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Vulnerability assessment and zoning of natural geomorphological hazards of Kermanshah province(Case Study: Flood and Earthquake)

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Abstract

Accidents that occur suddenly and cause damage to humans and the environment are known as natural hazards. These risks, due to their unexpected nature, in most cases cause a lot of financial and human losses. Among natural hazards, earthquakes and landslides are among the most devastating hazards. These hazards are more severe and harmful in urban communities due to greater population concentration. Therefore, identifying areas that are more vulnerable to natural hazards can be effective in planning to reduce the effects of these disasters. The present study aims to zoning vulnerability to natural hazards of landslides and earthquakes. Applied research and its method is descriptive-analytical; The required statistics and information have been collected through library studies and remote sensing data. Findings show that in the zoning of Kermanshah province in relation to fault lines and rivers, relatively high altitude and high slope, the central parts of the province have a high potential for flooding and vulnerability to natural earthquake risk. Which is one of the most important parts of this area of Kermanshah city as the center of the province

Keywords: Environmental hazards - Kermanshah province - Flood – Earthquak

Introduction

One of the issues that most cities in the world are dealing with is natural disasters (Alexander, 2002: 38). Natural hazards with different types and extent of their influence, as recurring and destructive phenomena, have always existed throughout the life of the earth and have always been a serious danger to humans since the creation of man (Pourtaheri, 1390: 32) . Natural disasters are devastating and sudden events that can happen in the world at any moment and result in major human and financial losses. Its consequences may be long-term and even irreversible (Rajabi et al., Quoting Ardehan, 1397: 184). Occurrence of natural hazards leads to changes in environmental conditions, which in turn leads to disruption of normal life and destructive effects on their settlements, and extensive economic, social and environmental damage. Imposes a burden on communities (wisner et al, 2008: 10). Due to the physical expansion and increase in density of large cities, in case of crisis, a dangerous situation is created, because the non-observance of the hierarchy of communication networks, narrow roads and distance from service and treatment centers in crisis areas at the time of accidents It becomes problematic, so the relationship between urbanization and environmental impacts in recent studies attracts more attention (Torabi, 2009: 2). The major part of natural hazards related to geomorphological processes is due to geomorphological, hydrological and atmospheric hazards (Omidvar, 1390: 17). Knowledge of geomorphology The problem of spatial analysis of terrestrial hazards in this study including hazards such as earthquakes; Flood and landslide is considered and explains and evaluates the potential risk and the degree and degree of vulnerability of humans living in these areas (Motamedinia, 1390). Although the above-mentioned geomorphological hazards have the behavior and characteristics of individual hazards, but the occurrence of each of them in the environmental zone is mainly the source and cause of the occurrence and coexistence of another hazard. For example, an earthquake can act as a trigger for a landslide. Many passive landslides are reactivated at the time of the earthquake and in some cases deepen and expand the disaster. For example, in the June 2004 earthquake in the Marzanabad region (Firoozabad Kojoor earthquake) major damage. The death was caused by the activation of a landslide (fall rock) on the Tehran-Chalous axis (sharifikia, 2007). Obviously, if there is no proper scientific and practical management in dealing with natural hazards, damages The human result from them will be many times more (Azizpour, 1390: 112). Kermanshah province is in a sensitive situation due to special features from different aspects, such as tectonic and geological aspects (location between the Great Zagros Fault), geomorphological (existence of slopes with a steep slope, Altitude difference of more than 2000 meters in Kermanshah city and in Paravo mountains and Kermanshah plain) and population (population changes as well as its increase due to the use of resources and increasing the level of sensitivity). Any planning without knowing the sensitivities and characteristics of the region will have destructive and irreparable consequences. Especially that the event of any phenomenon most likely causes the intensification or initiation of another natural hazard activity (Kheiri, 2009: 18).

