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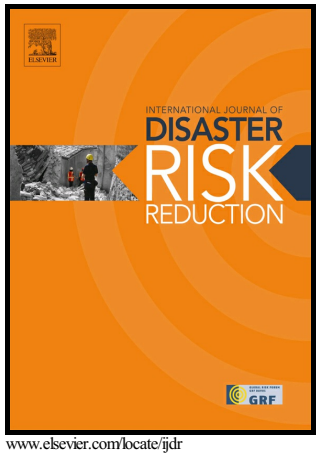
Mohsen Babaei, Afshin Shariat Mohaymany, Nariman Nikoo



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Emergency Transportation Network Design Problem: Identification and Evaluation of Disaster Response Routes

Mohsen Babaei[a], Afshin Shariat Mohaymany[b*], Nariman Nikoo[b]

[a]*Civil Engineering Department, Faculty of Engineering, Bu-Ali Sina University, Hamedan, Iran.*
[b]*Department of Transportation Planning and Engineering, School of Civil Engineering, Iran University of Science and Technology, Tehran, Iran.*

m.babaei@basu.ac.ir
shariat@iust.ac.ir
na_nikoo@iust.ac.ir

Abstract
Since disasters have considerable effects on transportation networks, the functionality of an emergency transportation network can play an important role in mitigation phase, especially in developing countries that sometimes suffer the sad experience of almost complete destruction of several cities. Transportation related disaster response activities typically include search and rescue, emergency medical care and fire-fighting trips. In this paper, the emergency transportation network design problem is proposed to determine the optimal network to perform emergency response trips with high priority in the aftermath of disasters. The problem has three objective functions designated to identify the optimal routes for emergency vehicles considering the length, the travel time and the number of paths, as a performance metrics of network vulnerability. A combined approach for considering the three objectives including weighted sum and lexicographic methods is used. The proposed model is solved using a branch-and-cut solution method. The suggested method is tested on the well-known Sioux-Falls network as well as on the real-world network of Tehran metropolis, Iran. Computational experiments are conducted to examine the effects of varying the maximum network length, and the relative weights of other objectives.

Keywords: Disaster mitigation, Emergency transportation network, Vulnerability analysis, Emergency response trips, Critical links.

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1. Introduction

Natural disasters such as earthquake, flood, and hurricane inflict significant human and financial losses every year. The number of natural disasters and people affected by these natural disasters has increased in recent years [1]. Comparing yearly earthquake death rates among Iran, Japan and the USA during three different periods revealed that while Japan and the USA have reduced their yearly rates, Iran's status has been worsening [2]. Unlike developed countries where the main concern is to return the city to the pre-disaster conditions quickly, developing countries attempt to rescue more people in the response phase [3]. Many Iranian cities have suffered from earthquakes. Statistical analyses show that Iran has

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