



## **Hazard Interactions and Interaction Networks (Cascades) within Multi-Hazard Methodologies**

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Here we combine research and commentary to reinforce the importance of integrating hazard interactions and interaction networks (cascades) into multi-hazard methodologies. We present a synthesis of the differences between 'multi-layer single hazard' approaches and 'multi-hazard' approaches that integrate such interactions. This synthesis suggests that ignoring interactions could distort management priorities, increase vulnerability to other spatially relevant hazards or underestimate disaster risk. We proceed to present an enhanced multi-hazard framework, through the following steps: (i) describe and define three groups (natural hazards, anthropogenic processes and technological hazards/disasters) as relevant components of a multi-hazard environment; (ii) outline three types of interaction relationship (triggering, increased probability, and catalysis/impedance); and (iii) assess the importance of networks of interactions (cascades) through case-study examples (based on literature, field observations and semi-structured interviews). We further propose visualisation frameworks to represent these networks of interactions. Our approach reinforces the importance of integrating interactions between natural hazards, anthropogenic processes and technological hazards/disasters into enhanced multi-hazard methodologies. Multi-hazard approaches support the holistic assessment of hazard potential, and consequently disaster risk. We conclude by describing three ways by which understanding networks of interactions contributes to the theoretical and practical understanding of hazards, disaster risk reduction and Earth system management. Understanding interactions and interaction networks helps us to better (i) model the observed reality of disaster events, (ii) constrain potential changes in physical and social vulnerability between successive hazards, and (iii) prioritise resource allocation for mitigation and disaster risk reduction.