Evaluation of seismic vulnerability spectrum of cities based on various intensity scenarios using μd, TOPSIS, and GIS Models (Case study of Yazd)

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Introduction

Vulnerability is a term used to show the amount and extent of damage and the losses caused by natural disasters in different communities (social, formal-physical, etc.). Vulnerabilities is identified as the sensitivity of the environment against the hazards. From among natural disasters, earthquakes can have a vast scope of losses for desert regions. Therefore, in order to reduce and prevent further damage, it is necessary to study its different aspects. The present study which is a developmental-practical using descriptive-analytic method examines the issue in Yazd. Since the seismic predictions based on statistical methods can provide satisfactory results, this study uses quantitative models μd, TOPSIS and GIS models, and Excel and SPSS Software to address the problem. Also, in order to reduce the error rate and to provide more accurate forecasts, 50 social-formal indicators variables were involved in the analysis and evaluation of data. The results of the μd model show that building damage from the earthquakes of up to 5 Merkali almost have no or very little damage. However, if earthquake intensity is more than 7 on the Richter scale, more than 50% of buildings are earthquake-vulnerable in the zone 2. And in the TOPSIS model, Social Vulnerability average in districts 0.412% which zone 2 and 1 with respective TOPSIS of 0.642 and 0.183 had the highest and lowest social vulnerability against earthquake in Yazd.

Earthquakes have long been among the most dangerous natural disasters and always have the highest risks. Earthquake risk is the expected loss through which environmental damages are incurred to the society and environment. In other words, risk is a combination of danger and vulnerability; and since vulnerability may be as diverse as human, functional, social, financial vulnerability or a combination of these, to estimate the risk requires a comprehensive approach. Accordingly, the present research by focusing on the vulnerability of the city against earthquake and using statistical and quantitative models investigate the issue to help organisations involved in preventing and controlling social and natural disasters have the ability to reduce and manage such possible dangers.

Material and Methods

This study is a developmental-practical investigation. It employs combination of descriptive, documentary and analytic documents. Statistical population comprises 50 neighbourhoods in 3 districts of Yazd. 50 variables, including social-physical indicators have been used utilising quantitative and statistical models to rank seismic vulnerability of the districts.
Study Area

Yazd with geographic coordinates 54 degrees, 22 minutes east longitude and 31 degrees, 53 minutes north latitude is the largest historical unit and the administrative Center in the province of Yazd. The average altitude of the city is 1230 meters above sea level. The population growth in Yazd has always been faster than other areas of the province. This has made the population be more than other townships and the whole province. In a single 60 year period (1946-2006), the population grew from 6352 to 194000.

Within the city there is only one known fault. 3 km North East of Yazd, there are deposits of marl and chalk and salt Neogene sandstones and conglomerates with northwest-southeast orientation along the fault. The fault is 47 km of pressure kind. Located in the central position of Iran's regional tectonic, it inherits most tectonic features of other sites.

Geographical location of the area has made the region one of the focal points of tectonic activity one the one hand, and various tectonic quakes with various severity of erosion and sedimentation processes on the other hand.

Results and Discussion

According to the logic of TOPSIS Model provided calculations, district 2 had the second lowest distance with the positive ideal and the maximum distance with the negative ideal. And district one had the farthest distance to the positive ideal and the lowest distance with the negative ideal.

According to the model which determines the average seismic injuries and damage:

District 2 with the highest density of 50% and district 3 with 32% have the lowest population density. Therefore, for this indicator, district 2 is the most vulnerable in terms of social damage. In the case of the socially vulnerable earthquake zone, the area between the city of Yazd.

In low-risk group that is group aged less than 14 years, district 3 with 29% had the highest and district 1 with the lowest rate, about 23%, had the lowest risk.

Regarding road network vulnerability index, district 2 with about 46 and district 1 with 18%, had the maximum and minimum vulnerability, respectively.

In addition, building damage in the earthquake of up to 5 Merkali had almost no or very little damage. However, if earthquake intensity is more than 7 on the Richter scale, more than 50% of buildings are earthquake-vulnerable in the zone 2. And in the TOPSIS model, Social Vulnerability average in districts 0.412% which zone 2 and 1 with respective TOPSIS of 0.642 and 0.183 had the highest and lowest social vulnerability against earthquake in Yazd.

Conclusion

Due to the necessity of the issue and regarding the conducted investigations, it was determined that structural damage in the earthquake of up to 5 Merkali are almost no or very little. And even if reached to a seismic intensity of 6 Merkali only about two percent of district 2 are damaged. However, if earthquake intensity is more than 7 on the Richter scale, more than 50% of buildings are earthquake-vulnerable in the zone 2. Therefore, this area of the city has the highest vulnerability to earthquakes. Also Structural damage is district 3 is less than 40% and less than 20% in district one. Statistically, the obtained TOPSIS in the district 1 is 0.83%, in district 2 is 0.642%, and in district 3 is 0.411%. Thus, district 1 and 2 in Yazd are the most vulnerable and the most resistant, respectively, against earthquake in terms of social damage.

Key Words: Damage, earthquake, model and technique, μd, TOPSIS, GIS, Yazd.
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