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Infrastructure systems analysis using simulation-based dynamic analysis of disruptive events due to natural hazards

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ABSTRACT

Governments have recognized that the proper functioning of critical infrastructures (CIs) determines the societal welfare. If a failed infrastructure is unable to deliver services and products to the others, disruptive effects can cascade into the larger system of CIs, due to interdependencies between them. Thus, it is of utmost importance that decision-makers understand the causal interdependencies and nonlinear feedback behaviors underlying the entire CIs network toward more effective and continuous during the life cycle of a system crisis response plans.In the present thesis a new modeling approach is proposed, based on System Dynamics (SD) to capture complex dynamics of CIs disruptions. Based on the architecture modeling and mathematical functions proposed by various scientists, a SD model is developed and applied to hypothetical scenarios for simulation-based impact analysis of single and multiple disruptive events. The model is applied for a network of critical infrastructures, considering the case of infrastructure interdependencies or autonomous infrastructures under several disruptive events, occurring simultaneously or not. With a particular emphasis on temporal aspects of system resilience, taking into consideration the time o infrastructure needs to restore and return to function, it also turns out that the model can be used for dynamic resilience assessment. A case study is developed, considering the infrastructure system of the city center of Thessaloniki. The model supports crisis managers in understanding scenarios of disruptions and forecasting their impacts to improve strategic planning in Critical Infrastructure Protection (CIP).

KEYWORDS

resilience, critical infrastructure systems, system dynamics, natural hazards, infrastructure systems resilience