

## THE COSTS OF NATURAL HAZARDS IN ALPINE ENVIRONMENTS

### CURRENT PRACTICE, END-USER NEEDS AND RECOMMENDATIONS

Clemens Pfurtscheller<sup>1</sup> and Annegret H. Thielen<sup>2</sup>

#### INTRODUCTION

Public funding for reducing risks of natural hazards is getting scarcer. At least in Austria, the budget for technical mitigation against mountain hazards is actually stagnating at approx. € 160 million per annum. Hence, economic efficiency and prioritization of measures that reduce risks due to natural hazards is of high importance. This paper compiles the results of the work package “Alpine Hazards” of the EU-FP7 project ConHaz. Starting with a general description of Alpine hazards and specific vulnerabilities of mountain regions, an analysis of current methods of cost assessments in countries within the European Alps was done for the cost categories of direct, indirect and intangible costs. Moreover, different methods for decision support are described and evaluated. Parallel, data on real losses and actual expenses for public safety were gathered. Finally, research gaps, end-user needs, and recommendations for cost assessments of the different damage categories are discussed.

#### ALPINE HAZARDS AND SPECIAL VULNERABILITIES OF MOUNTAIN AREAS

Relief energy can be seen as the key driver of hazardous processes and consecutive losses. So, mountain hazards or Alpine hazards are risks triggered by the downhill movement of water, snow, ice, debris and rocks (UNDRO 1991). These processes include avalanches, floods, debris flows, and landslides. Moreover, Alpine hazards are characterised by intermixtures of mediums and multiple processes as well as cascade effects. In addition, there is very limited space for settlement and economic activities in mountain regions. Combined with a mostly high concentration of assets in valleys, missing possibilities of the substitution of lifelines, especially lateral valleys are at high risk of getting isolated as a consequence of road blockages. Besides these predispositions, Alpine economies depend to a high share on tourism and have a high variability of (temporal) residents.

#### DATA ON ALPINE HAZARDS - SCALE AND PURPOSE DRIVEN

We analysed different data sources for the occurrences of mountain hazards in the European Alps at the supranational and national scale and associated damages. Although the DOMODIS guideline (Hübl et al., 2002) can serve as a common framework for event documentation, the data bases implemented in the different countries differ. Due to different scopes and entry thresholds, data entries are inconsistent and difficult to compare. For example, national data bases are much more detailed than global data bases, which totally underestimate local and regional events with a relatively low economic loss. Further, there is a huge data gap with regard to indirect losses. So, a minimum standard for data collection and storage, more international collaboration and linking event and damage data would be wishful.

#### COST TYPES OF NATURAL HAZARDS

In general, the assessment of costs triggered by natural hazards can be done before (ex-ante) and after (ex-post) an event. Tab.1 compiles the most important cost categories related to the risk cycle.

---

<sup>1</sup> Clemens Pfurtscheller. Austrian Academy of Sciences, Institute of Mountain Research (IGF), 6020 Innsbruck, Austria (e-mail: clemens.pfurtscheller@oeaw.ac.at) and Institute of Geography, University of Innsbruck, Austria

<sup>2</sup> Prof. Dr. Annegret Thielen. Institute of Earth and Environmental Science, University of Potsdam, 14476 Potsdam-Golm, Germany

**Tab. 1** Overview about cost types occurring in different stages of hazard events

stage of risk cycle	emergency management and response	reconstruction and recovery	event and risk analysis	prevention and preparedness
main cost category	variable operational costs	ex-post damage and losses	planning costs and decision support	costs for risk reduction
examples	emergency management	direct losses (asset losses)	risk analysis	annual costs for emergency infrastructure
	Rescue	losses due to business interruption	ex-ante estimation of costs and benefits of risk reduction options	investment and construction costs
	health care and supply	(long-term) output losses (indirect losses)	concept and design of risk reduction measures	costs for operation, use, maintenance and disposal
	repair critical infrastructure	losses of non-market goods (intangible effects)	decision support for choosing the optimal risk reduction option (e.g. CBA)	co-costs (e.g. environmental costs), co-benefits (e.g. recreational areas)

## DIRECT, INDIRECT AND INTANGIBLE LOSSES - SOME FACTS AND RECOMMENDATIONS

Damage functions are a common approach to assess direct damages of different alpine hazards. However, most studies focus on direct damage on buildings, whereas very little is known about damage to infrastructure. Also, there is a lack of multi-hazard approaches. More detailed methods are needed - preferably with regional damage functions that include intensity as well as resistance parameters. Furthermore, efforts to assess multiple hazard losses by an integrated approach should be enhanced. In the case of (long-term) indirect effects, only macro-economic and primarily science-based approaches are known. Therefore, on the local and regional scale, methods should be developed to assess interruptions of economic activities. Network failure approach is currently the best available method for the regional scale, but these approaches often neglect the measurement of economic flows. Further research on possible methods for the evaluation of indirect effects and case studies in Alpine valleys should be undertaken. Loss of life as an intangible loss is frequently quantified by counting casualties and injured people, but occasionally also by assessing e.g. the value of a statistical life. Other intangible effects are usually not assessed although a lot of approaches exist. However, the usefulness and reliability of such estimates are questioned by stakeholders. There is a great need for knowledge transfer on available valuation methods, participatory approaches and cooperation among different hazard communities.

## CONCLUSIONS

Cost assessments of damage, prevention and response measures to natural hazards provide crucial information for decision support and policy development in the fields of natural hazard and risk management as well as of planning for adaptation to climate change. Given that a multiplicity of analyses and case studies exist for assessing costs of alpine hazards, mitigation and adaptation measures as well as their benefits, the identification, compilation and assessment of such methods is essential as a basis for recommendations to end-users for assessing costs of natural risks. Moreover, a reliable costing approach for the complex hazard situations is desirable and should be part of a comprehensive risk management and adaptation strategy.

## REFERENCES

- Hübl J., Kienholz H., Loipersberger A. (2002). DOMODIS - Documentation of Mountain Disasters, State of Discussion in the European Mountain Areas. Vienna.
- Pfurtscheller C., Lochner B., Thielen A.H. (2011). Costs of Alpine hazards. ConHaz-Report of WP8 downloadable at <http://conhaz.org/>.
- UNDRO (1991). Mitigation Natural Disasters - Phenomena, Effects and Options. United Nations Disaster Relief, New York.

**Keywords:** mountain hazards, monetary evaluation of costs and benefits, decision support tools