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Landslide hazards and systems analysis: A Central European perspective

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Part of the problem with assessing landslide hazards is to understand the variable settings in which they occur. There is growing consensus that hazard assessments require integrated approaches that take account of the coupled human-environment system. Here we provide a synthesis of societal exposure and vulnerability to landslide hazards, review innovative approaches to hazard identification, and lay a focus on hazard assessment, while presenting the results of historical case studies and a landslide time series for Germany. The findings add to a growing body of literature that recognizes societal exposure and vulnerability as a complex system of hazard interactions that evolves over time as a function of social change and development. We therefore propose to expand hazard assessments by the framework and concepts of systems analysis (e.g., Liu et al., 2007)

Results so far have been promising in ways that illustrate the importance of feedbacks, thresholds, surprises, and time lags in the evolution of landslide hazard and risk. In densely populated areas of Central Europe, landslides often occur in urbanized landscapes or on engineered slopes that had been transformed or created intentionally by human activity, sometimes even centuries ago. The example of Germany enables to correlate the causes and effects of recent landslides with the historical transition of urbanization to urban sprawl, ongoing demographic change, and some chronic problems of industrialized countries today, including ageing infrastructures or rising government debts. In large parts of rural Germany, the combination of ageing infrastructures, population loss, and increasing budget deficits starts to erode historical resilience gains, which brings especially small communities to a tipping point in their efforts to risk reduction. While struggling with budget deficits and demographic change, these communities are required to maintain ageing infrastructures that are particularly vulnerable to landslides. Along with a large number of small, but costly landslide events and widespread insidious damages, the interplay of these societal trends determines landslide hazard and risk in Germany or elsewhere in Central Europe (e.g., Houlihan, 1994; Klose et al., 2015).

The case studies presented here help to better understand human-environment interactions in the hazard context. Although there has been substantial progress in assessing landslide hazards, integrated approaches with an interdisciplinary focus are still exceptional. The scope of historical datasets available for hazard assessments, however, covers the whole range of natural and social systems interacting with hazards, their influences on overall system vulnerability, and the feedbacks, time lags, and couplings among these systems. In combination with methods from the natural and social sciences, systems analysis supports hazard assessments across disciplinary boundaries to take a broader look at landslide hazards as is usually done.

References

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