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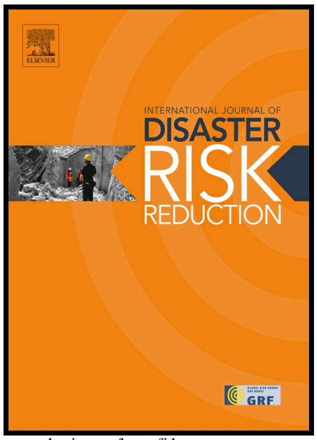

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Adaptive Multi-agent Relief Assessment and Emergency Response

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Abstract

The prediction of relief demand during disasters is an important operational task that should be performed before emergency response is initiated because such prediction enables the appropriate allocation and distribution of humanitarian supplies to affected zones. Current prediction methods appear to over or underestimate the calculation of relief demand—a problem that can be resolved by dispatching assessment vehicles to the affected zones of a region at the onset of a disaster. This study is aimed at facilitating the coordination of relief assessment and emergency response through the development of an adaptive multi-agent demand evaluation and demand-responsive model. Its main objective is to provide a model from which emergency response teams (ERTs) can obtain accurate information that will be used as basis by relief assessment teams (RATs) in effectively distributing humanitarian aid and conducting search and rescue operations. We propose a Markov decision process as a multi-agent assessment and response system, with reinforcement learning designed to ensure the integration of ERT and RAT operations. We use a coordination cluster system to coordinate ERT actors and use the proposed model to solve the problems occurring in a real-size network. Results show that the use of the model can improve emergency response operations and decrease death tolls.

Keywords: Multi-agent optimization, Emergency response, Relief assessment routing, Real-time relief demand, Reinforcement learning, Markov decision process.

1. Introduction

Fast and accurate response to humanitarian demands at the onset of a natural disaster is a significant issue that should always be a priority in disaster and relief management. The effectiveness of this response depends on various social and technical parameters, with one of the most sensitive being demand evaluation. Demand pertains to the urgent needs of a vulnerable population in a disaster-affected region and is used by emergency response teams (ERTs) as basis in the distribution of humanitarian supplies and the implementation of search and rescue operations. Relief demand has been extensively examined in operational research, the majority of which adopt prediction methods for estimating relief demand on the basis of zonal features [1], such as structural (building) stability and network reliability. The problem with these approaches is that they over or underestimate relief demand given the chaotic and stochastic nature of disaster conditions. This is why zonal information may not necessarily represent accurate values and why demand evaluation remains a challenging issue. Let us take a hypothetical city that is divided into n zones as an example. Each zone has a specific population