Theoretical Foundations

Risks are defined by the process of human interaction with the environment, otherwise the phenomena we risk are part of the normal behavior of nature. A process that has dominated geography since ancient times and perhaps since the domination of environmental algebra, and according to many geographers is the main axis of geographical activities. The process of human relationship with the environment for the main subject of geography flourished in the time of Humboldt and, then, found many ups and downs throughout history (Alijani, 1393: 2). Ratzel formulated this view, and in Europe, people like Vidal Dolablash advocated it. In the United States, too, individuals such as Davis and Huntington developed this view and provided the basis for environmental algebra or geographical factor, in response to which Savar introduced the concept of perspective and Burroughs introduced the concept of human ecology (Mathews and Herbert, 2004).). Environmental hazards are the result of improper human performance or exploitation of the environment. Identification and analysis of these hazards in the field of geography in two ways. First, the relationship between man and the environment is one of the main fields of study of geography (Harvey, 1969: 115). Second, hazards occur in place and place is the realm of geographical domination. As a result, the relationship between man and the environment is spatial in nature (Balteanu and Dogaru, 2011). Geographical research on natural hazards has a long history, beginning with a focus on physical processes and evolving as knowledge of physical and human interaction increases (Motz, 2011: 1). In fact, natural disasters are considered dangerous when humans are affected or affected by them (Ozzy, 1390: 18). Experiences of developing countries In this context, it indicates that they are more vulnerable to environmental hazards. So that the occurrence of 11 natural hazards during the 20th century has caused losses of about 631 billion dollars, most of which have been in developing countries (Pourtaheri, 1390: 33). Cities as a gathering place for human population are no exception to the occurrence of these natural disasters and it is necessary to find a solution to reduce the vulnerability of these settlements to natural hazards (Qanooti, 1388: 17). Among these, the three phenomena of earthquake, flood and landslide are among the most destructive of these events. The seismicity of an area is considered a serious danger (Yamani and Moradpour, 1392: 16). This issue is of special importance in Iran due to its location in the Alpine-Himalayan fault belt (Sasanpour, 2010: 29). Slip phenomenon is one of the natural hazards that the annual fog leaves a lot of human and financial losses in mountainous areas with slip-sensitive sedimentary formations (Masfaei, 2010: 2). Landslides alone account for 17% of the world's natural disasters and the death rate from this phenomenon varies in different parts of the world (Niazi, 1389: 9). Meanwhile, Iran has suffered from many crises due to its set of human and environmental characteristics and is one of the countries vulnerable to natural hazards (Rokn al-Din Eftekhari, 2008: 30). Identification and classification of areas with potential risk of such natural hazards is very important, and is effective for proper crisis management (Talei, 1390: 84). Therefore, if scientific and practical management is not appropriate in dealing with unforeseen events, the human damages caused by these disasters will be several times higher (Azizpour, 1390: 112).

Introduction of the study area

Kermanshah province with an area of 24434.25 square kilometers is the seventeenth province in Iran in terms of area. Complete geographical coordinates of Kermanshah province on the planet from longitude 45 degrees and 20 minutes and 39 seconds east to 48 degrees and 1 minute and 58 seconds east and from latitude 33 degrees and 37 minutes and 8 seconds north to 35 degrees and 17 minutes And is 8 seconds north. According to the latest changes in 1390, Kermanshah province consists of 14 cities, 31 cities, 31 districts and 84 villages (Nouri and Taghizadeh, 1390). Also, according to statistics published by the Statistics Organization of Iran in 2016, Zain province has a population of 1952,000 (Statistics Center of Iran, 2016)

