

# TAILORED ACTION PLAN FOR RISK MANAGEMENT IMPROVEMENT

Interreg Alpine Space X-RISK-CC  
project – 2023/2025

PILOT AREA:

Garmisch-Partenkirchen

In Bavaria, Germany

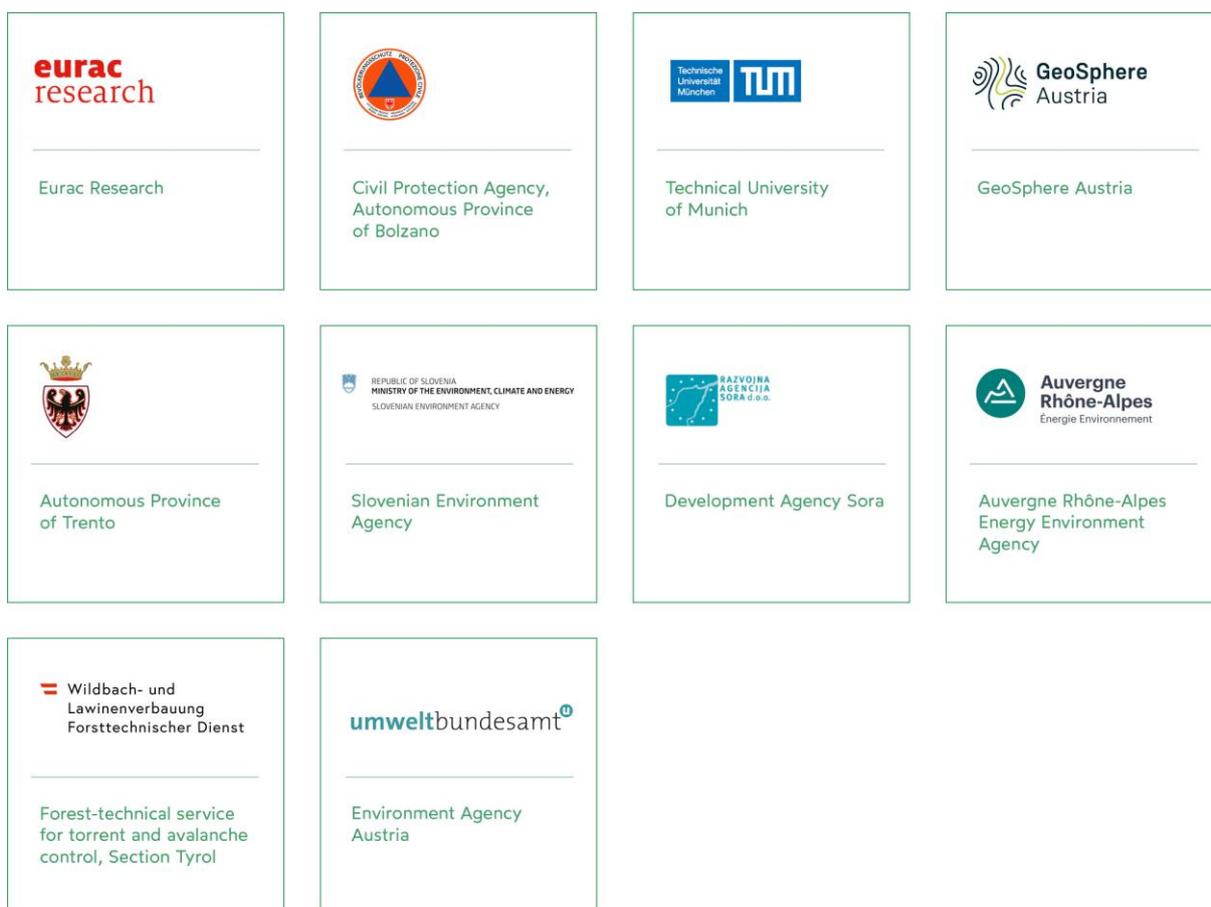
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# How to adapt to changing weather eXtremes and associated compound RISKS in the context of Climate Change

IMPRESSUM:



