Supply Location and Transportation Planning for Hurricanes: A Two-stage Stochastic Programming Framework

We develop a two-stage stochastic programming model with recourse actions for hurricane preparedness. In the first stage, it works to optimize the locations of Points of Distribution (PODs), medical supply levels, and transportation capacity, and in the second, transportation decisions or flow. Our model minimizes the total social cost, comprised of deprivation and commercial logistics costs. Contrary to the extant literature, which typically employs robust optimization, we use probability distributions to avoid overly conservative estimates of hurricane impact. Additionally, our model facilitates the determination of optimal deployment time. We demonstrate the benefits of our approach in a case study. As risk attitude goes from optimistic to pessimistic, decision makers increase the number of PODs exponentially to spread the risk around. A similar trend holds for total costs as a function of hurricane category and its interplay with risk. Further, for lower strength hurricanes, regardless of risk attitude, the optimal decision is to deploy closer to landfall at 12 hours; for higher strength hurricanes, resources are best deployed earlier, at 36 hours, based on an exponential increase in demand for medical supplies. Deployment cost also increases exponentially as landfall approaches. These costs outweigh deprivation savings from an accurate demand estimate closer to landfall. However, when budget is limited, risk attitude is found to influence deployment decisions and a funding preference for lower severity-level supplies.

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