Title: A Novel Agent-Based Simulation Tool to Optimize Electric Utility Restoration Following Storm Events in Connecticut

Abstract:

Storm damage to the electric grid impacted about 19 million US electric utility customers in 2017 and on average costs US consumers between $20 and 55 billion. Currently, most utility companies rely on the past experiences of emergency managers to determine the allocation of repair crews. Such allocation can be inefficient, time-consuming and costly since supplemental crews must travel from other states during large storm events. When a storm occurs, utility companies need to determine the optimal procedures to decrease cost and lost revenue and total restoration time. However, there are few analytical simulation and prediction tools available for utility managers to optimize storm recovery.

An agent based model (ABM) is a computer modeling technique comprised of agents who are given certain behavioral rules and operate in a given environment. It allows the user to simulate complex systems by varying user-defined parameters to study emergent, unpredicted behavior. An ABM can give utility company emergency managers the ability to optimize their restoration strategies before or during a storm event to quantify the costs and benefits of alternative restoration strategies

We report on the development of such a model for storm recovery in Connecticut. The model incorporates the road network and electric utility grid for the state, crew rest periods and area work center locations. Repair crews follow the roads to repair outages. The user can set the number of crews working, their starting location, outage repair time, travel speed and the crew search criteria used to determine where crews go after repairing each outage. Each variable can be stochastically varied across possible ranges to determine the best restoration strategies. Supplemental crews can be called and arrive after a set amount of time to simulate the cost and time benefits of using out-of-state crews. It is a modular and scalable simulation that could be applied to other regions or used to train emergency managers to improve their performance. Results indicate a strong relationship between the number of crews and individual outage repair times with statewide restoration times, while travel speeds have less influence on statewide repair times. All variables are strongly influenced by storm size. Bringing in outside crews can be beneficial, but it depends on the storm size and arrival time.

With this proof-of-concept model complete, we hope to expand the model to other regions of the country, add new functionality and develop it into a real-time tool to assist emergency mangers optimize storm restoration.