration needs, with a special focus on climate change. United Nations Environment Programme.
- Vicarelli, M., Sudmeier-Rieux, K., Alsadadi, A., Shrestha, A., Schütze, S., Kang, M. M., Leue, M., Wasielewski, D., & Mysiak, J. (2024). On the cost-effectiveness of Nature-based Solutions for reducing disaster risk. *Science of The Total Environment*, 947, 174524. <https://doi.org/10.1016/j.scitotenv.2024.174524>
- Ward, P. J., Daniell, J., Duncan, M., Dunne, A., Hananel, C., Hochrainer-Stigler, S., Tijssen, A., Torresan, S., Ciurean, R., Gill, J. C., Sillmann, J., Couasnon, A., Koks, E., Padrón-Fumero, N., Tatman, S., Tronstad Lund, M., Adesiyun, A., Aerts, J. C. J. H., Alabaster, A., ... de Ruiter, M. C. (2022). Invited perspectives: A research agenda towards disaster risk management pathways in multi-(hazard-)risk assessment. *Natural Hazards and Earth System Sciences*, 22(4), 1487–1497. <https://doi.org/10.5194/nhess-22-1487-2022>
- Weyrich, P., Scolobig, A., & Patt, A. (2019). Dealing with inconsistent weather warnings: Effects on warning quality and intended actions. *Meteorological Applications*, 26(4), 569–583. <https://doi.org/10.1002/met.1785>
- WMO. (2022). EARLY WARNINGS FOR ALL The UN Global Early Warning Initiative for the Implementation of Climate Adaptation. World Meteorological Organization. <https://library.wmo.int/records/item/58209-early-warnings-for-all>



8. Appendix

8.1. Preparatory survey with The HuT Demonstrators

The survey was sent to each of The HuT demonstrators ahead of the forum. Thirteen respondents, representing the demonstrator areas of The HuT project (Question 1), filled in the survey. Almost two years into the project, activities in all demonstrators were ongoing. However, the topics of focus and the specific challenges varied. To understand the respective topics and challenges and to define a common ground for the forum, the survey focused on:

- Multi-risk management aspects in the demonstrators (Q 2),
- Stakeholder relations in the context of multi-risk management (Q 3),
- Motivations to work on multi-risk (Q 4),
- Barriers and enablers for effective multi-risk management (Q 5 and 6), and
- Interests in the field of multi-risk management (Q 7, 8 and 9).

All respondents reported the presence of multi-risk management aspects in their respective demonstrators (Question 2). Respondents were allowed to select the one multi-risk management aspect that stood out most in their projects. Among these, multi-hazard warning systems (6 responses, 46%), multi-risk reduction measures, including NbS (3 responses, 23%) and multi-hazard/risk assessment (2 responses, 15%) were most prevalent. Emergency management and educational material were also mentioned.

Regarding the most relevant stakeholders for multi-risk management with whom the respondents collaborate (Question 3, only one answer was permitted), government agencies were by far the most named partner (7 responses, 54%). Academic institutions (3, 23%) and community groups or associations (2, 15%) were also mentioned, and one participant reported an equal collaboration with the local municipality and citizens.

The motivations to work on multi-risk (Question 4) varied between the different demonstrators with overall six different responses. While the integration of different perspectives and expertise (4 responses, 31%) and occurrence of a cascading event/disaster (3 responses, 23%) slightly stood out, four options were named twice each (capacity building opportunities by learning across risks, increasing public trust and raising awareness for multi-risks, 15% each) or once (strengthening of networks, and inherent interdependence of weather related risks, 8% each).

After understanding the demonstrator settings through the previous questions, the survey then focused on the concrete implementation and challenges of multi-risk management. When asked for the main barriers that hinder multi-risk management (Question 5), respondents identified a **lack of expertise and knowledge** as a key barrier. This seems to be generally important, regardless of the specificities of a given case, as it was reported by 9 respondents (69%). However, as three answers were allowed to this question, four other barriers were widely shared among respondents and cases: **limited policy instruments** (6, 46%) **limited data, limited evidence on benefits**, and **sectoral silos** (5 each, 38%). Other barriers that were identified three times or less were: **limited risk management tools** and **limited political will** (3, 23% each), **path dependency from single-risk-centred management systems** (2, 15%) and **limited budget, limited human resources** and **uncertain nature of risks** (1, 8% each).



