Chapter 51
A Fuzzy Approach to Disaster Modeling:
Decision Making Support and Disaster Management Tool for Emergency Medical Rescue Services

Jan Stoklasa
Palacky University in Olomouc, Czech Republic

ABSTRACT

The decision making process of the Emergency Medical Rescue Services (EMRS) operations centre during disasters involves a significant amount of uncertainty. Decisions need to be made quickly, and no mistakes are tolerable, particularly in the case of disasters resulting in a large number of injured people. A multiphase linguistic fuzzy model is introduced to assist the operator during the initial phase of the medical disaster response. Based on uncertain input data, estimating the severity of the disaster, the number of injured people, and the amount of forces and resources needed to successfully deal with the situation is possible. The need for reinforcements is also considered. Fuzzy numbers, linguistic variables and fuzzy rule bases are applied to deal with the uncertainty. Outputs provided by the model (severity of the disaster, number of reinforcements needed etc.) are available both as fuzzy sets (for the purposes of disaster planning) and linguistic terms (for emergency call evaluation purposes).

INTRODUCTION

Disaster can be defined as an event threatening human life, health, property or environment, with an unusually extensive impact on the society. Such situations usually require a change of attitude and value system revision to be successfully dealt with.

For the purpose of this chapter only disasters that result in a large (significantly surpassing the usual) number of injured people with prevailing mechanical injuries will be considered. There are many disaster classifications. We can distinguish between man-made disasters (traffic accidents, industrial accidents etc.) and god-made (or natural) disasters, such as earthquakes, tsunamis etc.

DOI: 10.4018/978-1-4666-4707-7.ch051

It makes sense to use this approach to disaster classification from the perspective of general disaster response. The case of medical rescue services response to disasters requires a different classification approach. A useful classification should be based on the prevailing type (source) of injuries. Among the typical types on injuries, mechanical injuries are the most frequent. We can also consider chemicals, radiation, biological agents or explosions to be possible sources of injuries. In this chapter, we focus on the mechanical type of injuries and all disasters resulting in this type of injuries.

Should such a life or health threatening event occur in our lives, we count on the Emergency Medical Rescue Services (EMRS) to provide us with assistance. Their forces are trained to be able to cope with almost any every-day health threatening event that might happen. But when a more serious event – disaster – occurs, classical problem solving strategies seize to work. EMRS staff needs to think and act differently, procedures they know and do well no longer suffice (Boer, 1999).

The amount of forces and resources needed to successfully cope with such situations may be difficult to determine or even to estimate. The key role in the rescue process is played by the EMRS operator, who evaluates the emergency call. Disasters occur quickly, suddenly and with an unusual impact on the environment and people. This implies that whatever decisions need to be made cannot be postponed, and every mistake can result in damage to property or health or even in casualties. Moreover, people reporting these events to the EMRS Operations center may be affected by the disaster themselves. This can make their evaluation of the severity of the disaster inappropriate (both under and over-estimated).

In order to make the decision as correctly and quickly as possible, every available piece of information needs to be taken into consideration, regardless of its uncertainty. Decision making support in the form of a mathematical model can mean a substantial simplification of EMRS operator's work as well as a means of mistake elimination. And in this context mistakes can mean life losses.

The main purpose of this chapter is to show that linguistic fuzzy modeling can prove itself useful even in the context of medical disaster response, where mainly during the initial time period uncertainty is inevitable and has to be dealt with. The emergency call usually comprises rough information describing the event. The exact location, number of casualties, severity of injuries etc. is not available. We usually deal with guesses of the person that is reporting the disaster. This is however the only piece of information concerning the disaster itself and its impact (Stoklasa, 2009) that is available during the first minutes of disaster response. Decisions need to be made even in situations when there is lack of information, or the precision of data is low. We may even need to deal with contradictory information. Any tool that can help us use this kind of data effectively, to verify it somehow and to draw valid conclusions is most welcome. We need to speed up the decision making process and eliminate possible mistakes when lives are at stake. Fuzzy logic and linguistic fuzzy modeling may provide such a tool.

The stress under which the operators of EMRS operation centers work reaches critical levels during disasters. It is surprising that we still do not have available a sufficiently well working system for these purposes (at least in the Czech Republic) – not even now in the 21st century. The need for such a decision making support tool has been at least recognized during the last few years. This chapter describes how we deal with this challenge. Based on the practical experience of professional EMRS workers and operators, as well as hospital representatives and interviews with them, the linguistic fuzzy model described later in this chapter was developed.