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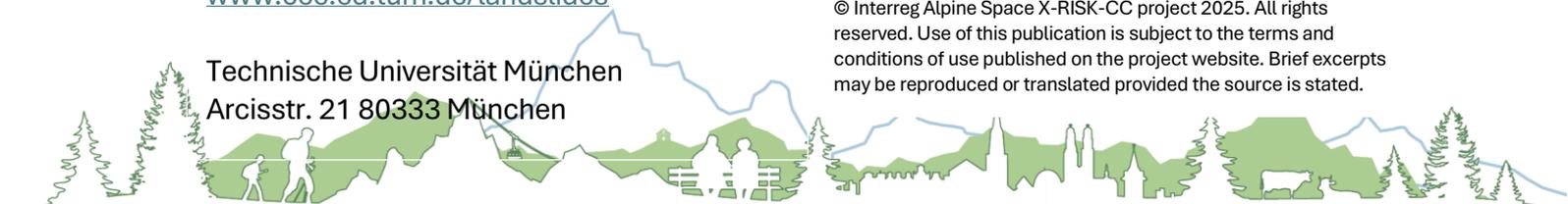
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# INTRODUCTION TO THE X-RISK-CC PROJECT

## Project Background and Objectives

The X-RISK-CC project addresses the increasing challenges posed by climate-related extreme weather events across the Alpine Space. Recent years have demonstrated that compound and cascading extremes—such as storms combined with heavy precipitation, or heatwaves followed by drought and flooding—can challenge current risk management capacities. The unexpected magnitude and intensity of these extremes can cause compound impacts and domino effects that turn into complex, long-lasting, or even irreversible consequences. While scientific evidence links climate change to the increasing intensity and frequency of such events, knowledge and management of their cascading impacts and risks remain insufficient. The X-RISK-CC project aims to improve risk management of such extreme events in the context of climate change. By considering selected pilot areas across the Alpine Space, co-designed, context-specific interventions are elaborated based on a comprehensive assessment of past extreme events, future climate projections, and systematic evaluation of existing risk management capabilities and gaps. This document presents the Tailored Action Plan developed for one of the project pilot areas.

## The Pilot Area of Reference

The Garmisch-Partenkirchen region is highly exposed to mountain hazards, including rockfalls, debris flows, hyperconcentrated flows and (torrential) floods. Recurrent intense summer rainstorms have triggered multiple events across the Partnach, Ferchenbach and Hammersbach catchments — also affecting the touristically used Partnach gorge and Höllental gorges — with major events in 1999, 2005, 2018, 2020, and 2021. Several decades of observations make clear the strong link to extreme precipitation, underscoring increasing vulnerability as rainfall intensifies under climate change and highlighting the need to continuously develop risk management.

For further details on the pilot area, the natural hazards that occurred and the activities that led to the co-creation of the tailored action plan, refer to the document “PILOT DOSSIER: GARMISCH-PARTENKIRCHEN, IN BAVARIA”, available at the project website under “Outcomes”.

Outcomes:

[X-RISK-CC - Alpine Space Programme](https://www.alpine-space.eu/project/x-risk-cc/)

[www.alpine-space.eu/project/x-risk-cc/](https://www.alpine-space.eu/project/x-risk-cc/)



X-RISK-CC – Web GIS:

[Information on intensity and frequency of weather extremes in the entire Alpine Space](https://cct.eurac.edu/x-risk-cc/)

[cct.eurac.edu/x-risk-cc](https://cct.eurac.edu/x-risk-cc/)



# THIS DOCUMENT

Based on the results of participatory workshops with local stakeholders, this document presents the Tailored Action Plan (TAP) which outlines the priority actions to strengthen the region's capacity across different phases of the risk management cycle. The TAP addresses key gaps e.g., in early warning systems, data integration, coordination mechanisms, infrastructure resilience, legal frameworks, and public awareness. The actions are designed to be implementable and aligned with both regional and transnational objectives of the Alpine Space for disaster risk reduction and climate change adaptation.

## Purpose and Concept

While this document provides the overall structure and documentation, the TAP itself provides a dynamic and evolving database of priority measures. The actions can be continuously updated and adapted over time and serve as a practical reference for identifying next steps. This flexible approach acknowledges that effective risk management in the context of climate change requires ongoing learning, adaptation, and coordination among stakeholders.