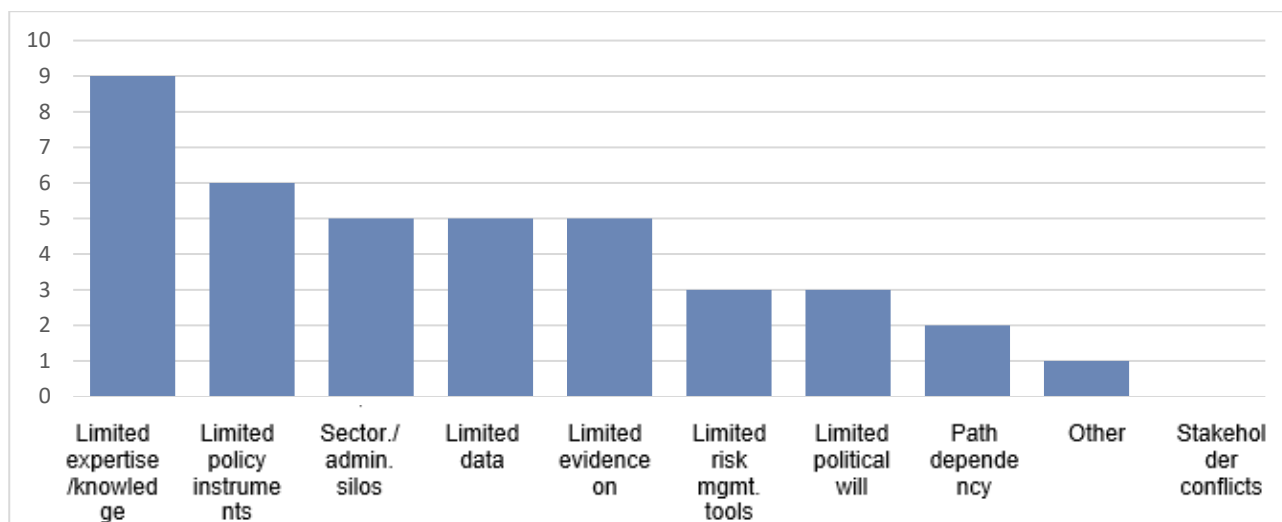


Figure 3: Q5. In your DEM, which do you consider to be the three main barriers that hinder multi-risk management (or could-hinder if multi-risk management has not been considered / implemented so far)?

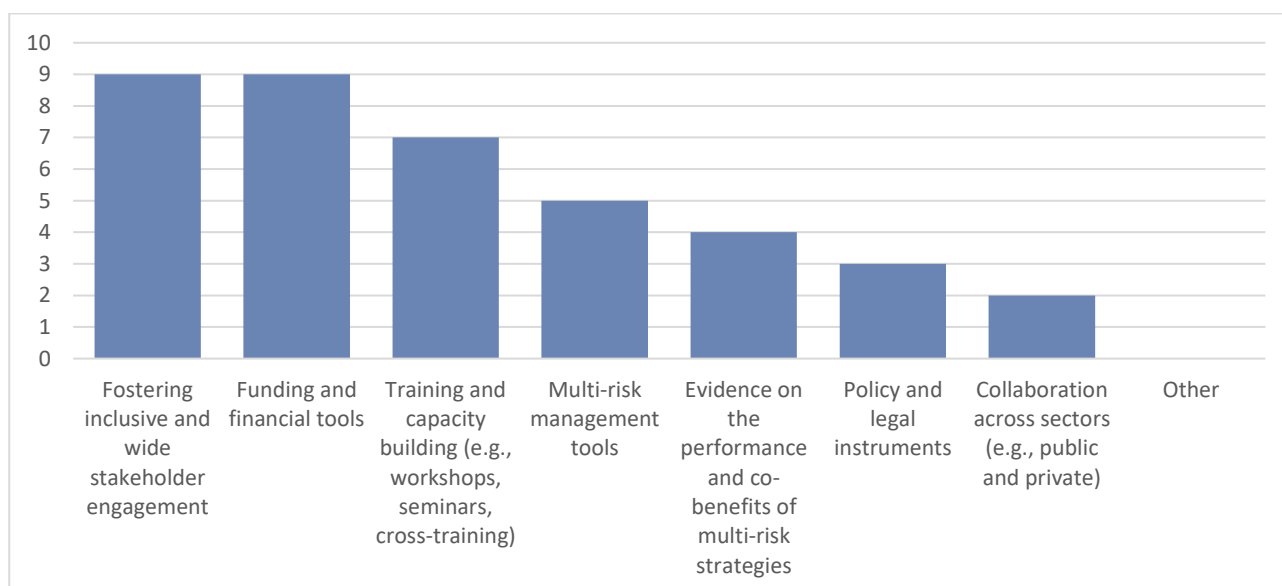


Figure 4: Q6. In your DEM, which do you consider to be the three main enablers that can contribute to effective multi-risk management? (or could-contribute if multi-risk management has not been considered / implemented so far)

Next to the barriers, enabling factors were also included in the questionnaire (Question 6). Two key enablers stood out and appear to be relevant across cases and settings: Fostering inclusive and wide stakeholder engagement and funding/financial tool for multi- risk management (9, 69% each) were named by a large share of the respondents. However, training and capacity building (7, 54%) was also mentioned by more than half of the respondents and should also be considered as generally relevant. The remaining options were all relevant to some demonstrators with multi-risk management tools being named five times (38%), evidence on the performance and co-benefits of multi-risk strategies four times (31%), policy and legal instruments three times (23 %)

and collaboration across sectors twice (15%). These enablers appear to be relevant but rather case specific.

