How to select optimal mitigation strategies for natural hazards?

The planning of mitigation strategies against (natural) hazards requires finding a balance between the cost of the mitigation and the residual risk. As discussed in this paper, existing approaches for selecting the optimal protection level found in literature and practice exhibit several inconsistencies. We provide a general formulation of the optimization problem and study the implications of budget constraints on the solution. The need for an optimal allocation of resources for risk protection amongst different subsystems (e.g., cities or catchments in the case of flood) with a limited budget is investigated. We examine decision criteria, such as Benefit-Cost Ratio (BCR) or Marginal Costs (MC), which are typically used for measuring the efficiency of the investment and prioritizing the investment opportunities. A numerical example demonstrates the identification of an optimal risk mitigation strategy in five regions for different levels of budget constraint. It compares strategies identified with BCR and MC criteria to the globally optimal solution, demonstrating the limitations of the criteria for identifying optimal risk management decision.