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Analysis of temporal and spatial overlapping of hazards interactions at different scales

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The aim of this work is to develop a methodological framework to analyse the impact of multiple hazards on complex territorial systems, not only focusing on multi-hazard interactions but evaluating also the multi-risk, i.e. considering the impact of multiple hazards also in terms of exposure and vulnerability.

Impacts generated by natural hazards in the last years are growing also because many regions of the world become subject to multiple hazards and cascading effects. The modelling of the multi-hazard dimension is a new challenge that allows the stakeholder to face with the chain effects between hazards and to model the risk in a real holistic way.
Despite the recognition of the importance of a multi-hazard approach in risk assessment, there are only a few multi-risk approaches developed up to now.
The examination of multiple hazards, in contrast to single-hazard cases, poses a series of challenges in each step of the risk analysis, starting from the assessment of the hazard level, passing trough the vulnerability evaluation, and arriving finally at the resultant risk level. Hazard interactions and hazard contemporaneity arising from their spatial and temporal overlap may not only influence the overall hazard level, but also the vulnerability of elements at risk.

In the proposed approach a series of possible interactions between hazards are identified and classified. These interactions are then analysed looking at the temporal and spatial evolution of the hazards and the consequent impacts and represented through an explicative graphical framework.
Different temporal dimensions are identified. The time of the impact differs from the time of the damage because, even after the end of the impact, damages remain until recovery and restoration processes are completed. The discrepancy between the time of the impact and time of the damage is very important for the modelling of multi-hazard damage. Whenever a certain interval of time occurs between two impacts (generated by two hazards), it is important to evaluate the evolution of the systems in this time windows, in order to know the residual level of damage with which the system starts to be stressed by the second hazard or to evaluate if the systems has been able to completely recover from the previous impact.
Spatial overlapping plays the main role in the analysis of the cumulative physical damage on infrastructures, which requires an evaluation of the combination of different types of damages, generated by different hazards.
The analysis is carried on considering different scales, passing from the local to the national one. Enlarging the scale, different phenomena can be integrated into the analysis and different mechanisms of interactions can be implicated.
This methodological approach is applied to analyse a series of multi-hazard events from the past in Italy.