Robust Network Design for Earthquake Preparedness

Abstract

We develop robust models for earthquake preparedness by optimizing the number, location, and capacity of distribution centers (DCs). The goal is to minimize the total social costs, which include setup and initial supplies, as well as the deprivation costs associated with delayed access to supplies. The models incorporate various earthquake magnitude-specific uncertainties, such as facility damage, casualty by severity, and travel time. Examining the concept of social costs in light of an emerging concern in humanitarian logistics - the robustness of relief networks, we model two types of robustness: parameter uncertainty within a scenario and relative regret across scenarios. This unique approach reveals (1) the magnitude of social costs in the aftermath of an earthquake; (2) the hidden risks associated with inaccurate modeling of deprivation costs; and (3) the impact of budgetary constraints. We demonstrate the applicability of our approach via a case study featuring the Northridge region in California, which experienced two of the strongest earthquakes recorded in North America in 1971 and 1994.

Keywords: disaster planning; humanitarian logistics; facility location; capacity allocation; deprivation cost; robust optimization; scenario planning; regret limit