MULTI-HAZARD RISK ANALYSES

CHALLENGES OF INTERACTION AND CONNECTIVITY

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INTRODUCTION

Events in the Eastern European Alps like in August 2005 with an extreme flood event accompanied by strong lateral erosion and sediment transport as well as debris flows, rock falls and landslides in the smaller catchments caused extraordinary high economic damages. These high economic loss events occurred in countries with a well-established mainly single hazard management. As a consequence of the event in August 2005 it has to be acknowledged that these high economic losses do not always result from single hazards but also from multiple hazards and combined events.

However, multi-hazard analyses and multi-hazard risk analyses − both referring to joint analyses of multiple hazards − are still rarely carried out and pose undoubtedly a series of challenges. Furthermore, multi-hazard risk analyses need to rest on a place-based synoptic view and have to consider different types of interactions including triggered events, change of deposition and cascade effects.

In the presented study, we will give a brief overview of multi-hazard risk approaches and focus on different types of interactions from a perspective of complex system research. The influence of this consideration regarding the current hazard and risk management strategies will be highlighted.

MULTI-HAZARD RISK ANALYSES

The term multi-hazard is used by the UN in the context of risk management and with the focus on overall risk reduction (UN 2002). This indicates that the need is seen to conflate and jointly investigate the whole range of threatening hazards, resulting in an integrated multi-hazard risk output. Consequently, the term multi-hazard risk can be interpreted as the consideration of multiple (if possible all relevant) hazards posing risk to a certain area under observation.

Although hazard and risk analysis methods are already well-established for many natural single processes, their joint investigation poses a variety of challenges.

- Especially, the widely differing properties of the single processes as intensity, return period or characteristics affecting elements at risk, but also the varying procedures to estimate/model, and units to quantify them complicate multi-hazard analyses. Different classification and index schemes are used to overcome the problem how to merge the diverse single-hazard analyses to multi-hazard. These classifications and schemes are specifically elaborated for one purpose/stakeholder with a low transferability.
- Quantitative multi-hazard risk analyses based on an analysis scheme which assures the comparability of the single-hazard risk components offer a more flexible alternative and even the possibility to sum up the single risks to one overall risk. Consequently, on the one hand, multi-hazard risk analyses are easier to compute comparing with solely multi-hazard analyses since the single risks can be easily combined due to matching units but on the other hand, the data requirements are very high.
- For both, multi-hazard analyses and multi-hazard risk analyses, general challenges exist like the selections of the adequate scale and the data availability.

Furthermore, one aspect which is still not taken into account is the interaction of hazards. In current multi-hazard (risk) analyses the hazards are usually still considered as independent from each other.

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This basic assumption cannot be supported by observations in the field because mutual impacts alter the disposition and the triggering of natural hazards and negligence might lead to miss- or underestimation of the actual hazard/risk.

INTERACTIONS WITHIN A MULTI-HAZARD APPRAOCH

Geomorphic processes are components of geo-systems and only certain characteristics which possibly pose a threat to elements at risk convert them into hazards. As components of geo-systems these processes are not independent and separated from each other. Especially alpine areas are characterized by the interaction and connectivity of different geomorphic systems (compare Üblagger 1992). Furthermore, the interlinkage between atmo-, bio-, hydro- and lithosphere is crucial for spatial and temporal trajectories in geomorphic systems, particularly, under the consideration of global environmental change. In the investigation and modelling of natural hazards, this aspect is still very rarely (explicitly) taken into account but each hazard is studied discretely.

The occurrence of geomorphic processes/hazards depends on the system state and behaviour, the disposition and internal as well as external triggering factors. The variable disposition refers to fast alterations, e.g. seasonal or daily changes (water pore pressure, vegetation period, etc.) and currently known patterns may change due to general environmental change. However, continuous and discrete geomorphic processes may alter the general setting within the geo-system, i.e. the dispositions of other processes/hazards or act as trigger for other processes/hazards. To exemplify, slopes which are steepened by the erosion of rivers and are subsequently prone to lateral landslides. These landslides result in a damming of the respective channel sections, and lead to second-order hazards of possible flood wave outbursts. In single-hazard analyses the most important processes and parameters concerning disposure and triggering are identified and integrated in the modelling procedure. For most multi-hazard analyses a similar approach is now applied, identifying still separately the important factors to be considered for each single process. After investigating them separately only the results are brought together. However, a multi-hazard analysis would offer the possibility to create a framework containing all considered processes and taking into account additionally the relations and interconnections between them.

We investigated the relationships between potentially hazardous processes and their relevance for the overall risk and risk management, subdivided into relations concerning disposition and triggering. We will explain what a system approach in combination with the disposition-triggering model for multi-hazard analyses means and give examples of studies in which hazard relationships are already taken into account. Regarding the investigation of deposition as well as of triggering at least two steps are necessary, 1) identification of the influences and links between the different hazards (e.g. using a matrix, event trees), and 2) the establishment of the links between the hazard models adjusted to the modelling scale and methods used.

Furthermore, we will make the transfer to explain why the relations are relevant and to be considered for risk management and risk reduction and how they could be taken into account. Additionally, we will give examples for a medium-scale multi-hazard analysis and the implementation of hazard relations.

REFERENCES

Üblagger, G. (1992). Gefahrenpotentiale in Systemarer Betrachtung. Internationales Symposium Interpraevent. Bern. Band 6. 293-318

UN (2002). Johannsburg plan of implementation of the world summit on sustainable development.
Tech. rep. United Nations. available at:
http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

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