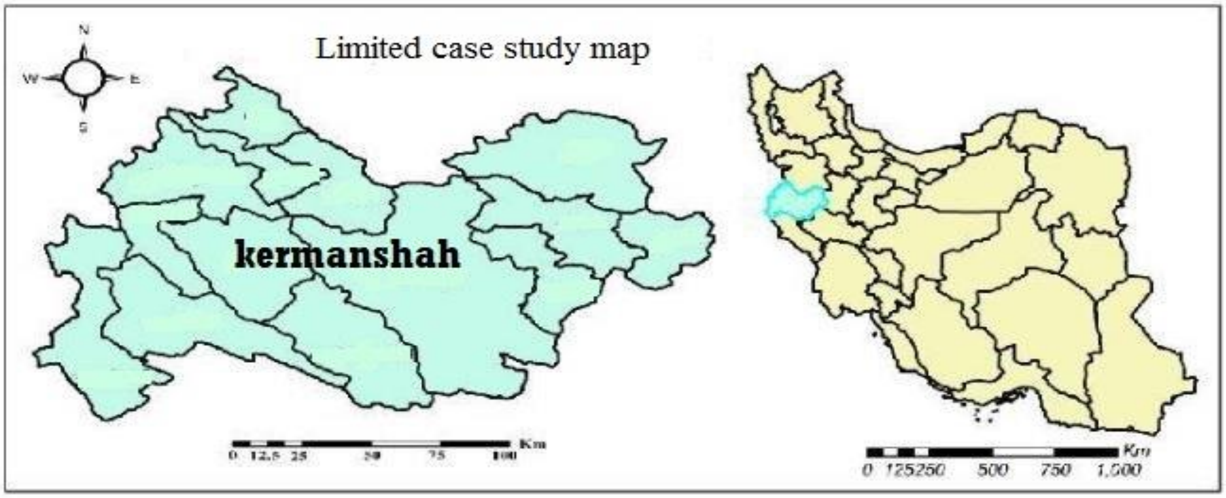

Figure (1): Limited case study Source: Author's drawing, 1397

research method

Various tools and methods have been used to achieve the objectives of the research; The first step includes research tools

• Digital elevation model (DEM) in order to provide slope layers, slope direction and height of the study area

• Vector file of waterways, canals, rivers and soil type, vegetation, geological status, distance from fault, distance from the main arteries of the province and land type.

In the next step, the weights and ranking values were assigned to the layers and classes of each layer. The process of assigning weight and ranked values was formed using the Fuzzy Ahp method. FAHP is a multi-criteria decision-making approach that uses a pairwise comparison procedure to achieve the desired goals among multiple options.

[1].Larhorn & Pedricz
FAHP Hierarchical Analysis Model

This model was first proposed in 1983 by two Dutch researchers named Larhorn and Pedriks, which was based on the logarithmic least squares method, but was not accepted due to the complexity of the computational and methodological steps, until in 1996 a Chinese researcher Chang called a method called development analysis method based on dynasty analysis Presented a fuzzy hierarchy in which triangular fuzzy numbers were used to calculate [16]. The fuzzy numbers used in this model and specifically in the present study are triangular fuzzy numbers that will be M = (m, α, β) [17]. The geometric space of such a set in a fuzzy environment is given in Figure (3).

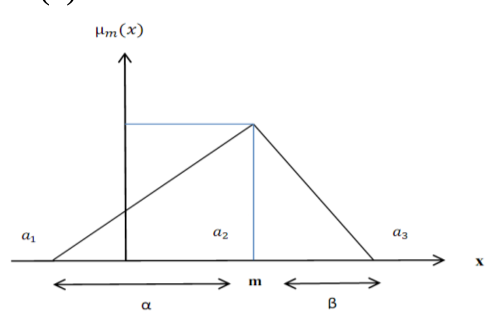

Figure 3: Triangle number membership function in fuzzy environment

The mathematical structure of the membership of triangular fuzzy numbers will also be as follows.

$$\begin{Bmatrix} 1-\frac{m-x}{\alpha}, & m-\alpha \le x \le m \\ 1-\frac{x-m}{\beta}, & m \le x \le m+\beta \end{Bmatrix}$$

Therefore, according to Chang method, the fuzzy hierarchical analysis model has the following steps:

Step 1: In this step, a hierarchical diagram is drawn.

Step 2: In the second step, fuzzy numbers are defined for pairwise comparisons. Based on the studies that have been done in this regard and also the recommendation that Chang offers, the fuzzy spectrum used in this research is presented in the form of Figure (4).

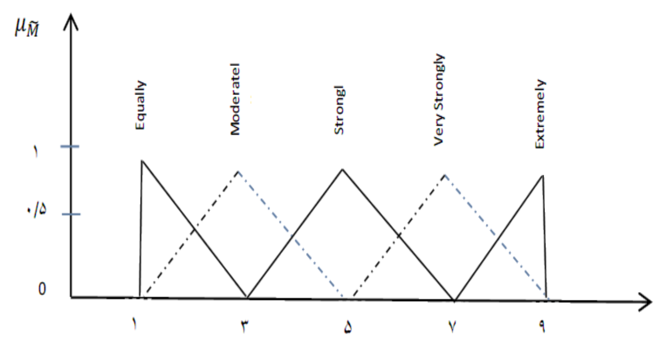

Figure 4: Linguistic variables used in the research

[1].Triangular Fuzzy Number

Step 3: The formation of the matrix will be a pairwise comparison that has been done using triangular fuzzy numbers in the present study.