When asked about the aspects of multi-risk management most interesting for future activities in the demonstrators (Question 7) three favourites emerged: Multi-hazard-early warning systems (8, 62%), nature-based solutions (6, 46%) and multi-hazard/risk planning (5, 38%). Multi-risk emergency management was important to three respondents (23%), multi-hazard/risk assessments to two (15%) and one respondent mentioned permanent mitigation measures such as avalanche and landslide dams (8%). Notably, no respondent selected the option “multi-risk management is not relevant for my demonstrator”.

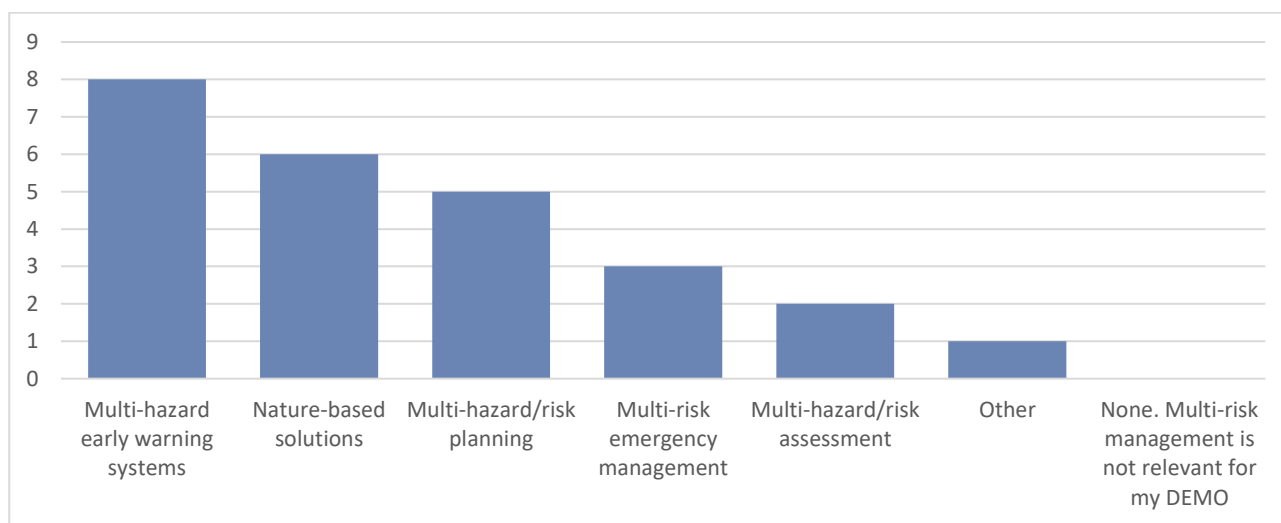


Figure 5: Q7. Which aspects of multi-risk management would you find most interesting for your DEM in the future?

In an open section where participants could add further comments on multi-risk management in their demonstrators (Question 8), one respondent answered that despite the presence of multiple risks in their demonstrator, focusing on the multi-risk concept in risk communication would not provide additional benefits and sending clear messages for each possible risk would be more important. Another respondent contributed the observation that stakeholders who have an established warning system for one (most relevant) hazard in place could not easily be convinced that a new (and more expensive) warning system for multiple hazards was necessary.

Lastly, we asked the demonstrators for ideas and particular interests for I-DRRnF (Question 9). Several issues emerged, pointing to cost-benefit analyses, educational material, sharing of practical insights from similar projects and stakeholder engagement. ‘These ideas were considered in designing the presentations and questions for the group discussion.

All in all, the results of the survey show that multi-hazards are indeed a relevant issue in all demonstrator areas and that the main interests revolve around MHEWS and risk-reduction measures, including nature-based solutions. This is in line with previous discussions in The HuT steering group and with demonstrators, and the results encouraged us to proceed with making these issues the main themes of the second I-DRRnF. The respondents’ motivations to work on multi-risk were quite diverse, allowing us to include multiple issues in the debates. The barriers and enablers served as the main guidance for defining the contents of the forum.