## Methodology

The methodology employed to develop the TAP for each pilot area of the project follows a **Community-Based Approach**, engaging stakeholders across all phases of the risk management cycle (prevention, preparedness, response, recovery). **Participatory workshops with local stakeholders** were conducted **between 2023 and 2025** in each pilot area.

### Participants in the workshops of the pilot area Garmisch-Partenkirchen, in Bavaria:

- **Bayerisches Landesamt für Umwelt** (Representatives of flood control strategies and torrents)
- **Wasserwirtschaftsamt Weilheim** (Representatives of flood warning, flood protection and river management)
- **Landratsamt Garmisch-Partenkirchen** (Representatives of disaster protection and climate change management)
- **Bergwacht Bayern** (Representatives of disaster protection)
- **Markt Garmisch-Partenkirchen** (Representatives of the Gorge operation and civil construction authority)
- **Gemeinde Grainau** (Representatives of municipal maintenance and flood protection)



## Prioritization Strategy

The gaps identified over the course of the participatory workshops and presented in the “PILOT DOSSIER: GARMISCH-PARTENKIRCHEN, IN BAVARIA” could not all be addressed as part of the TAP. The actions presented here focus on the most urgent gaps as ranked by the stakeholders participating in the 3<sup>rd</sup> stakeholder workshop. Some risk management or response organizations were not represented in all conducted workshops. These include, for example, the offices of the mayors, the volunteer fire departments, as well as nature conservation authorities and associations. The actions proposed here thus represent valid solutions on some of the challenges in dealing with natural hazards but cannot be considered complete or as the sole basis for prioritizing next steps.



# STRUCTURE AND CONTENT OF THE TAILORED ACTION PLAN

Each action in this document includes:

- **IDENTIFICATION:** Unique code, title, and summary
- **GAP ADDRESSED:** Specific weakness or need in current risk management
- **FRAMING:** Position in risk management cycle, action type, governance level, target groups
- **DESCRIPTION:** Detailed explanation of the action, preliminary steps, expected benefits, and potential challenges

In the following, **detailed descriptions of each action are provided**, outlining the rationale of each action, the gap or need it addresses, its position within the risk management cycle, and the intended target groups. Together, these descriptions serve to contextualize the actions, support prioritisation and monitoring, and provide a transparent basis for coordination, decision-making, and future updates of the action plan.



# TAILORED ACTION PLAN

## Action 01 – Promoting ongoing dialog on future weather extremes and hazards

### GAP THE ACTION ADDRESSES

Conflicting interests in safety/operation of Partnach Gorge and upstream catchment and environmental concerns.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Communication
- Governance Level: Local
- Target Groups: Local actors with responsibilities in the Partnach Gorge and upstream catchment as well as regional water management authorities, forest management authorities and the Bavarian nature conservation agency.

### DESCRIPTION OF THE ACTION

Provide a forum to organise exchange on scientific evidence of how future conditions in the catchment might develop under climate change scenarios and its impacts on weather extremes and hazards as well as the natural environment. Particularly, focus on the types of action required to maintain long-term status of operability of the Partnach Gorge and accessibility to the Reintal for purposes of recreation and emergency response.

Possibly define a common strategy that aligns the local targets for long-term operation and accessibility of the Partnach Gorge and upstream catchment.

### POSITIVE OUTCOMES

- Common knowledge base on future expected conditions of all organisations directly involved
- Fostering understanding for future actions

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- Potential needs for legislative action to pave the way for common strategy (further actions).



## Action 02 – Adapting governmental training programs to address future conditions

### GAP THE ACTION ADDRESSES

Conflicting interests in safety and operations of the Partnach Gorge and upstream catchment, alongside environmental concerns.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Knowledge building / Communication
- Governance Level: Trans-regional
- Target Groups: Future decision-makers and risk managers that are employees of governmental agencies

### DESCRIPTION OF THE ACTION

(Already existing) Conflicts of interest between different agencies can be intensified by the arising challenges in addressing the negative impacts of climate change. Solutions to some issues might negatively affect the status quo with regards to other aspects.

This action proposes adapting governmental trainee programs in water management, forest management and nature conservation to incorporate new scientific knowledge on future conditions and sensitizing trainees to the potential conflicts in addressing the challenges that arise from these conditions.

