



An approach to modeling interactions between extreme weather events during multi-hazard events

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Multi-hazard events refers to scenarios where two or more hazards occur in the same region and/or time period where the resulting impact is either greater or lesser than the sum of their impacts if they were to happen independently. The combined effects resulting from multi-hazard scenarios are therefore unlikely to be assessed through simple addition of losses, due to the independent effects, and instead require system approaches to understand and quantify risk.

The dynamics between single hazards during multi-hazard events are complex and diverse. Hence, as a first step, it is necessary to differentiate their main typologies (coincident or consecutive) based on their occurrence in time and space. On the one hand, coincident hazards represent events happening within the same geographical region, either simultaneously or with overlapping time frames (i.e. a secondary hazard is occurring whilst a primary hazard is still taking place). On the other hand, consecutive hazards take place sequentially in the sense that a second hazard impacts a system prior to its full recovery from the previous one. A second step in understanding multi-hazard situations involves identifying the interrelationships established (between single hazards) during compound events (interdependence, triggering, change conditions, association or mutual exclusion).

Following these steps it becomes possible to understand the way that one hazard can influence the magnitude and/or likelihood of subsequent hazards. Furthermore, in order to adequately develop a risk assessment of multi-hazard scenarios, it is also necessary to evaluate the exposure and vulnerability (and the changes that they might suffer) of the risk receptors.

In this context, project ICARIA (Improving ClimAte Resilience of crItical Assets, www.icaria-project.eu, GA: 101093806) aims at developing a comprehensive asset level modeling framework to quantify the risk associated with multi-hazard events for critical infrastructures and services in European Regions. Specifically, it focuses on three case studies: the Barcelona Metropolitan Area in Spain, the Salzburg Region in Austria and the South Aegean Region in Greece.

Based on a literature review, workshops with relevant stakeholders and the analysis of historic events, the main multi-hazard events of interest for the case studies have been identified. For all of them, the physical interactions established between the single-hazards involved have been determined in order to set an initial step to develop multi-hazard risk assessment methodologies in a later phase of the project. The joint probability of these events will be also estimated for current and future scenarios. The multi-hazard events taken into account within ICARIA are the following ones:

- Pluvial flood and storm surge
- Drought and forest fire
- Drought and heat wave
- Heat wave and forest fire
- Extreme wind and forest fire
- Heat wave, drought and forest fire

The understanding of the mechanism and effect of the abovementioned events will enable the assessment of the risk that these scenarios pose to the critical infrastructures of a region. Thus, these methodologies will stand as a valuable tool to improve the preparedness of key infrastructure to cope with such events.