8.2. Preparatory analysis of key barriers from relevant literature

The survey provides insights into those barriers and enablers that are most relevant in The HuT demonstrators. In this section, we take a closer look at specific aspects that the survey indicates as potential fields of interest. First, in response to the identified importance of MHEWS and NbS for multi-hazard management and the high interest for future work on both subjects, we give an overview of the literature on both issues. Second, we analyse how the experiences from the demonstrators are reflected in the scientific literature. For this, we conducted a short literature review on the key barriers identified in the survey and contrasted them with findings from previous studies. Specifically, we focus on the most mentioned barriers to multi-hazard management: (1) lack of expertise and knowledge, (2) limited policy instruments, (3) sectoral silos, and (4) limited evidence on benefits. We discuss each with regard to relevant literature, using examples from MHEWS and NbS.

8.2.1. Early warning systems and nature-based solutions for multi-hazard management

The increasing frequency and intensity of natural hazards, driven by climate change, urbanization and environmental degradation, pose significant challenges to communities worldwide. Moreover, according to recent studies, about 19% of the disasters recorded globally can be classified as multi-hazard events (Lee et al., 2024). In response, MHEWS have emerged as a critical tool in reducing disaster risks by providing actionable information and an integrated approach for multi hazards. Unlike traditional systems that focus on single hazards, MHEWS aim to address the interconnected and cascading nature of risks, ensuring a better preparedness and response to complex disaster scenarios (UNDRR & WMO, 2023). These systems integrate monitoring, forecasting, communication and preparedness strategies aimed at addressing a wide range of risks, including natural hazards, biological hazards and made-made risk (e.g., industrial accidents). In Europe for example, the relevance of such an approach is particularly important as the region (as well as most other regions across the world) is experiencing a growing number of overlapping disasters, such as heatwaves exacerbating heath and wildfire risks, or heavy rainfall triggering both floods and landslides (UNDRR & WMO, 2023; Ward et al., 2022).

Relevant international agreements such as the Sendai Framework for Disaster Risk Reduction (SF-DRR), the Paris Agreement, and the 2030 Agenda for Sustainable Development recognize the importance and urgency of adopting MHEWS, and large efforts have been put into the further development and operationalization of such systems. One example of such efforts is the Early Warning for All initiative, launched by the United Nations in 2022 which has the objective of ensuring that early warning systems protect everyone on Earth from hazardous weather, water, or climate events by 2027 (WMO, 2022). However, even though more than half of the countries in the world report the existence of MHEWS in their territory, progress across the globe remains uneven and numerous challenges continue to hinder the implementation of MHEWS (UNDRR & WMO, 2023).

While significant advances are being made, particularly in aspects such as technology which is improving observation and forecasting capabilities, disaster risk efforts still struggle with the prevalence of fragmented governance and single-risk or sector-oriented EWS. This siloed approach challenges the effectiveness of integrated efforts, as it overlooks the complex



interplay between hazards and their cumulative impacts. The successful implementation of MHEWS requires robust coordination among agencies, clear communication protocols, and sustained investment in capacity building. Moreover, sustainable, long-term funding, and the proper integration of indigenous and traditional knowledge are also necessary (UNDRR, 2024).

In recent years, NbS have developed into an integral part of DRR strategies and approaches around the globe (EEA, 2021; UNDRR, 2023a). A variety of approaches for utilizing nature for climate adaptation in general and for reducing natural hazards in particular, are discussed in literature, proposed in policy briefs and implemented in practice. Green (and blue) infrastructure, nature's contributions to adaptation (NCA), ecosystem-based adaptation (EbA), ecosystem-based disaster risk reduction (eco-DRR) and other terminologies all fall into the field of nature-based solutions, as defined by the United Nations Environment Assembly: "Nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits" (UNEP/EA.5/Res.5). These approaches are often connected or overlapping (Dunlop et al., 2023), but may convey slightly different framings and visions of nature (O'Sullivan et al., 2020). Other sector-specific umbrella concepts such as Integrated Water Resources Management or Integrated Coastal Zone Management also include NbS aspects as elements (UNEP, 2024).

In Europe, many measures that would today be called NbS have a long history in mitigating disaster risks. In Switzerland, for example, protection forests have been purposefully planted or maintained for a long period, dating back several centuries (Rüegg et al., 2022). The first forest conservation legislation (the Swiss Federal Forest Law) in the 19th century was implemented in response to several devastating flood events and centered around the protective function of forests, which at that time were at threat of being cut down (Mather & Fairbairn, 2000). Today, NbS for DRR are promoted in political agendas at international scales (UNDRR, 2023a, 2024; UNEP, 2023), national scales (e.g. in national biodiversity strategies and action plans (UNDRR, 2024) and national adaptation plans), sectoral scales and sub-national/local scales (UNDRR, 2023a) and widely researched in academia (e.g. (Joseph et al., 2024; Vicarelli et al., 2024; Debele et al., 2023; Dorren & Moos, 2022; Martin et al., 2021; Kumar et al., 2020; Seddon et al., 2020; McVittie et al., 2018; Nel et al., 2014). UNDRR has provided an extensive toolkit to support countries in making NbS an integral part of DRR and climate change adaptation in general (UNDRR, 2023a).

