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Temporal aspects in the development of a cascading-event crisis scenario: A pilot demonstration of the CRISMA project

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In this abstract we illustrate the various temporal aspects to be considered in a multi-hazard crisis scenario set up as pilot study in the EU-FP7 Integrated Project CRISMA. In the framework of CRISMA a simulation-based decision support system for crisis management is developed facilitating the modeling of realistic crisis scenarios, related pre-event vulnerabilities, as well as possible response actions and associated varying potential impacts on society. Both external factors driving crisis development and actions of the involved crisis management team are considered in the system setup.

The presented case is a complex cascading-event crisis scenario that is initiated by an earthquake causing building collapse and a consequent gas pipeline failure that triggers a follow-up fire in a nearby forest with potential to spread and endangering a village of the neighborhood. In terms of the hazard components, major earthquakes are rapid-onset events that can occur at any time without warning while fires are rather slow-progressing hazards usually allowing a certain lead time for preparations. In our scenario, which is based on the 2009 L'Aquila earthquake in Italy, a series of low-magnitude events preceding the main shock over a few months increases population awareness and at the same time brings disaster managers to assess risks and evaluate evacuation options already in the pre-disaster phase. This seismic swarm and the associated period of increased general awareness thus add an additional temporal component to the scenario, initiating response considerations earlier as when compared to a single shock scenario. In addition, the seismic vulnerability of buildings may increase due to damage accumulation, with higher probability of collapse at a given earthquake intensity.

With regard to best possible impact mitigation, detailed spatio-temporal exposure and vulnerability characteristics of population and associated assets have to be analyzed for all crisis stages including consideration of full-evacuation and no-evacuation scenario options. Short and medium-term exposure patterns such as hourly, daily, weekly, and seasonal variations provide the starting point information for evacuation planning, i.e. exact numbers of people at risk and estimates for sheltering requirements. Inherent hazard-specific vulnerabilities determine people with special needs who are considered high priority during evacuation. The nature of a cascading event also implies that alerting actions have to be adapted to changing conditions as people are already generally aware of the crisis situation after the earlier earthquake warning, but at the same time need to be continuously updated on relevant changes. Fires do for example often entail strong smoke development which can pose serious threat to people exposed (i.e. intoxication). In areas with reinforced concrete or masonry buildings (like in most Mediterranean countries) it is then usually advised to stay inside the houses in order to avoid getting trapped in smoke immersions in the streets. However, in a multi-hazard scenario involving potential earthquake-caused building damage, it might be decided to rather initiate full and particularly fast evacuation of the threatened area, because general building safety is no longer guaranteed and preparation time is very limited. Evacuation might then respectively be further hindered by blocked roads due to damaged infrastructure or presence of debris from collapsed buildings as well as by the progressing fire and smoke-induced reduced visibility, all also causing further panic in the population. One particular aspect of the occurrence of cascading effects is the accumulated stress that it causes to crisis management, i.e. in a sense that the fire event must be responded to when all the civil protection resources are already dedicated to addressing the seismic consequences.

Coming back to the reference event of the presented scenario, the 2009 L'Aquila EQ, in that case a few days before the main shock it was decided by the responsible assessment team not to evacuate. There was a lack of supportive instruments and tools enabling the comparison of the effects of different measures, thus it was basically counted on the very low probability of a large shock to follow a swarm of small seismic events. The CRISMA system is designed and supposed to fill in this gap and provide effective and comprehensive decision support for crisis management and impact mitigation by integrating alternative-scenario simulation. Thereby also the efficiency of distribution of civil protection resources and means to simultaneously fight multiple hazard events will be analyzed.