Future government actors need a good understanding of the system complexities, knowledge on scientific evidence of climate change and its expected impacts, understand the methods for analysing these impacts and possess the tools and communications skills to navigate emerging conflicts and develop solutions.

### POSITIVE OUTCOMES

- Common knowledge base on the expected impacts of climate change in relevant systems.
- Skills to manage conflicts and develop solutions.
- Long-term reduced conflict in the planning and approval of actions.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- None identified



## Action 03 – Guideline for decision-making: resolving conflicts on the prioritization of nature conservation and water management concerns

### GAP THE ACTION ADDRESSES

Conflicting interests in safety and operation of the Partnach Gorge and upstream catchment versus environmental concerns.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Knowledge building / Communication
- Governance Level: Trans-regional
- Target Groups: Decision-makers in water management and nature conservation

### DESCRIPTION OF THE ACTION

Conflicts of interest between water management and nature conservation have on some occasions lead to major delays in the realization of projects. In Bavaria, both agencies are subordinate to the Bavarian Environmental Ministry and there is no guidance on how their respective concerns should be prioritized or addressed.

The aim of the guideline is to provide binding decision-making processes to applied when conflicts arise between water management and nature conservation objectives.

### POSITIVE OUTCOMES

- Clear basis for prioritisation of water management or nature conservation concerns in the planning and implementation of mitigation actions.
- Acceleration of approval processes for planned projects and actions.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- The guideline must be reassessed in regular intervals as new evidence on the state of climate change and its impacts emerge.



## Action 04 – Improving warnings by including measurements from gauging stations

### GAP THE ACTION ADDRESSES

Improving warning and the alert chain.

### FRAME THE ACTION

- Risk Management Phase: Response
- Type of Action: Communication
- Governance Level: Local
- Target Groups: Local actors involved in emergency response, e.g., disaster management of the administrative district, gorge management, fire fighters, mountain rescue

### DESCRIPTION OF THE ACTION

Include latest measured values of river discharge and water levels (dependent on availability at respective gauging station) into warning message. In comparison to receiving only regional-scale warning of heavy precipitation (forwarded text, originally issued by the Flood Information Service in Bavaria - HND and the German Weather Service - DWD), the extended warning message contains the latest measured values of discharge and/or water level provides very localised and precise information, indicating the direct consequences of heavy precipitation on the river discharge in the respective catchments. This information helps emergency response organisations to better interpret the local hazard situation and react appropriately.

### POSITIVE OUTCOMES

- Improved real-time knowledge of hazard situation in upper catchments
- Reduced workload for local actors.
- Locally reduced risk of false alarms.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- Effort required by the Water Authority Weilheim and disaster management office of the administrative district of Garmisch-Partenkirchen to include latest information on gauging stations tailored to individual recipients.



## Action 05 – Improving warning alerts via automated phone call

### GAP THE ACTION ADDRESSES

Improving warning and the alert chain.

### FRAME THE ACTION

- Risk Management Phase: Response
- Type of Action: Communication
- Governance Level: Local
- Target Groups: Local actors involved in emergency response, e.g., disaster management of the administrative district, gorge management, fire fighters, mountain rescue

### DESCRIPTION OF THE ACTION

Adapting the communication channel of warnings in the warning chain. Instead of only written warning via E-mail or text message, a warning via automated phone call is beneficial. Local actors reported that warnings during the nighttime are likely to take longer to be processed, as a singular sound or screen notification is more likely to be missed. As an alternative, an automated phone call that needs to be picked up to be terminated is much harder to miss. Ideally these types of warning will be tailored to local actors in regions that are likely to be affected e.g. in combination with Action 04.

### POSITIVE OUTCOMES

- Making warning more accessible
- Reduced reaction times on a local level

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- Risk of negative impact on local actors, if the number of people to receive automated calls is not tailored to the correct recipients.



## Action 06 – Improving warnings: including convective rainfall events into the DWD warning system

### GAP THE ACTION ADDRESSES

Improving warning and the alert chain.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Communication
- Governance Level: National
- Target Groups: General public/Citizens, regional and local authorities, local actors responsible of emergency response

### DESCRIPTION OF THE ACTION

Convective rainfall events (thunderstorms) are difficult to predict accurately in terms of timing, duration and location using traditional forecasting methods. As a consequence, the German Weather Service (DWD) warning system does currently not provide real-time alerts for these events. Authorities, decision-makers, and citizens currently receive limited information about local storm risks, reducing their ability to take preventive action.