NbS have been applied to mitigate a wide range of hazards separately, including those focused on in The HuT demonstrators (droughts, floods, forest fires, heatwaves, landslides and storms). Other notable climate impacts and risks to which NbS are widely applied are reduced water availability, soil erosion, freshwater flooding, loss of timber production, loss of food production and biomass cover loss (Chausson et al., 2020). Research on hazards shows that not all risks are equally reduced by NbS. A review by Sudmeier-Rieux et al. (2021) revealed floods, mountain hazards, storms/hurricanes/tropical cyclones, pollution, drought and heat islands, coastal erosion, wildfires and sea level rise as the most frequently studied NbS-related hazards globally.

In terms of concrete NbS DRR practices, evidence indicates that maintaining a natural and biodiverse landscape by clearing invasive species, for example, reduces the impacts of hazards such as droughts, wildfires and floods while at the same time creates opportunities for employment in rural poor communities, and decreases the vulnerability of the local economy

(Nel et al., 2014). Several studies proved the ability of NbS to mitigate climate impacts effectively (Turner et al., 2022), be as effective or more so than alternative interventions (Chausson et al., 2020) and even cost-effective (Vicarelli et al., 2024, Higuera Roa et al., 2023). In Europe, case studies exemplify the success of NbS for DRR. Notable examples include the restoration of wetlands and floodplains, such as the Rhine River floodplains in Germany, which effectively reduces flood risks by enhancing water retention and slowing down floodwaters (Thomas & Knüppe, 2016). Similarly, afforestation projects in Portugal and Spain showcase the ability of forests to stabilize slopes, averting landslides and soil erosion (EEA, 2021). However, even though the capacity of NbS to mitigate certain disaster risks and deliver co-benefits (including increased ecosystem resilience, human wellbeing and biodiversity, beside mitigation of other risks, see e.g. Chang et al., 2024) has been well documented, little research on the capacity of NbS in the management of multi-risk has been published.

NbS may robustly mitigate various climate impacts. However, it is also important to consider to what extent they imply trade-offs between different adaptation functions and how these trade-offs can be accounted for (Ou et al., 2022; Turner et al., 2022). Such trade-offs could be for instance, NbS reduce soil erosion and increase vegetation cover but at the same time lower water availability (Chausson et al., 2020); that trees prevent landslides but, if not properly managed, become driftwood and increase the risk of clogged weirs and bridges and increase downstream impacts on infrastructure; that a healthy vegetation cover reduces overall soil erosion, but under certain canopy covers, vegetation runoff may be funnelled and lead to concentrated and thus increased erosion at certain spots; or that vegetation stabilizes the ground against landslides but that vegetation weight and wind-induced loads on trees can, under certain circumstances, increase the risk of shallow landslides or that one hazard reduces an NbS's ability to mitigate other hazards (e.g. wildfires, storms or invasive species impairing the protection function of forests against landslides).

8.2.2. Experiences in The HuT demonstrators confronted with MHEWS and NbS barriers

While the concept of MHEWS emerged several years ago, significant gaps in their global coverage remain (UNDRR & WMO, 2023). Adoption and success of MHEWS are affected by challenges linked to the increasing unpredictability, complexity and severity of hazardous events, as well to the difficulties for reaching and supporting vulnerable communities (often those exposed to greater risks).

NbS, a newer concept, faces the same issue of not being widely implemented. It is therefore an important question to find out which obstacles prevent these innovative multi-hazard approaches from being applied. While there is little literature specifically on the barriers and enablers to the implementation of MHEWS, many studies exist on this topic on NbS. These studies have shown that the uptake of NbS remains unsatisfactory. Most of these studies also analysed why NbS uptake is lagging (e.g. Christopher et al., 2024; Martin et al., 2021; Sarabi et al., 2020) and look at both the barriers that hinder implementation of NbS and enablers that support their uptake. Given that both MHEWS and NbS are applied throughout a wide array of scopes and settings, different barriers and enablers apply in each case. Several studies have analysed barriers in specific settings, e.g., urban NbS (Castellar et al., 2024; Dorst et al., 2022; Sarabi et al., 2020), or for specific NbS, e.g., flood management (Christopher et al., 2024; Raška et al., 2022). However, Solheim et al. (2021) came to the conclusion that many NbS barriers share the same root causes, irrespective of whether the NbS were planned in urban areas or rural settings.



