

## *Policy Brief by the University of Vienna*

# Cascading Natural Hazard Processes and Their Impact on Alpine Spatial Development in Austria

The Alpine regions of Austria are increasingly affected by cascading natural hazard processes - phenomena in which one event triggers subsequent events. The term "cascading effects" broadly encompasses a variety of processes, such as the sequence of earthquake – landslide – valley blockage – dammed lake – lake breach – downstream flood with far-reaching impacts, or earthquake – tsunami – flooding of extensive coastal areas, to name two examples only. It also includes temporally separated events like earthquake – slope destabilisation – shallow landslides and debris flows during subsequent heavy rainfall, or wildfire – erosion. Cascading events (also referred to as process chains) often change their characteristics over time, for example, through the accumulation or deposition of material, significantly complicating their dynamics and predictability. A shallow landslide, for instance, may evolve into a debris flow or form a dammed lake, the breach of which could trigger a downstream flood wave. Such events are particularly prevalent in high mountain areas, where steep terrain fosters high process dynamics. These developments pose new challenges for protecting society (including population and infrastructure) and ecosystems.

Society is often inadequately prepared for the increasing complexity and consequences of such processes, as practical experience is often lacking. Cascading effects can also result in more severe consequences than "simpler" processes due to their higher magnitude—for instance, by incorporating additional mass or spreading across larger areas. Climate change, land-use changes, and the increasing pressure on alpine regions exacerbate the related risks: glacier recession and permafrost thaw destabilise slopes, leading to more frequent landslides. If these processes connect with lower-lying settlement areas, energy- and mass-intensive events with high damage potential can occur.

The findings of INTERPRAEVENT 2024 underscore the urgent need for integrative risk management approaches to address these complex challenges and ensure sustainable spatial development in mountain regions.

## ***KEY MESSAGES***

- **Complex Interactions:** Cascading natural hazards are characterised by dynamic processes that evolve over time and can amplify each other (e.g., a translational landslide transitioning into a debris flow).
- **Greater Magnitude and Consequences:** Cascading processes often release more energy and material masses, leading to more severe damage than isolated natural hazard events.
- **Increased Uncertainty:** Predicting such events is challenging, as they are often singular or infrequent and strongly influenced by local conditions.
- **Vulnerability of Alpine Regions:** High mountain areas provide ideal conditions for cascading effects due to steep terrain and high process dynamics. At the same time, these events increasingly threaten densely used spaces and critical infrastructure.
- **Climate Change as a Catalyst:** Climatic changes increase the frequency and intensity of extreme events, dynamically reshaping the risk landscape. For instance, thawing permafrost and melting glaciers destabilise slopes, while extreme weather events heighten the frequency and intensity of processes.
- **Inadequate Preparedness:** Stakeholders including populations and decision-makers are often poorly prepared for such complex events due to a lack of experience and warning systems.

## ***RECOMMENDATIONS FOR ACTION***

- **Promote Interdisciplinary Research:** Invest in studying cascading natural hazard processes to improve predictive models and deepen understanding of interactions.
- **Integrate Risk Management into Spatial Planning:** Systematically consider cascading effects in hazard and risk maps, as well as spatial planning processes, to effectively minimise risk zones.
- **Enhance Awareness:** Develop information campaigns to raise awareness among decision-makers and the population about the risks of cascading natural hazards.
- **Foster Cross-Border Collaboration:** Strengthen international cooperation, e.g., through EU programmes or bilateral agreements, as cascading processes do not adhere to national boundaries.
- **Implement Flexible Financing Mechanisms:** Provide resources for both preventive measures and rapid responses to complex natural events