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Network resiliency assessment integrating network interdependencies

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Using a systemic approach for modeling urban dysfunctions during a flood event, networks can be considered as the "flood gateway" in the built environment [Lhomme et al., 2009]. Moreover networks, considering their characteristics, play an important part in crisis (for instance road network allows emergency response) but not always for positive aspects. Indeed, recent experience feedbacks have highlighted the negative role of technical networks during a crisis. In other word, networks are critical infrastructures. That is why one of the objectives in order to design resilient cities is to design resilient networks. More generally, evaluating network infrastructures for potential vulnerabilities is an important component of strategic planning, particularly in the context of managing and mitigating service disruptions [Murray et al. 2008]. Because societal functions are highly dependent on networked systems and the operability of these systems can be vulnerable to disasters there is a need to understand how networked systems are resilient.

Through direct connectivity, policies and procedures, or geospatial proximity, most of critical infrastructure systems interact. These interactions often create complex relationships, dependencies, and interdependencies that cross infrastructure boundaries. Moreover, critical infrastructure systems often cross geographic, political, cultural, and organizational boundaries. In fact, networked systems spread information, goods but also risk through a territory. For a critical infrastructure, getting dysfunctional is a phenomenon that transcends by far the failure of any, even major, single component. The often incomprehensible cause of system crashes stems from the inherent features of the critical infrastructures: they are multicomponent systems, prone to cooperative behavior, and typically responding in a non-linear fashion to stimuli and perturbations [Gheorghe and Vamanu, 2008]. These considerations are verified for the networks.

It is important to draw distinctions between two related but different concepts: a CI (Critical Infrastructures) system, and a system of CIs. A system of CIs offers a range of public goods and services through the interdependencies among its individual CI system components. Understand complexity of these interactions is a huge issue in order to understand and to assess urban resilience. Indeed, if we know where disturbances will occur, it is possible to assess recovery capacity of a city and to adapt recovery management. The objective here is to study networks as a system of CI's (telecommunication, water, electricity and transportation) taking into account the complexity of these different systems and the complexity of their interactions thanks to a generic modeling.

The first part of this presentation introduces the general methodology for assessing urban resilience. In a second part, we present a tool to produce failure scenarios of interdependent networks due to flood events, based on automation of these scenarios thanks to failure mode and effect analysis (FMEA) results. Finally, the methodology used in a GIS is presented, including the design of new network resiliency indicator.

Reference

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