Following an initial screening of the available literature, and with the intention to better understand the experiences of The HuT demonstrators with regards to multi-risk management, a set of key barriers and enablers to NbS and MHEWS (as multi-hazard approaches) implementation was used for the development of a survey that was distributed among demonstrators in preparation of the I-DRRnF. The results of the survey provide us with a list of barriers that are most relevant to the demonstrators, they are listed in Table 8. We conducted a literature review on these reported barriers to better understand the barriers experienced in The HuT demonstrators and support the discussion on ways to overcome those barriers.

Table 8: Summary of key barriers identified by The HuT demonstrators. Included are responses given five times or more.

Barriers to multi-risk management most relevant to The HuT demonstrators
- Lack of expertise and knowledge (9) and limited data (5) - Limited policy instruments (6) - Sectoral/administrative or institutional silos (6) - Limited evidence on benefits derived by the adoption of multi-risk responses (5)

Barriers:

Across multiple NbS studies, common patterns and recurring barriers can be identified. They can be clustered in multiple ways, e.g., into four categories: unknown effects of NbS, difficult locational decisions, institutional settings, and availability of resources, land and physical capability (Raška et al., 2022), six categories: social, technical, financial, political, institutional and economic barriers (Christopher et al., 2024) or nine categories: socio-cultural, institutional, human resources and capacities, education and knowledge products, economic and financing, technical, legal, political and environmental barriers (Martin et al., 2023). These categories each consist of unique barriers which differ between different contexts. E.g. Castellar et al. (2024) identified 24 barriers for the implementation of NbS at the urban scale and Raška et al. (2022) found 17 barriers to the implementation of NbS for flood regulation.

In practice, barriers are often highly interdependent (Sarabi et al., 2020) and it is only to a certain extent possible to regard barriers and enablers separately one at a time. In practice, it may be the interaction of multiple barriers or the absence of a specific enabler – despite the presence of other enablers – that prevent the implementation of an NbS. To address this complexity, Raška et al. (2022) introduced a framework of barriers interactions, illustrating how one intended NbS may be confronted with multiple barriers in a sequence (cascading interaction) or at the same time (compound interactions). Therefore, overcoming these barriers requires the combined implementation of different strategies, and an holistic approach with complementary tools and instruments is particularly beneficial in facilitating the NbS implementation (Kumar et al., 2020).

Regarding the relevance of different barriers, an analysis conducted within the EU Horizon 2020-funded PHUSICOS³ project, which aimed to demonstrate the effectiveness of NbS to reduce risks of extreme weather events in rural mountain areas, identified and ranked NbS barriers based on literature and workshop sessions. Their results show a lack of expertise and knowledge as the most relevant barrier, followed by evidence of performance and co-benefits, stakeholder conflicts, path dependency, lack and complexity of financing, and lack of supportive policy/legal frameworks (Martin et al., 2023). These results are in line with our survey on multi-hazard approaches in general. In particular, limited knowledge and expertise is a recurring barrier. The only exception

³ PHUSICOS was an EU Horizon 2020 funded research project aiming to demonstrate that nature-based and nature-inspired solutions (NbS) for reducing the impact of extreme weather events in rural mountain landscapes, are technically viable, socially acceptable, cost-effective and implementable at the regional scale. More information at: <https://www.phusicos.eu/about/>

was the barrier “stakeholder conflicts”, which was not among the most important barriers in The HuT demonstrators. Nevertheless, stakeholder engagement is of course relevant. When asked about multi-risk management enablers, The HuT demonstrators identified stakeholder engagement, as the most important enabler.

Key barrier 1: Lack of expertise and knowledge

The barrier to multi-risk management that was identified by the highest number of demonstrators was the lack of expertise and knowledge. In practice this can be classified in two groups: lack of knowledge of multi-hazard risks, a lack of expertise and knowledge with regards to multi-hazard risk management strategies, options and their implications. Our literature review on MHEWS and NbS barriers revealed that the latter is equally relevant for MHEWS (Hermans et al., 2022) and NbS (Martin et al., 2023) implementation. Even though some of the required knowledge is present in science, it is not always sufficiently or effectively communicated between science and stakeholders (Kumar et al., 2020). Regarding NbS, Šakić Trogrlić et al. (2024) observed that stakeholders involved in risk management were not aware of the multiple benefits of NbS, particularly when future climate scenarios were discussed. A reason for this barrier is that knowledge brokers and training programs aimed at increasing NbS skills and knowledge are limited (Solheim et al., 2021)⁴. In the case of MHEWS, a lack of understanding of multi-hazard dynamics (e.g. cascading effects) can hamper the introduction of effective warning systems and limited risk knowledge is one of the main challenges affecting multi-hazard early warning effectiveness (UNDRR & WMO, 2023).

