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The physical vulnerability of elements at risk: a methodology based on fluid and classical mechanics

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The impacts of the flood events occurred in autumn 2011 in the Italian regions Liguria and Tuscany revived the engagement of the public decision makers to enhance in synergy flood control and land use planning. In this context, the design of efficient flood risk mitigation strategies and their subsequent implementation critically relies on a careful vulnerability analysis of both, the immobile and mobile elements at risk potentially exposed to flood hazards.

Based on fluid and classical mechanics notions we developed computation schemes enabling for a dynamic vulnerability and risk analysis facing a broad typological variety of elements at risk. The methodological skeleton consists of (1) hydrodynamic computation of the time-varying flood intensities resulting for each element at risk in a succession of loading configurations; (2) modelling the mechanical response of the impacted elements through static, elasto-static and dynamic analyses; (3) characterising the mechanical response through proper structural damage variables and (4) economic valuation of the expected losses as a function of the quantified damage variables.

From a computational perspective we coupled the description of the hydrodynamic flow behaviour and the induced structural modifications of the elements at risk exposed. Valuation methods, suitable to support a correct mapping from the value domains of the physical damage variables to the economic loss values are discussed.

In such a way we target to complement from a methodological perspective the existing, mainly empirical, vulnerability and risk assessment approaches to refine the conceptual framework of the cost-benefit analysis. Moreover, we aim to support the design of effective flood risk mitigation strategies by diminishing the main criticalities within the systems prone to flood risk.