

Chapter 8

Relief Distribution Networks: Design and Operations

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ABSTRACT

Logistics area is often recognized as one of the key elements in achieving effective disaster preparedness and response efforts. This chapter presents modeling and solution approaches for both the problem of prepositioning emergency supplies prior to a disaster as well as the problem of their distribution after the disaster onset. Depending on whether uncertainty is taken into account or not, work in these areas will be classified into two major categories: stochastic or deterministic. A distinction will also be made between exact methods and heuristics. In addition, the advantages and limitations of each of these two classes of approaches will be discussed. An emphasis will be put on the particularities and characteristics of relief distribution networks. More advanced issues in the design and operations of these networks will also be discussed as interesting research avenues.

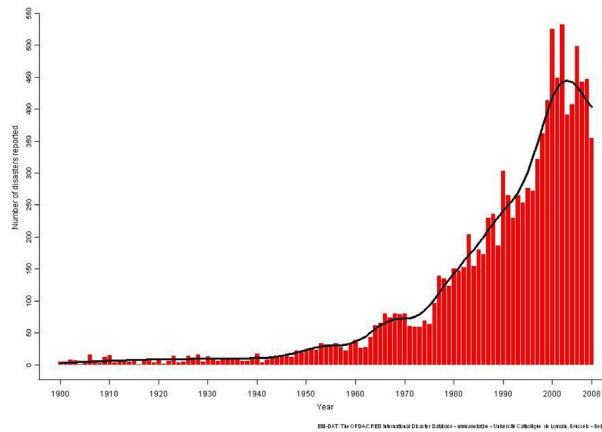
INTRODUCTION

In the past few years, there has been an increased interest in the design and operations of relief distribution networks. This attention is mainly motivated by a worldwide increasing trend in natural disaster numbers (see Figure 1) as well as the alarming and devastating impacts of these disasters on human lives and global economy.

According to the Center for Research on the Epidemiology of Disasters (CRED), the number of disasters resulting in 100,000 to 999,999 victims around the globe doubled during 1987-2006 (CRED 2006). In 2007, 414 natural disasters were reported worldwide killing 16847 persons, affecting more than 211 million others and causing over 74.9 US\$ billion in economic damages (CRED 2007). On its part, the United States was affected by many costly disasters that year. These disasters caused more than US\$ 9 billion in damage (CRED 2007). However, with almost US\$ 129 billion,

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Figure 1. Natural disasters reported 1900-2008. Source: EM-DAT DATABASE



hurricane Katrina 2005 remains the hydro meteorological disaster responsible for the highest damages ever reported (CRED 2006). The severity of disaster impacts is often aggravated by the worldwide economy connectivity that helps spreading disaster effects far-away from the region where they actually occur (Akkihal 2006). This was the case of hurricane Katrina in 2005 and hurricane Ike in September 2008. Both disasters stroked the Gulf region which is a source of fuel supply, causing fuel price increases in distant regions. Figure 2 illustrates the importance of natural disasters economical impacts for the last few years.

Despite the importance of disasters economical effects, mitigating their impacts on human lives remains the major concern. This can be achieved through an adequate and timely delivery of emergency supplies such as tents and medical products to affected populations. However, efforts dedicated to provide these kinds of supplies after a disaster onset are often criticized (GPO 2007, OIG-08-11). In fact, disaster preparedness has been widely identified as an important strategy to insure an effective disaster response. Logistics area is indeed often recognized as one of the key elements in achieving effective disaster prepared-

ness and response efforts (OIG-08-11, Jenkins 2007, CRID 2006, OIG-06-32, Kemball-Cook and Stephenson 1984, Ardekani and Hobeika 1988, Larson et al. 2005).

This chapter is aimed at addressing both pre-disaster preparedness and post-disaster responsiveness in a distribution network operated by a humanitarian relief organization. In this context, different types of emergency supplies must be delivered quickly to disaster-affected populations in order to mitigate their sufferings. Emergency supplies may generally be classified into two categories: consumable items such as clothing and food; and non-consumable items such as shelters and electricity devices. As noticed in Akkihal (2006), non-consumable items are critical to a timely disaster-response and must therefore be delivered in the early stages of the disaster. We are interested in a relief distribution network where emergency supplies are first received and stored in permanent facilities (logistics centers) generally located in large cities. These supplies are then shipped to temporary supply units (local distribution centers) in theater where they are pre-positioned for distribution to people in need. Since disasters are generally low probability high impact events, demand arrival, size and location

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