Key barrier 2: Limited policy instruments

Limited policy instruments were chosen six times in the survey, making it the second most mentioned barrier to multi-hazard management. Suitable policy instruments and mechanisms have been identified as a crucial prerequisite for successful MHEWS development (UNDRR, 2023b) as well as a limiting factor for NbS implementation (Davis et al., 2024). The most common types of possible policy instruments are planning/legislative instruments, economic instruments and information instruments.

In the context of MHEWS, recent studies highlight that policy instruments continue to primarily address risks from a single-hazard and single-sector perspective, limiting further advancements on the use and effectiveness of multi-hazard approaches (Ward et al., 2022). Here, key limitations could be linked to the challenges of accounting for the interrelations between multiple hazards, which demand for robust coordination and cooperation from different actors across distinct levels. However, this is something that is still missing in practice as siloed working still appears to be the norm in risk management (Šakić Trogrlić et al., 2024). Regarding NbS, studies assessing the impact of different instruments and offering examples of successful policy instruments are rare (Mendonça et al., 2021), and empirical evidence on NbS policy design and implementation is missing, especially at national and local level (Davis et al., 2024). Other studies identified limited standards, technical guidelines and legal norms for the monitoring and maintenance of NbS as key challenges (Sarabi et al., 2020). Furthermore, NbS lack proper integration in legal systems, e.g. because they require interventions at landscape scale (Cohen-Shacham et al., 2019) and legally binding mechanisms are scarce (Martin et al., 2023). In the EU, for example, many NbS policies are voluntary and do not require EU member states to implement them in national policies or at local level (Davies et al., 2021; Calliari et al., 2022).

⁴ An example of an existing Massive Open Online Course is available at <http://www.reconnect.eu/mooc/>.

Key barrier 3: Sectoral/administrative or institutional silos

Also mentioned six times in our survey results, sectoral/administrative and institutional silos are another important barrier. They are reported an inherent barrier to multi-hazard assessment and management in Europe, where fragmented decision-making and lack of coordination and communication among the responsible agencies (often tasked with managing separate hazards) appear to be affecting the uptake of such integrative multi-hazard approaches (Šakić Trogrlić et al., 2024). As by definition NbS also encompass multiple sectors and require the joint expertise of a variety of actors (environmental departments as well as all co-benefits concerned, e.g. hydrology, engineering, urban planning, tourism and recreation, health, forestry), NbS implementation also faces difficult challenges through sectoral silos (Sarabi et al., 2019; Martin et al., 2021; Dorst et al., 2022). NbS for multiple hazards would often involve an even larger group of administrative units further aggravating the challenge.

MHEWS face the same issue that different hazards are often dealt with by different administrative divisions (horizontal or vertical) which may issue different warnings, produce inconsistent visual or textual information, or use different communication channels. Importantly, in the case of multi-hazard warnings, the disciplines involved in the value chains for different hazards also vary considerably, especially between geological and meteorological hazards (Golding, 2022). This contributes to deepening the divide between different sectors and levels of administration. Finally, the private sector is playing an increasingly important role in the provision of weather forecasts, but cross-sectorial harmonization and agreements need to be promoted in order to improve warning quality and effectiveness (Weyrich et al., 2019).

Key barrier 4: Limited evidence on benefits derived by the adoption of multi-risk approaches

The lack of evidence on the benefits derived by the adoption of multi-risk approaches is also a challenge applicable to both MHEWS and NbS. In the case of NbS, it is specifically evidence on the delivery, performance and co-benefits that is scarce. Chaussou et al. (2020) observed an acute lack of robust, site-specific investigations of the effectiveness of NbS interventions compared to traditional alternatives. These would be the basis for reliable cost-benefit analyses. The same applies to MHEWS, for which few cost-benefit analyses in comparison with single hazard warning systems exist. This is in part due to a lack of robust and consistent approaches for measuring the monetary value and returns of co-benefits, in particular of NbS, (Ommer et al., 2022) as well as the DRR Performance of NbS (Nelson et al., 2020; Solheim et al., 2021). Multifunctionality is a critical and unique aspect of NbS (and by definition also of other multi-hazard responses, including MHEWS), therefore not being able to fully account for co-benefits in cost-benefit analyses remains a formidable challenge to NbS (Scolobig et al., 2023). In many cases NbS are considered as an alternative to conventional approaches or grey infrastructure, which often have a proven track record or a clear protocol to assess their effectiveness. Additionally, external costs (e.g. carbon footprint, biodiversity loss) are usually not included in such assessments.

