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Assessing the vulnerability of residential lands against earthquakes and ways to reduce vulnerability using spatial analysis: Case study of Tabriz city

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Abstract

Earthquakes are known as one of the most important and dangerous natural hazards in earthquake-affected areas and can lead to severe physical, economic and social damage in cities. Based on the information and data collected about Tabriz city, this article evaluates the vulnerability of urban uses against earthquake risk. The current research was carried out with a descriptive-analytical method and by using the GIS environment as well as the zoning of earthquake-prone areas, an appropriate estimate of the vulnerability of residential uses in Tabriz city was made using spatial and descriptive data. Based on the analysis of spatial data, the residential lands near the faults were examined, and by using appropriate methods, weak points and high-vulnerability uses are identified. Then, solutions to improve and strengthen urban uses are provided and suggestions are provided to reduce vulnerability and increase resistance against earthquakes. The results showed that a significant percentage of Tabriz city is in high and very high vulnerability classes. According to the seismic vulnerability zoning of the city and the distribution of vulnerable classes in Tabriz city, it can be concluded that most of the area is vulnerable to earthquakes.

1. Introduction

Earthquakes are considered as one of the powerful natural phenomena that threaten the safety and health of humans and the environment. Due to dense population, structure of buildings, complex infrastructure and economic and social sensitivities, cities are considered as very sensitive places against earthquakes, especially in densely populated areas like Tabriz city. The purpose of this article is to investigate and evaluate the vulnerability of residential use in Tabriz city against earthquakes. Vulnerability of residential use refers to the vulnerability of different sectors. This evaluation identifies the weaknesses and strengths of the existing systems and can be used as solutions to increase the security and resistance of the city against earthquakes. To do this evaluation, analytical methods are used in this article. At first, the city of Tabriz is studied completely and (buildings) are examined. Then, using (spatial data analysis such as: identifying the location of faults and earthquake-prone points in the GIS environment) the vulnerability of residential use is evaluated. The purpose of assessing the vulnerability of residential use is to identify and evaluate the weak points of different parts of the city against earthquakes. This assessment can help city managers, urban planners and relevant organizations to take measures to increase the city's resistance and security against earthquakes. Also, the results of this evaluation can be used as a way to increase public awareness and educate people about appropriate behaviors in case of an earthquake. Finally, this article provides suggestions and solutions to improve the vulnerability of urban use against earthquakes. These suggestions can include strengthening buildings, improving infrastructure, improving telecommunication networks, equipping public places with safety equipment and earthquake training. By implementing these suggestions, the vulnerability of urban use against earthquakes will be reduced and the city of Tabriz can be improved in facing future earthquakes. In the end, this article refers to related sources and studies in the field of urban use vulnerability assessment and earthquake risk management. And it can be used as a basis for future research in this field.

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2. Method

According to the purpose of the study, the type of research is based on descriptive-analytical method. Argument has been used in document review and library study and then using the extracted principles in presenting the proposed method and checking the studied area based on it. For the division of the earthquake zone, the multring buffer tool is used to obtain information. Vulnerability from the tabulate intersection tool and also to generate vulnerability maps, this software is also used.

2.1.Theoretical

Earthquake means strong shaking of the earth (Dakhkhoda dictionary), which usually causes the earth to break under the pressure. This rupture fluctuates from a few millimeters to tens of meters, and the released energy is released from the rock and becomes terrestrial. These are ruptures (Ebrahimzadeh et al., 2015). Earthquake as a natural hazard has a direct and indirect impact on the society and is considered as an important challenge in the development process (Johnson, 2004).

Vulnerability is a situation that begins in historical, cultural, social processes that use them and limit the response of individuals and groups to crisis. This view sees vulnerability as "a product of characteristics such as: race, religion, social base, gender, age that affect access to power and resources" (Winsor, Blahi, Cannon, & Davis, 2004) and harm Acceptability is somehow related to social and economic status

2.1 Understanding the study area

The city of Tabriz with a population of 1 million 693 thousand 42 people is bounded from the north by Warzghan city, from the south by Maragheh city, from the east by Haris and Bostan Abad cities, from the west by Esko city and northwest by Shabstar city. The area of Tabriz city is approximately 1781 square kilometers. This city is located at 46.25 east longitude and 38.2 north latitude from the Greenwich Peninsula and its approximate altitude varies from 1300 to 2100 meters above sea level.

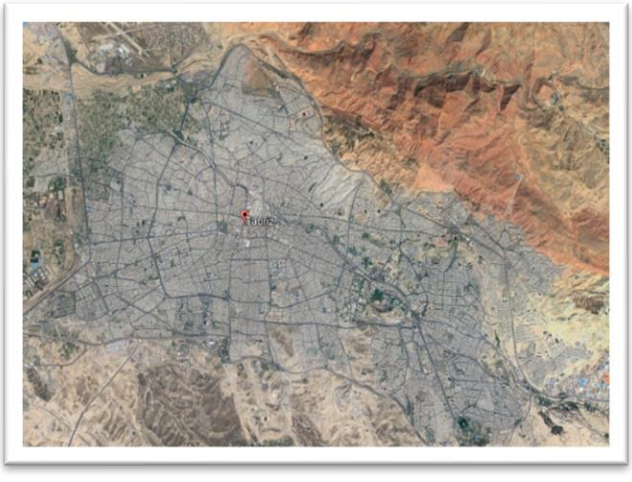

Figure 1. Map of the study area

2.1. Fault range

The Tabriz fault is one of the linear structures of Iran, which can be traced with a length of 100 km from Misho mountains (in the west) to Bostanabad (in the east). The best effect of this fault can be seen in the north of Tabriz and that is why it is named Tabriz fault. Its general trend is north of 115 degrees east and its slope is vertical. From Sufiyan to the west, this fault passes through Khoi city towards Mako and then reaches the Ararat mountains in Turkey. Its southeastern continuation is the Soltanieh Mountains in southeastern Zanjan, which may reach the Qom-Zafrah fault.

