On the Probabilistic Characterization of Robustness and Resilience

Over the last decade significant research efforts have been devoted to the probabilistic modeling and analysis of system characteristics. Especially performance characteristics of systems subjected to random disturbances, such as robustness and resilience have been in the focus of these efforts and significant insights have been gained. However, as much of the undertaken research and developments aim to fulfill the particular needs of specific application areas and/or societal sectors somewhat diverging perspectives and approaches have emerged. In the present paper we take basis in recent developments in the modeling of robustness and resilience in the research areas of natural disaster risk management, socio-ecological systems and social systems and we propose a generic decision analysis framework for the modeling and analysis of systems across application areas. The proposed framework extends the concept of direct and indirect consequences and associated risks in probabilistic systems modeling formulated by the Joint Committee on Structural Safety (JCSS) to facilitate the modeling and analysis of resilience in addition to robustness and vulnerability. Moreover, based on recent insights in the modeling of robustness, a quantification of resilience is formulated utilizing a scenario based systems benefit modeling where resilience failure is associated with exhaustion of the capital accumulated by the system of time. The proposed framework and modeling concepts are illustrated with basis in a simple interlinked system model comprised by an infrastructure system, a governance system, a regulatory system and a geohazards system. It is shown how the robustness and the resilience of the interlinked system may be modeled and quantified, how robustness and resilience are influenced by the stochastic dependency structure of the disturbance events and corresponding resistances, how robustness and resilience depends on the capacity of the social system to plan for and respond to disturbances over time and how robustness and resilience interrelate.

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