8.3. Workshop agenda

International DRR Nexus Forum (I-DRRnF) 2024 Agenda

Thursday, November 21, 2024	
09:30 - 09:40	Welcome and opening Opening remarks and overview of the Forum's objectives and agenda (M. Calvello, A. Scolobig)
09:40 - 10:45	Expert presentations on MHEWS - Overview MHEWS (B. Golding) - Practice examples MHEWS (J. Robbins & A. Rubio Martin) - Q&A
10:45 - 11:00	Coffee break
11:00 - 11:45	Expert presentation on NbS for multi-hazard DRR - Overview NbS for multi-hazard DRR (J. Martin) - Good practice NbS for multi-hazard DRR (M. Vanoni) Q&A
11:45 - 11:55	Introduction to the World Café format and discussion topics
11:55 - 12:45	World Café round 1 4 groups, please chose the group and discussion topic according to the coloured dot on your name tag - MHEWS Barriers I (Yellow) - MHEWS Barriers II (Red) - NbS Barriers I (Green) - NbS Barriers II (Blue)
12:45 - 13:00	Reporting back and closing remarks
13:00	Lunch



8.4. List of Participants

Name	Institution	Country
Adria Rubio Martin	Universitat Politecnica de Valencia	Spain
Alessio Menini	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)	Italy
Alex Asurza	Universitat Politecnica de Catalunya	Spain
Ana Gabriela Fernandez Garza	Universitat Politecnica de Valencia	Spain
Andrey Krasovskiy	International Institute for Applied System Analysis	Austria
Anke Schlünsen-Rico	Helmholtz-Zentrum HEREON	Germany
Anna Scolobig	University of Geneva	Switzerland
Attila Lovas	Middle Tisza District Water Directorate	Hungary
Brian Golding	MET Office UK	United Kingdom
Carina Fearnley	University College London	United Kingdom
Danijel Schorlemmer	GFZ Potsdam	Germany
David Bela Vizi	Middle Tisza District Water Directorate	Hungary
Eisharc Jaquet Solé	ARANTEC Engenharia SL	Spain
Elias Huland	University of Geneva	Switzerland
Enrique Vidal	ARANTEC Engenharia SL	Spain
Eric Gielen	Universitat Politecnica de Valencia	Spain
Erica Moresco	ICONS	Italy
Florian Kraxner	International Institute for Applied System Analysis	Austria
Francesca Cossu	Confagricultura Nuoro Ogliastro	Italy
Francesco Lo Conti	LEITHA S.R.L.	Italy
Francis Nieto Torres	ARANTEC Engenharia SL	Spain
Gaetano Pecoraro	Università degli Studi di Salerno	Italy
Giedre Godiene	Vilnius University	Lithuania
Gintautas Stankūnavičius	Vilnius University	Lithuania
Glauco Gallotti	Leitha - Unipol Group	Italy
Guido Rianna	Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)	Italy
Harpa Grimsdottir	Icelandic MET Office	Iceland
Helga Fazekas	Middle Tisza District Water Directorate	Hungary
Ilan Kelman	University College London	United Kingdom
Ilaria Bonetti	ICONS	Italy
Janos Agocs	Middle Tisza District Water Directorate	Hungary
Jo-Ting Huang-Lachmann	Helmholtz-Zentrum HEREON	Germany
JoAnne Bayer	International Institute for Applied System Analysis	Austria
Joanne Robbins	MET Office UK	United Kingdom
Jogscha Miriam Abderhalden	University of Geneva	Switzerland
Jonathan Pratschke	University of Naples Federico II	Italy
Julia Aguilera Rodriguez	University of Geneva	Switzerland
Juliette Martin	International Institute for Applied System Analysis	Austria



Katy Freeborough	United Kingdom Research and Innovation	United Kingdom
Laurens Oostwegel	German Research Centre for Geosciences	Germany
Luca Piciullo	NGI	Norway
Manuel Pulido Velazquez	Universitat Politecnica de Valencia	Spain
Marcel Hürlimann	Universitat Politecnica de Catalunya	Spain
Marco Vanoni	Amt für Wald- und Naturgefahren, Canton of Grisons	Switzerland
Mario Rohrer	University of Geneva	Switzerland
Markus Stoffel	University of Geneva	Switzerland
Maryam Rokhideh	University College London	United Kingdom
Michele Calvello	Università degli Studi di Salerno	Italy
Péter Gergő Katona	Middle Tisza District Water Directorate	Hungary
Péter Solyom	Middle Tisza District Water Directorate	Hungary
Shivangi Chavda	GNDP	United Kingdom
Stanislav Hroncek	Global Water Partnership Central and Eastern Europe	Slovakia
Urdur Gunnarsdottir	Austurbrú	Iceland
Valentina Bacciu	Consiglio Nazionale delle Ricerche	Italy
Veronika Schick	ETH Zürich	Schweiz