$$\tilde{A} = \begin{bmatrix} \tilde{x}_{11}\tilde{x}_{12} & \dots & \tilde{x}_{1n} \\ \tilde{x}_{21}\tilde{x}_{22} & \dots & \tilde{x}_{2n} \\ \dots \quad \dots & \dots & \dots \\ \tilde{x}_{m1}\tilde{x}_{m2} & \dots & \tilde{x}_{mn} \end{bmatrix}$$

$$S_i = \sum_{i=1}^{m} M_{gi}^{i} \otimes \left[\sum_{i=1}^{n}\sum_{i=1}^{m} M_{gi}^{i}\right]^{-1}$$

$$\sum_{i=1}^{n}\sum_{i=1}^{m} M_{gi}^{i} = \left(\sum_{i=1}^{n} l_i , \sum_{i=1}^{n} m_i , \sum_{i=1}^{n} u_i\right)$$

$$\left[\sum_{i=1}^{n}\sum_{i=1}^{m} M_{gi}^{i}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} l_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} u_i}\right)$$

In this relation, i will be the row number and j will be the column number

Step 5: Calculate the degree of magnitude of S_i for all indices in which the magnitude of the two fuzzy numbers S_1 = (l_1, m_1,u_1) and S_1 = (l_2, m_2, u_2) is defined as follows:

$$\begin{Bmatrix} 1 & m_1 \geq \quad m_2 \\ 0 \text{اگر} u_2 \geq \quad l_1 & \\ \dfrac{l_2 - u_1}{(m_1 - u_1) - (m_2 - l_2)} & \end{Bmatrix}$$

Step 6: In this model, calculating the weight of the indicators in the matrix will be a pairwise comparison. The following relationship has been used for this purpose:

$$d'(A_i) = \text{Min } V(S_i \leq S_k) \quad k = 1,2, \ldots , n$$

Therefore, the non-normalized weight vector for the research indicators will be as follows:

$$W'(d'(A_1), d(A_2), \ldots , d(A_n))^T$$

Final step: In this model, the calculation of the final weight vector will be:

$$W = \left(d\left(A_1\right), \ d\left(A_2\right), \ \ldots, \ d\left(A_n\right)\right)$$

Research Findings

Investigation of earthquake risk areas

The faults of the province are in the form of small and large fractures in most of the northern, northeastern, western and central parts of the province. Fault risk-taking shows that the risk of faults in these areas is higher. One of the parameters determining the risk of faults is the distance dimension, which at the time of activity and occurrence of the earthquake, the inverse ratio in intensity and risk has it. Therefore, the distance dimension was considered as one of the factors affecting earthquake hazards for urban settlements. Finally, using other parameters affecting vulnerability to natural hazards (earthquake), the vulnerabilities of the province were identified.

