



Economic optimization of natural hazard protection – conceptual study of existing approaches

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Risk-based planning of protection measures against natural hazards has become a common practice in many countries. The selection procedure aims at identifying an economically efficient strategy with regard to the estimated costs and risk (i.e. expected damage). A correct setting of the evaluation methodology and decision criteria should ensure an optimal selection of the portfolio of risk protection measures under a limited state budget. To demonstrate the efficiency of investments, indicators such as Benefit-Cost Ratio (BCR), Marginal Costs (MC) or Net Present Value (NPV) are commonly used. However, the methodologies for efficiency evaluation differ amongst different countries and different hazard types (floods, earthquakes etc.). Additionally, several inconsistencies can be found in the applications of the indicators in practice. This is likely to lead to a suboptimal selection of the protection strategies.

This study provides a general formulation for optimization of the natural hazard protection measures from a socio-economic perspective. It assumes that all costs and risks can be expressed in monetary values. The study regards the problem as a discrete hierarchical optimization, where the state level sets the criteria and constraints, while the actual optimization is made on the regional level (towns, catchments) when designing particular protection measures and selecting the optimal protection level. The study shows that in case of an unlimited budget, the task is quite trivial, as it is sufficient to optimize the protection measures in individual regions independently (by minimizing the sum of risk and cost). However, if the budget is limited, the need for an optimal allocation of resources amongst the regions arises. To ensure this, minimum values of BCR or MC can be required by the state, which must be achieved in each region. The study investigates the meaning of these indicators in the optimization task at the conceptual level and compares their suitability. To illustrate the theoretical findings, the indicators are tested on a hypothetical example of five regions with different risk levels. Last but not least, political and societal aspects and limitations in the use of the risk-based optimization framework are discussed.