Identifying and classifying the vulnerability of Kerman primary and secondary emergency roads using a fuzzy Approach

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Extended Abstract

Introduction

Natural disasters are regarded as one of the issues that most cities around the world encounter. Naturally, the first step in dealing with crises and disasters is to rescue people and mitigate aftereffects of that event which requires an immediate reaction in no time.

With development of urbanization, population density, construction of large industrial cities and expansion of metropolises, the impact of urban transportation network performance on the cities, in general, becomes more visible to such an extent that poor transportation network and its poor performance after the earthquake lead to a breakdown of relief measures and reconstruction activities. This can result in adverse social, political and economic consequences. On the other hand, proper performance of each component of transportation network depends on the efficiency of other components. For example, the collapse of a bridge disrupts all its related routes kilometers away or even damage to traffic control equipment such as traffic lights will reduce the efficiency of traffic flow at intersections. Therefore, the damage on each component has a profound impact on the overall efficiency of the network.

The purpose of the present research is to identify Kerman's emergency routes and determine vulnerability rate of them in order to identify and prioritize decisive factors in an assessment of Kerman's disaster management infrastructure. Then, based on available data and analysis of them by GIS and Fuzzy Logic, the primary and secondary emergency routes are identified so that they can be used for disaster management in case of emergency.

Methodology

In this research, regarding the views of experts in National Disaster Management Organization, the parameters effective on the assessment of emergency routes of Kerman are population density, open empty space, width of ways, and number of floors. Preliminary data collection of the research was conducted through library method and field survey. To prepare vulnerability maps of roads and determine transportation network of emergency routes, SDM Fuzzy extension was used in ArcGIS. Hence, using this software it is attempted to access and respond to the main objectives of this research.

After identifying all the layers of information and preparation of effective factors in locating the stations, it is necessary to prepare factor maps of each layer. Preparation of map factors is

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consisted of two stages of processing and weighting of information layers. In weighting stage, based on the relative effectiveness in identification and assessment of vulnerability of emergency routes, each factor is weighted by Fuzzy Logic. In every fuzzy factor map, the value of each class and location unit is shown by different levels of fuzzy membership between zero and one. In order to provide fuzzy factor maps in this research, according to the definition of linear membership functions and regarding the positive and negative effects of each parameter and the criteria, ArcGIS have been used.

Results and Discussion

The factors to identify the vulnerability emergency routes include width of ways, population density, number of floors, and open empty spaces. Thus, each factor was analyzed using Fuzzy Logic and its final map was produced.

Width of ways: based on the studies conducted, a way must be more than fifteen meters in width to be used as an emergency route.

Number of floors: the less the number of building floors in a city is, the less vulnerability rate. As the degree of walled area (low height-to-width ratio buildings approach) increases, the possibility of closing routes will raise. Therefore, debris and rubble can block streets. This can make rescue operations suspended.

Population density: each part of a city that has a high congestion of population is more prone to population density and traffic congestion in case of crisis. Therefore, choosing emergency routes which are not placed in a congested area is a matter of importance.

Open empty space: in choosing the emergency transportation network, level 1 emergency routes and enough space for storage of humanitarian aid are really necessary. The fewer is the congestion of buildings, the more empty spaces available in the city.

Kerman road map of vulnerability based on fuzzy membership is divided into groups 0.9 fuzzy membership, very low vulnerability (green points), 0.7 fuzzy membership, low vulnerability (blue points), 0.5 fuzzy membership, medium vulnerability (purple points), 0.3 fuzzy membership high vulnerability (orange points), 0.1 fuzzy membership, very high vulnerability (red points).

According to the map, Jomhouri Boulevard, Ayatollah Sadoughi, Joupari Ring Road, Ekhtiar-Abad Old Road, 22 Bahman Boulevard, Imam Khomeini Highways, Daneshgah Boulevard, Mahan Road, and Kouhpayeh Road always have a very low vulnerability. Seyyedi Boulevard, Qods Boulevard, Resalat Boulevard, and Mehr Street have a low vulnerability. Shohada Avenue, Hejab Boulevard, the end of Jahad Avenue, Hamzeh Boulevard, Shiraz Boulevard, Shahid Mostafa Khomeini Avenue, Mehr Avenue, and Bastani Parizi Street have a medium vulnerability. Sarbaz Avenue, Jahad Boulevard, Shahid Beheshti Avenue, and Imam Jom'e Street have a high vulnerability, and Imam Hossein Boulevard, part of Jahad Avenue, and 24 Azar Avenue have a very high vulnerability.

Conclusion

The results reveal that among the four factors mentioned above, the width of ways has the highest weight and open empty space has the lowest weight. Moreover, in order of preference, each factor has been studied as the most important factors affecting identification and assessment of emergency routes. According to the prepared vulnerability map, the level 1 emergency ways includes ring roads that have appropriate width and a lot of empty spaces and low population density in the vicinity which are the best ways to connect fast-network suburban transportation. Jomhouri Boulevard and Ayatollah Sadoughi which also have proper width and low distance from the airport, railway and exit of Kerman to Shiraz, Tehran, and most of other major cities are considered as level 1 emergency routes. Other main streets are also given the vulnerability and possibility of connecting with outreach centers (Red Crescent, hospitals, fire stations, and security centers have been chosen as level 2 emergencies).

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