A real-time thunderstorm nowcasting system can help improve warning of convective rainfall events. The system should enable timely warnings through a user-friendly visualization tool and alert system for improved risk communication.

### POSITIVE OUTCOMES

- Timely alerts allow better protection of people and infrastructure.
- Authorities can allocate resources more effectively.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- False alarms could cause unnecessary action and reduce trust in the system.
- No system is perfect and even an advanced nowcasting system might not be able to predict all events.
- A nowcasting system relies on high-quality radar and sensor data, which may not always be available.
- Authorities and citizens might depend too much on automated alerts and neglect other preparedness measures.



## Action 07 – Building a cadastre on bridge and embankment conditions

### GAP THE ACTION ADDRESSES

Missing access to information on the conditions of bridges and protective structures that may be impacted during extreme events.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Knowledge building
- Governance Level: Local
- Target Groups: Local actors involved in emergency response, e.g., disaster management of the administrative district, gorge management, fire fighters, mountain rescue

### DESCRIPTION OF THE ACTION

Local emergency response organizations currently lack comprehensive information on the condition of bridges and protective structures that may be jammed or damaged during extreme events, e.g., events such as floods with combined sediment and driftwood transport.

Bridges, embankments and protective structures are dimensioned using design loads that consider water level above the mean. In addition, there are surpluses considered for cases such as wind, waves, and driftwood. However, not all structures were designed according to the same standards. Additionally, as structures age, they might not satisfy the same resistance criteria as when they were first constructed. As a result, these types of structures can be vulnerable to increasing loads resulting from climate change as well as adverse superposing of high water levels with wood transport or high sediment volumes during compound events.

A cadastre that documents the conditions of bridges and other relevant structures can help the local actors involved in emergency response anticipate critical weak points during (compound) hazard events and account for potential impacts during emergency response. The cadastre should document the actual design of the structure, its condition and vulnerability to compound loads as well as potential behaviour under overload.

### POSITIVE OUTCOMES

- Improved knowledge of weak points enabling anticipation and mitigation of cascading impacts.
- Authorities can effectively allocate resources where impacts are anticipated.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- Resources on local level, e.g., municipalities, needed to build cadastre.
- Cadastre needs to be updated regularly.



- Awareness of potential synergies or conflicts with existing databases managed by, e.g., water management agencies.



## Action 08 – Guidelines for systematic assessment of bridge and embankment conditions

### GAP THE ACTION ADDRESSES

Missing access to information on bridge conditions and conditions of protective structures that may be impacted during extreme events.

### FRAME THE ACTION

- Risk Management Phase: Preparedness
- Type of Action: Knowledge building
- Governance Level: Local
- Target Groups: Local actors involved in emergency response, e.g., disaster management of the administrative district, gorge management, fire fighters, mountain rescue

### DESCRIPTION OF THE ACTION

Local emergency response organizations lack access to information on bridge conditions and conditions of protective structures that may be jammed or damaged during extreme events, e.g., events with combined sediment and driftwood transport.

To systematically assess conditions of bridges, embankment structures and protective structures there is a need for guidance on how the assessment should be performed. The guidelines should define requirements for the assessment for different structure types, such as important design parameters, criteria for categorizing the system conditions and how to identify critical load cases for individual structures (considering compound events that go beyond design cases) and their potential impacts. Ideally, a training module on how to apply the guidelines will also be developed.

### POSITIVE OUTCOMES

- Improved knowledge of infrastructure conditions relevant to local hazard situations.
- Provide a foundation for building an up-to-date cadastre of bridge and embankment conditions (Action 07).
- Ensures common standard in assessing infrastructure conditions in response planning and emergency response.
- Empowers municipalities to perform assessments independently for above mentioned purposes without being reliant on external resources.

### POSSIBLE CRITICALITIES/ SIDE EFFECTS

- Guidelines must integrate interdisciplinary aspects, including structural design, reliability assessment and hazard processes.
- Guidelines are not always generalizable as relevant hazard processes depend on the specific area of application



# CONCLUSIONS AND NEXT STEPS

This document represents a living framework for improving risk management in the X-RISK-CC pilot area of Garmisch-Partenkirchen in response to climate-related extreme events. The actions identified through participatory workshops with local stakeholders address critical gaps across different phases of the risk management cycle.

