Resource Allocation for Emergency Response in CAL EMA Region IV

M.S. Thesis in Operations Research (completion date: March 2011)

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last update: October 2010

Background:
California is a state prone to many natural disasters such as earthquakes, fires, and floods. The CAL EMA (California Emergency Management Agency) is in charge of planning for such events, and in coordination with other state and local agencies, CAL EMA prepositions resources to provide basic food, water, medical supplies, and shelter in potentially affected areas.

As part of that planning, every year CAL EMA conducts a full-scale exercise called “Golden Guardian” [CAL EMA 2011]. During the exercise, CAL EMA devises a plan for a disaster evacuation and relief scenario, and tests its execution. The scenario for Golden Guardian 2011 involves a large flood in the Sacramento-San Joaquin Delta Region.

CAL EMA’s plans are based on past experiences, but CAL EMA does not have the analytical tools to optimize the prepositioning of strategic resources before the disaster. This is important because the efficiency of subsequent logistics (such as the distribution of supplies to affected areas during the disaster) highly depends on those strategic decisions.

The objective of this thesis is to provide strategic analysis in support of the Golden Guardian 2011 scenario.

Thesis Scope:
The geographical scope of the thesis is CAL EMA Region IV, which consists of eleven counties in the north central valley of central California, with an emphasis on the Sacramento-San Joaquin Delta Region. It encompasses affected population areas during flooding disasters, and relief locations like county fairgrounds and local military bases.

Method:
This thesis will use the stochastic optimization model developed by Salmeron and Apte [2010] for Natural Disaster Asset Prepositioning. This model’s objective is to preposition supplies, medical services, transportation capacity, and ramp space in order to minimize casualties in affected areas. It is a strategic model that can look at different disaster scenarios simultaneously.

The proposed research will model a network of approximately eight affected population areas (APAs) and ten relief locations (RLs) with estimated travel times between them dependent on the vehicle used. The RLs will have prepositioned resources (PRs) and shelter dependent on their capacity. Some RLs also have airstrips for air transportation. The people in the APAs that have been injured after a disaster are modeled as the emergency population (EP). These people will need to be transferred using vehicles from the APAs to the RLs. The displaced population (DP) will need transport to the RL for shelter. A last group
considered is the affected population (AP) that can stay in the APA but need resources from the RL to survive. The model will look at the optimal way to evacuate EP, supply resources to AP, and transport DP to the RLs. The model will study the first 72 hours after a flood disaster. It will produce a plan for strategic prepositioning of resources that helps minimize the expected number of casualties (those from the EP who are not transported, and those from the AP who do not receive supplies). As a secondary objective, the model also maximizes the DP transported to RL shelters.

Data will be provided by experts at CAL EMA and the Federal Emergency Management Agency (FEMA). Possible RLs have already been designated by FEMA and shelter and resource capacities are being investigated at the time of writing this proposal. APAs will be assigned by looking at past floods and how they affected the region of study. Demographic data have also been provided, including population without vehicles and population below the poverty line, which can help estimate the DP and the AP. Initial vehicles by type available during emergencies have been designated. Where data is not available CAL EMA has agreed to use its experts to give a best estimate for inputs.

**Project Time Line:**

- **Oct 2010** Presentation at California Emergency Management Agency & Naval Postgraduate School Research & Technology Exercise Integration Seminar 27 OCT
- **Nov-Dec 2010** Model refinement and data collection
- **Jan-Feb 2011** Final analysis and documentation of results
- **Mar 2011** Presentation of final report to stakeholders. Thesis completion and graduation.

**References:**


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