North Tabriz fault is one of the old faults of Iran, which passes through Zanjan_Abhar depression, north of Tabriz and northwest of Azerbaijan and continues to the Caucasus. During the previous Devonian, this fault divides the Azerbaijan region into two blocks. The northeastern block has sunk and the southwestern block has been underground until the end of the Carboniferous; Therefore, the activity of this fault may have started from the Devonian period; Although its older age is probable.

Figure 2 shows the area of Tabriz fault as well as residential areas located in that area.

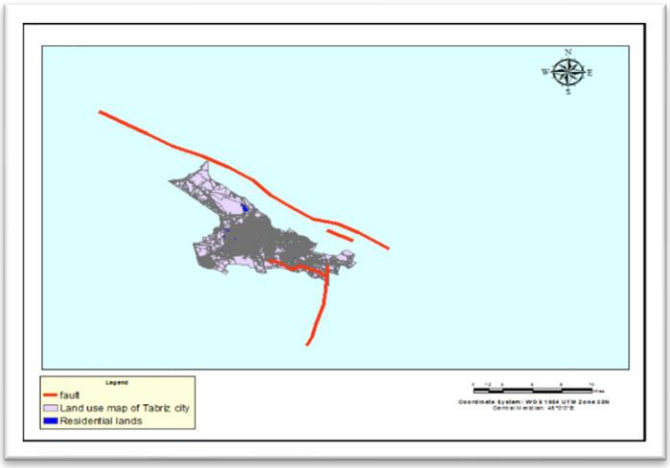

Figure 2. Fault map

3. Results

Based on the evaluation done, the residential lands located in the south of Tabriz city in the range of 300-500 meters from the South Tabriz fault (Figure 2) are more vulnerable. And in the northern fault of this city, the lands located at a distance of 5 kilometers are more vulnerable.

The lands in the western and southwestern parts, which are located at a distance of 10-15 km from the fault, are relatively less vulnerable.

In the southeastern part of the lands that are located at a distance of 500 meters and 1 kilometer from the fault, they are exposed to medium and high vulnerability. The central part is also very vulnerable.

As it is clear in Figure 3, the northern fault has the greatest potential risk on buildings, so engineers and relevant authorities should pay more attention to this area in terms of retrofitting. Lands that are in the danger zone of the fault line should be placed on resistant formations. . As the evidence of historical earthquakes shows, the relative resistance of the earth has never

shown adequate tolerance against destructive earthquake waves (Rustaei, 2010).

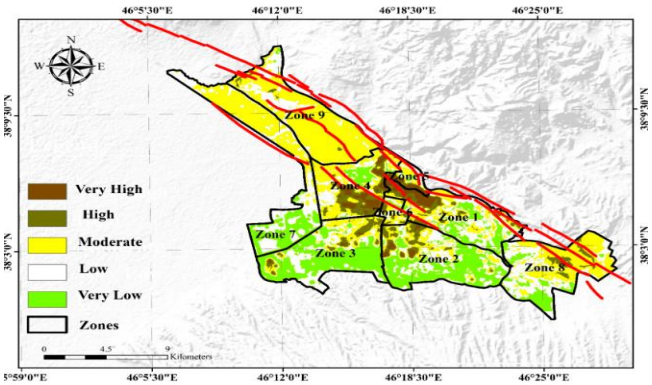

Figure 3. Earthquake line zoning map

4. Discussion

Planning solutions aimed at reducing vulnerability:

First step: Identifying vulnerable areas and vulnerability indicators

The second stage: creating complete information about buildings and how they resist earthquakes and using the collected information in order to strengthen the city and manage the crisis.

The third step: drawing a map of vulnerability to earthquakes as a tool for prevention planning

The fourth stage: conducting extensive studies regarding the reduction of earthquake risk and damage, in various fields such as: economic, social, physical studies, etc.

The fifth stage: continuous monitoring of the relevant officials, especially the municipality, on the way of construction and development of the city to prevent the continuation of the process of building the vulnerability of the city.

The sixth stage: the strength of the social structures of the society is an important step in reducing vulnerability; Because when an earthquake occurs, the weak performance of social organization in formal and informal societies increases the level of vulnerability.

The seventh stage: providing legal facilities; Such as residential loans, giving loans for renovations, strengthening houses, etc.

5. Conclusion

The assessment is for Tabriz city. It includes areas with very high, high, medium, low, very low and no risk. It can be seen from the assessment in Figure (3) that most of the residential lands in the north of Tabriz are in the area with the danger is high. Bagh Misheh town and Valiasr area are in the dangerous ring in terms of faults. Bagh Misheh town is located on a fault system. The greatest possible danger comes from the movement of faults. Therefore, civil engineers should pay attention to this point. The results of spatial vulnerability assessment using spatial data analysis in GIS environment showed that a significant percentage of residential lands and neighborhoods in Tabriz city are in high and very high vulnerability class. Even the parts that are within 10 kilometers of Baghsal are at moderate risk. According to the vulnerability zoning of Tabriz city, it can be concluded that most of the residential lands of this city are vulnerable to earthquakes.

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