Stochastic Networks in Disaster Response: Developing a predictive capability

Mr. John Coles and Dr. Jun Zhuang, Dept. of Industrial and Systems Engineering, University at Buffalo

We hypothesize that the dynamics of an agency-agency network that forms in response to a disaster can be reasonably predicted based on the composition of the agency network, behavioral models for each type of agency, and a set of rules for interagency cooperation. Using stochastic network analysis, game theory, and dynamic programming, we plan to develop an agency-centric model that can be adapted to different disaster scenarios. Collecting data about the agencies involved in a disaster response operation is a complicated, expensive, and slow process. To our knowledge, no previous research has have studied the changes in a network of agencies over time. This research fills this gap by studying the length (i.e. how, why, and when they begin and end) and strength (i.e. what, how much, how often resources and information are shared) of partnerships between agencies, comparing the pre and post-disaster states to understand how and why these relationships form. Initial research was conducted in Haiti to examine how a cross-section of agencies behaved in response to a disaster and how it changed a network of partners. This research was funded by NSF RAPID (awards #1034730 and #1034740) and has provided an initial data, from which we hope to develop a stochastic network model for agency interaction after a disaster. The initial dataset generated following the Haitian earthquake provided some insights into how network change (see Figure 1), however, since each disaster has unique components that may alter network formation and structure, we are in the process of collecting data. Heavy flooding in the U.S. that followed Hurricane Irene and Tropical Storm Lee in 2011 provided an excellent parallel testing ground to monitor how organizations in the U.S. respond to wide-spread disaster scenarios. This set of disasters was chosen because of the apparent difference between Haiti and the US, and the scope of the disaster event. By comparing and contrasting agency behavior in the United States and Haiti, we hope to identify some of the dynamics of a disaster situation that affect decision-making about partnership selection, formation, and longevity.

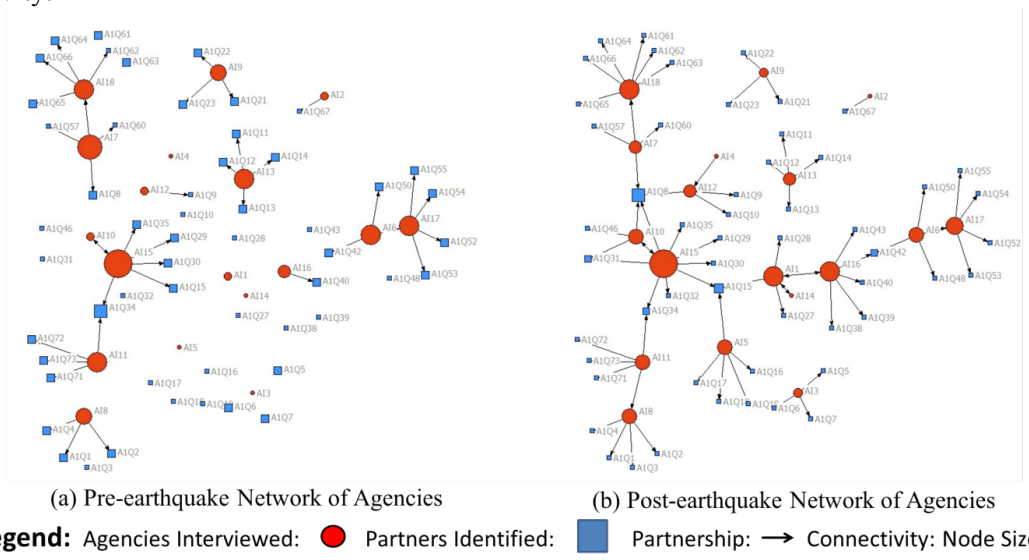

Figure 1: Networks (a) and (b) were developed from interviews conducted in Haiti in 2010.

In this poster we provide an overview of the research in its current state. Since we are in the process of identifying the best model framework to build our stochastic network. We would like to identify a framework that will include important aspects of the small-scale aspects agency-agency interaction (e.g., trust, resource allocation, agency type) while also being able to solve the network to optimality (or epsilon-optimality if the true optimal is too difficult) for a particular agency. Novel perspective or comments on a good approach to building such a stochastic network would be greatly appreciated from the academic community, as this study is developed to ensure accurate and transferable results.