

A Scenario Robust Bi-objective Model for Integrating Disaster Mitigation and Preparedness

Abstract

The potential synergy between mitigation and preparedness phases of disaster management is often overlooked as it falls between the cracks of framework development, such as FEMA's four phases of emergency management. We develop a scenario robust bi-objective model to draw on this untapped potential by analyzing the tradeoff between two competing objectives; i.e., minimizing mitigation cost associated with the readiness of a disaster-prone region versus minimizing preparedness social cost consisting of logistics, deprivation, and fatality costs. Recognizing data inaccuracy in the disaster management setting, uncertain parameters within each scenario are modeled via easy-to-estimate deterministic uncertainty sets. In addition to adopting an existing medical supply deprivation framework, we also develop complementary deprivation functions to account for the human suffering due to shortage and delayed arrival of food and water supplies based on empirical studies. Our model guides policymakers regarding inter-system benefits gained from a vertical collaboration between agencies charged with the mitigation and preparedness roles that currently operate in silos, thereby engaging in suboptimal policies. Using an extensive case study of a hurricane-prone zone we illustrate our model application wherein empirical models are utilized to estimate key parameters such as readiness of the region. Through a cost-benefit framework, our results provide fresh insights into collaborative strategies policymakers can adopt for a unifying approach to disaster management.

Keywords: OR in Disaster Relief ; Bi-objective Robust Optimization; Vertical Integration; Hurricanes; Deprivation Costs; Readiness; Social Cost; Cost-Benefit Analysis