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Risk assessment and management in transportation systems: a methodology for evacuation design

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This paper proposes an unifying approach for the simulation and design of a transportation system under conditions of incoming safety and/or security. Safety and security are concerned with threats generated by very different factors and which, in turn, generate emergency conditions, such as the 9/11, Madrid and London attacks, the Asian tsunami, and the Katrina hurricane; just considering the last five years. Methods for planning a transportation specified and calibrated in ordinary conditions cannot be directly applied in emergency conditions. In these conditions, with different levels of precision, public decision-makers must predict with transportation models (implemented by the system analyst) the effects of implementing their measures upon the system and how these measures may interact (implemented by operational forces) with the individual reactions of the users served by the transport system in question. The development of models for emergency conditions in transportation systems has not received much attention in the literature. In this paper, transportation risk assessment is proposed with quantitative models where real conditions are reproducible on a computer simulation. After the risk assessment, possible mitigation measures are proposed within for risk management by means of network design. This paper is developed with the following main objectives: (a) to formalize the risk problem with clear diversification (for the consequences) in the definition of the vulnerability and exposure in a transportation system; thus the paper offers improvements over consolidated quantitative risk analysis models, especially transportation risk analysis models (risk assessment); (b) to formalize a system of models for evacuation design and simulation; (c) to specify a model for system design in emergency conditions (risk management); (d) to apply the model for system design in a real system for exposure reduction. The application is developed for two Italian towns of about 9000 and 180000 inhabitants and is chosen as it has a similar number of potential evacuees to the majority of cases

in real threats when entire small towns or parts of a city have to be evacuated. The application can be extended to large buildings, passing from car to people. The paper includes the first published simulated curve between vulnerability and exposure for a transportation system.