

Multi-Scale Models for Transportation Systems under Emergency Conditions

Abstract

The range of emergencies that can affect transportation networks varies from foreseeable weather related events (e.g., severe storms), to man-made disasters (e.g., terrorist attacks) to epidemics (e.g., 2014 Ebola disaster). Over the past decade, the frequency and intensity of these disasters has increased, causing significant disruptions in local and regional transportation systems. How to prepare for and respond to a disruption in transportation systems is a complex decision incorporating a variety of factors, from system use to system preparation. Moreover, unexpected human behaviors (e.g., disordered movements) often occur during emergency situations. The human behaviors under panic affect the process of evacuation and further complicate decision-making in the preparation for and response to a disruption. To address these challenges, the objectives of this project are to: 1) determine when a planned closure of a transportation mode should occur, 2) investigate and model pedestrian movement during a closure event (i.e., evacuation), 3) examine the impact of panic on human behavior during evacuation and develop mathematical models to incorporate it into pedestrian movement, 4) develop and assess the policies to be followed during such evacuations, 5) develop multi-scale decision-making models for the response to disruptions in local and regional transportation systems, and 6) integrate the multi-scale models as a decision-making aid during emergencies. This project consists of two thrusts: 1) multi-transportation-mode decision-making models for emergency response in local and regional transportation systems, and 2) human behavior during an emergency. We will develop optimization and simulation models to achieve our research objectives. Optimization models will support the decision-making processes used to determine which actions are taken to prepare for and respond to disruptions in transportation systems. Simulation models will play a key role in the evaluation and comparison of the outcomes among decisions/policies, and in identifying the effectiveness of policies, especially in situations that are difficult to test in the real world. Analyses and models in this project will be conducted at two interdependent scales – at the local scale of individual transportation modes (e.g., airplane, subway, ferry, etc.) and transportation hubs, and at a macro-scale across geographical regions or at a network level.

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