

Chapter 52

Planning for Hurricane Isaac using Probability Theory in a Linear Programming Model

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ABSTRACT

The author demonstrated how linear programming (LP) models with embedded probability theory were applied for disaster planning to mitigate the damages of hurricane Isaac. The purpose of the article was to raise awareness of software-based disaster planning methods, and to demonstrate how uncertainty can be quantified as risk estimates to substitute for and then added as constraints in LP models. Several LP approaches and alternatives were reviewed from the literature. Three LP problem-solving techniques were demonstrated: graphing, algebraic systems of linear equations, and using spreadsheet software. Two disaster planning LP models were solved based on the Federal Emergency Management Agency case study of hurricane Isaac in 2012. The case study focused on allocating emergency supplies to strategic Point of Distribution locations. A unique feature of the article was showing how uncertainty could be quantified as risk by calculating the mean, standard deviation and coefficient of variation for airboat trips based on historical data from hurricane Katrina. Several insights of LP model formulation were given to assist others.

INTRODUCTION

New Orleans Louisiana and the neighboring Gulf of Mexico regions were prepared for natural disasters after having experienced two catastrophic events, namely ‘category 3’ hurricanes Camille

in 1969 (Rappaport, 1997) and Katrina in 2005 (NOAA, 2012). Hurricane Katrina was the “deadliest and most destructive ... the costliest natural disaster, as well as one of the five deadliest hurricanes, in the history of the United States” (Knabb, Rhome & Brown, 2006, p. 10).

Hurricane Isaac reached the New Orleans coastal peninsula around at 2 a.m. Wednesday

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August 29, 2012 as a ‘category 1’ strength with up to 75 mile per hour winds (NOAA, 2012). As evidence of its power, Isaac produced a tornado in Pascagoula, Mississippi (CNN, 2012). Isaac departed Louisiana after approximately 24 hours, leaving five fatalities (Plaisance & Smith, 2012).

Ironically, Isaac struck almost seven years to the day after Katrina practically destroyed New Orleans in 2005. Isaac damages were estimated at \$2 billion with seven fatalities across five states (Anderson, 2012; AP, 2012a; Bojorquez, 2012; Menon & O’Grady, 2012) as compared to the \$108 billion in damages and 1833 deaths attributed to Katrina (Knabb et al., 2006; AP, 2012b). Louisiana was well prepared for an emergency response to Isaac by having safety shelters open and survival supplies stock piled according to the Clarion Ledger (2012).

Recently completed infrastructure projects helped make disaster preparedness for hurricane Isaac a success. The \$14.4 million dollar improved levees in New Orleans did not fail as they did in 2005 (Knabb et al., 2006; Bojorquez, 2012) although minor flooding from a Lake Pontchartrain surge occurred in Slidell (McConnaughey, 2012).

The human services disaster planning efforts by numerous agencies were also effective. Of particular interest in this study were the operations of the Federal Emergency Management Agency (FEMA) in planning the allocation of supplies to each Point of Distribution (POD) where residents could pickup food, water and medical rations. Figure 1 shows a cargo truck unloading supplies at a FEMA POD days before Isaac hit - this project was based on disaster planning best practices.

Awareness of disaster planning methods helps any society avoid the loss of human lives as well as to reduce the costs of mitigation (Taleb 2007; vanAsselt & Renn, 2011). Simonovi (2010) suggested practitioners could use a mathematical technique called ‘linear programming’ for disaster planning and he provided several examples using software programs. Another researcher concluded that software-based estimation tech-

niques were helpful in estimating uncertainty to avoid fatalities based on a study of hurricane Ike which hit the Texas Gulf coast near oil refineries in 2008 (Strang, 2012). Therefore, the purpose of this paper is to demonstrate how risk analysis techniques may be used for disaster planning.

This is a theoretical study of how risk assessment techniques were applied in a linear programming model to help strategically plan the emergency provision allocations to a POD, by using historical data to quantify uncertainty, as well as use current data to estimate labor requirements and fuel costs.

Nonetheless, mathematical models cannot totally replace human logic, and mistakes can be made, so it is essential to apply quality assurance when using software tools to assist with disaster planning. Simonovi (2010, p. 35) made an interesting observation about this caveat: “a linear programming model used for emergency planning at the University Hospital in New Orleans resulted in many patients being rationed only [supplements] instead of meals.” Thus, this paper will also present limitations along with the guidelines when applying risk analysis within linear programming models for disaster planning.

Figure 1. Emergency supplies being unloaded from cargo truck at POD in New Orleans before Isaac



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