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Risk-based consequences of extreme natural hazard processes in mountain regions – Multi-hazard analysis in Tyrol (Austria)

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Reinsurance companies are stating a high increase in natural hazard related losses, both insured and economic losses, within the last decades on a global scale. This ongoing trend can be described as a product of the dynamic in the natural and in the anthroposphere. To analyze the potential impact of natural hazard process to a certain insurance portfolio or to the society in general, reinsurance companies or risk management consultants have developed loss models. However, those models are generally not fitting the scale dependent demand on regional scales like it is appropriate (i) for analyses on the scale of a specific province or (ii) for portfolio analyses of regional insurance companies. Moreover, the scientific basis of most of the models is not transparent documented and therefore scientific evaluations concerning the methodology concepts are not possible (black box). This is contrary to the scientific principles of transparency and traceability.

Especially in mountain regions like the European Alps with their inherent (i) specific characteristic on small scales, (ii) the relative high process dynamics in general, (iii) the occurrence of gravitative mass movements which are related to high relief energy and thus only exists in mountain regions, (iv) the small proportion of the area of permanent settlement on the overall area, (v) the high value concentration in the valley floors, (vi) the exposition of important infrastructures and lifelines, and others, analyses must consider these circumstances adequately. Therefore, risk-based analyses are methodically estimating the potential consequences of hazard process on the built environment standardized with the risk components (i) hazard, (ii) elements at risk, and (iii) vulnerability. However, most research and progress have been made in the field of hazard analyses, whereas the other both components are not developed accordingly. Since these three general components are influencing factors without any weighting within the risk concept, this has sufficient implications on the results of risk analyses. Thus, an equal and scale appropriated balance of those risk components is a fundamental key factor for effective natural hazard risk analyses.

The results of such analyses inform especially decision makers in the insurance industry, the administration, and politicians on potential consequences and are the basis for appropriate risk management strategies. Thereby, results (i) on an annual or probabilistic risk comprehension have to be distinguished from (ii) scenario-based analyses. The first analyses are based on statistics of periodically or episodically occurring events whereas the latter approach is especially applied for extreme, non-linear, stochastic events. Focusing on the needs especially of insurance companies, the first approaches are appropriate for premium pricing and reinsurance strategies with an annual perspective, whereas the latter is focusing on events with extreme loss burdens under worst-case criteria to guarantee accordant reinsurance coverage. Moreover, the demand of adequate loss model approaches and methods is strengthened by the risk-based requirements of the upcoming capital requirement directive Solvency II.

The present study estimates the potential elements at risk, their corresponding damage potentials and the Probable Maximum Losses (PMLs) of extreme natural hazards events in Tyrol (Austria) and considers adequatly the scale dependency and balanced application of the introduced risk components. Beside the introduced analysis an additionally portfolio analysis of a regional insurance company was executed. The geocoded insurance contracts of this portfolio analysis were the basis to estimate spatial, socio-economical and functional differentiated mean insurance values for the different risk categories of (i) buildings, (ii) contents or inventory, (iii) vehicles, and

(iv) persons in the study area. The estimated mean insurance values were incorporated with additional GIS and statistic data to a comprehensive property-by-property geodatabase of the existing elements and values. This stock of elements and values geodatabase is furthermore the consistent basis for all natural hazard analyses and enables the comparison of the results. The study follows the general accepted moduls (i) hazard analysis, (ii) exposition analysis, and (iii) consequence analysis, whereas the exposition analysis estimates the elements at risk with their corresponding damage potentials and the consequence analysis estimates the PMLs.

This multi-hazard analysis focuses on process types with a high to extreme potential of negative consequences on a regional scale. In this context, (i) floodings, (ii) rockslides with the potential of corresponding consequence effects (backwater ponding and outburst flood), (iii) earthquakes, (iv) hail events, and (v) winter storms were considered as hazard processes. Based on general hazard analyses (hazard maps) concrete scenarios and their spatial affectedness were determined. For the different hazard processes, different vulnerability approaches were considered to demonstrate their sensitivity and implication on the results. Thus, no absolute values of losses but probable loss ranges were estimated.

It can be shown, that the most serious amount of losses would arise from extreme earthquake events with loss burdens up to more than € 7 bn. solely on buildings and inventory. Possible extreme flood events could lead to losses between € 2 and 2.5 bn., whereas a severe hail swath which affects the central Inn valley could result in losses of ca. € 455 mill. (thereof € 285 mill. on vehicles). The potential most serious rockslide with additional consequence effects would result in losses up to ca. € 185 mill. and extreme winter storms can induce losses between € 100 mill. and 150 mill..