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# Risk prediction of Critical Infrastructures against extreme natural hazards: local and regional scale analysis

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Natural hazard events can induce severe impacts on the built environment; they can hit wide and densely populated areas, where there is a large number of (inter)dependent technological systems whose damages could cause the failure or malfunctioning of further different services, spreading the impacts on wider geographical areas.
The EU project CIPRNet (Critical Infrastructures Preparedness and Resilience Research Network) is realizing an unprecedented Decision Support System (DSS) which enables to operationally perform risk prediction on Critical Infrastructures (CI) by predicting the occurrence of natural events (from long term weather to short nowcast predictions, correlating intrinsic vulnerabilities of CI elements with the different events' manifestation strengths, and analysing the resulting Damage Scenario. The Damage Scenario is then transformed into an Impact Scenario, where punctual CI element damages are transformed into micro (local area) or meso (regional) scale Services Outages. At the smaller scale, the DSS simulates detailed city models (where CI dependencies are explicitly accounted for) that are of important input for crisis management organizations whereas, at the regional scale by using approximate System-of-Systems model describing systemic interactions, the focus is on raising awareness.
The DSS has allowed to develop a novel simulation framework for predicting earthquakes shake maps originating from a given seismic event, considering the shock wave propagation in inhomogeneous media and the subsequent produced damages by estimating building vulnerabilities on the basis of a phenomenological model [1, 2].
Moreover, in presence of areas containing river basins, when abundant precipitations are expected, the DSS solves the hydrodynamic 1D/2D models of the river basins for predicting the flux runoff and the corresponding flood dynamics. This calculation allows the estimation of the Damage Scenario and triggers the evaluation of the Impact Scenario. The regional output of cascading effects can be used as an input model for more detailed analyses within urban areas for instance.
The DSS weights the overall expected Crisis Scenario by also considering, through an appropriate Consequences Analysis, the number of citizens affected by the Service(s) outages, the expected economic losses of the major industrial activities hit by the unavailability of relevant Services (electricity, water, telecommunications etc.) and the influence of outages of the availability of Public Services (hospitals, schools, public offices etc.)

[1] S.Giovinazzi, S. Lagomarsino: A macroseismic method for the vulnerability assessment of buildings. 13th World Conference on Earthquake Engineering, Vancouver, BC, Canada (2004)
[2] S. Lagomarsino, S.Giovinazzi: Macroseismic and mechanical models for the vulnerability and damage assessment of current buildings. Bull Earthquake Eng., 4:415-443 (2006)