INTEGRATED MITIGATION, RESTORATION, AND SCHEDULING PROBLEM FOR INTERDEPENDENT INFRASTRUCTURE NETWORKS

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ABSTRACT

We consider the problem faced by managers of interdependent civil infrastructure systems of mitigating the impact of a non-routine event, and restoring essential public services after this non-routine event causes disruptions to these services. In order to restore the services, we must determine the set of components (or tasks) that will be temporarily installed or repaired, assign these tasks to work groups, and then determine the schedule of each work group to complete the tasks assigned to it.

This research considers a novel integrated interdependent network design and scheduling problem (IINDS) that can serve as a decision aid to formulate the restoration efforts in these interdependent infrastructure systems. The objective function of the problem provides a measure of the community resilience, which is the ability of communities to carry out response and recovery activities in ways that minimize physical and social disruptions. The objective function of IINDS problem evaluates how well the services are being restored over the horizon of the restoration plan, rather than just focusing on the performance of the systems after all restoration efforts are complete. We develop new optimization methods for this class of problems that use concepts from the areas of network flows and scheduling.

Our methods are tested on realistic data sets representing the infrastructure systems of New Hanover County in North Carolina and Lower Manhattan area of New York City, which were created through collaborations with managers of these systems. Our computational results demonstrate that we can provide integrated restoration and scheduling plans of high quality with limited computational resources. We also discuss the benefits of centralized decision making and information sharing among interdependent infrastructure systems as opposed to independent decision making of each infrastructure separately. Further, we provide a mathematical framework that integrates pre-event mitigation decisions into IINDS problem. Finally, we discuss future research directions about how IINDS problem can be extended to model other flow network systems.