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Location and Emergency Inventory Pre-Positioning for Disaster Response Operations: Min-Max Robust Model and a Case Study of Yushu Earthquake

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Abstract

Pre-positioning emergency inventory in selected facilities is commonly adopted to prepare for potential disaster threat. In this paper, we simultaneously optimize the decisions of facility location, emergency inventory pre-positioning, and relief delivery operations within a single-commodity disaster relief network. A min-max robust model is proposed to capture the uncertainties in both the left- and right-hand-side parameters in the constraints. The former corresponds to the proportions of the pre-positioned inventories usable after a disaster attack, while the latter represents the demands of the inventories and the road capacities in the disaster-affected areas. We study how to solve the robust model efficiently and analyze a special case that minimizes the humanitarian cost. The application of the model is illustrated by a case study of the 2010 earthquake attack at Yushu County in Qinghai Province of PR China. The advantage of the min-max robust model is demonstrated through comparison with the deterministic model and the two-stage stochastic model for the same problem. Experiment variants also show that the robust model outperforms the other two approaches for instances with significantly larger scales.

Keywords
Disaster Relief; Facility Location; Network Flow; Inventory Pre-positioning; Min-max Robust Optimization