## Key Outcomes

- Comprehensive inventory of eight tailored actions co-designed with local stakeholders
- Integration of scientific climate projections with local knowledge and practical experience

## Implementation Approach

The TAP proposes activities for improving risk management in the pilot area, developed within the X-RISK-CC project through a collaborative framework between research and practice. However, the initiation and implementation of adaptation measures addressing future extreme weather events and associated risks remain the responsibility of local and national authorities and are expected to take place after the project has concluded.

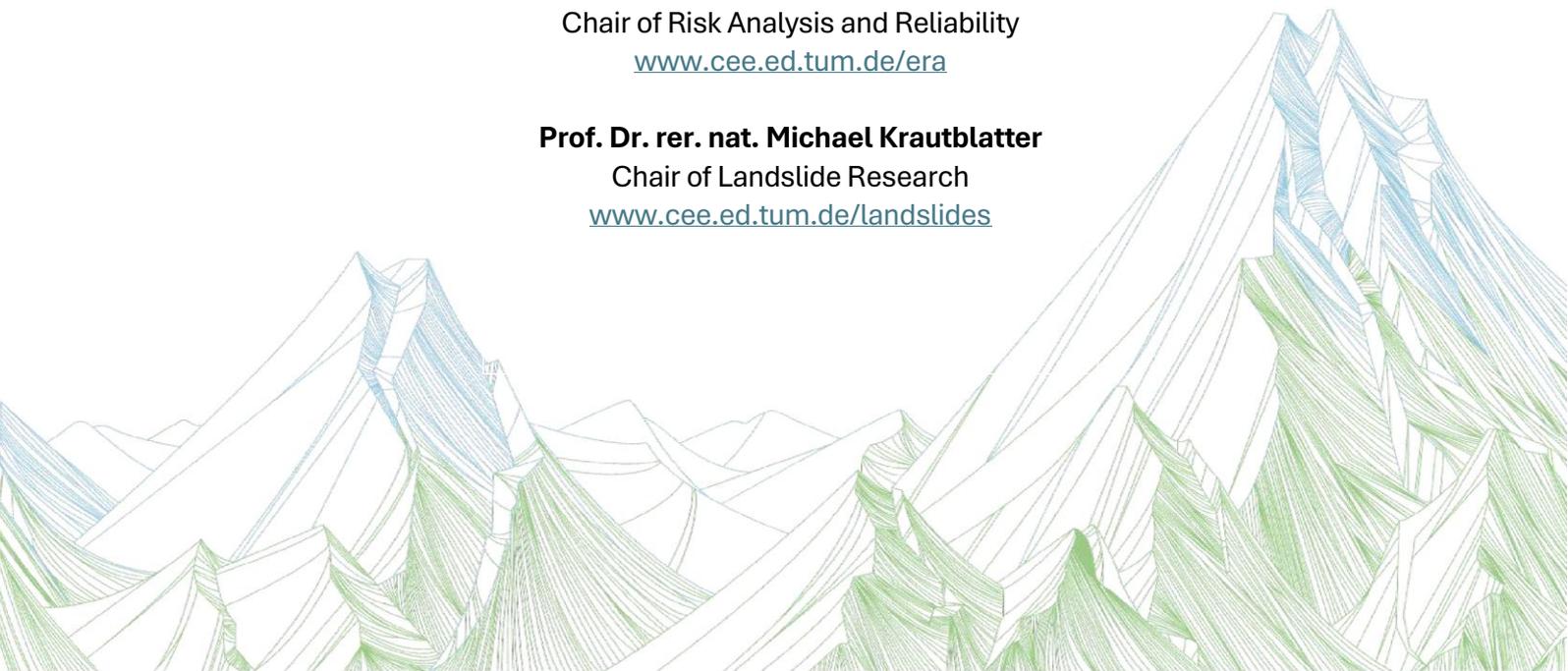
For implementation to proceed, the responsible organizations will need to recognize the relevance of the identified gaps and take ownership of advancing these or comparable actions.



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