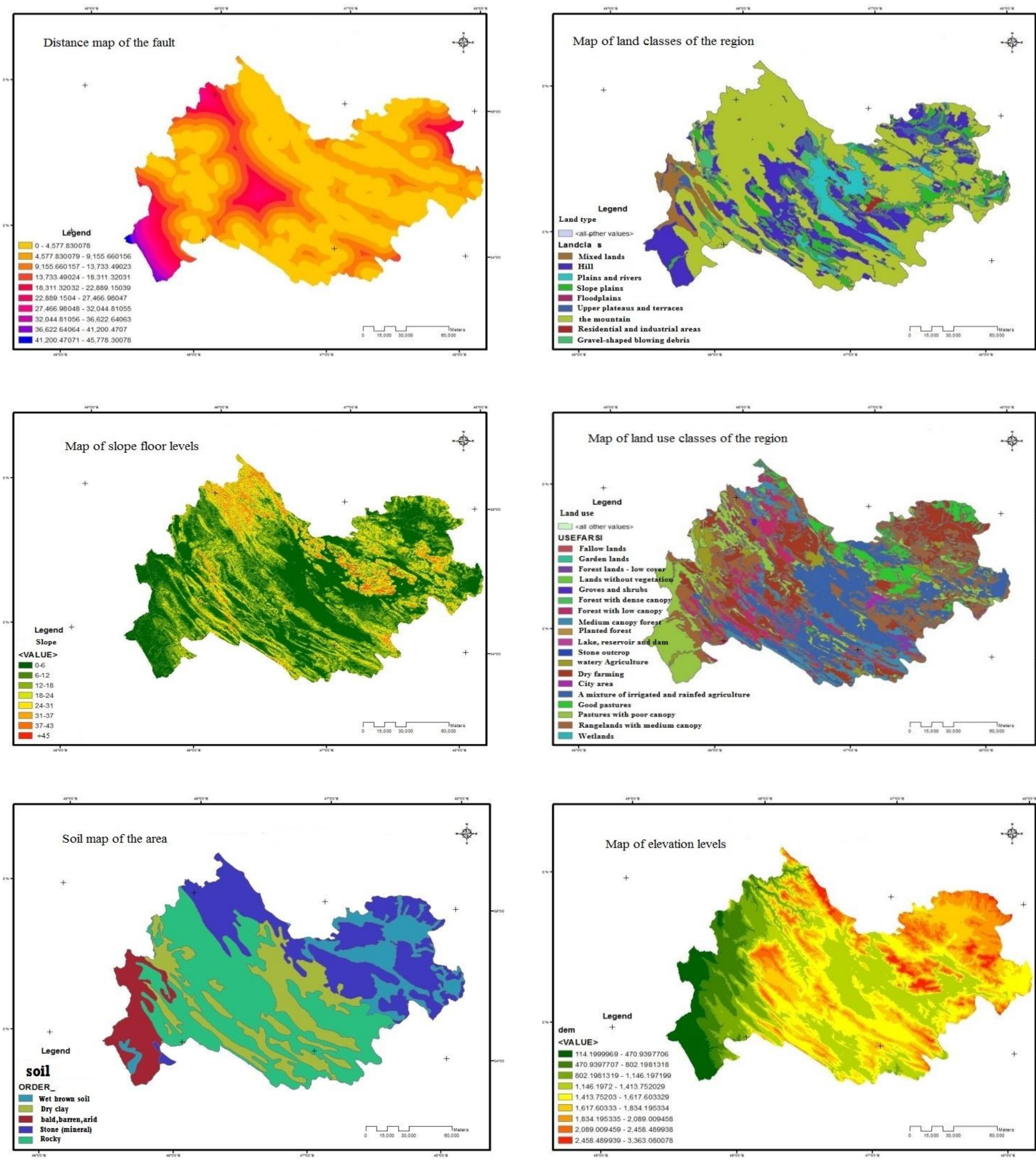

Figure 2) From right to left of the map (height, distance from fault, type of land use, soil type, vegetation and land type)

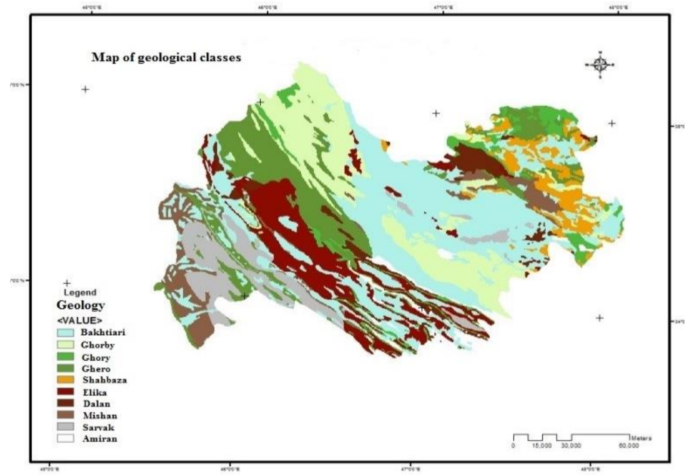

Figure 3) Geological status of the study area Source: Writers drawing, 1397

Source: Writers drawing, 1397

In the next step, to determine the earthquake-vulnerable areas, the mentioned layers were weighed by FAHP model. In this model, after weighting the research variables in the form of trigonometric fuzzy numbers, the variables were identified with different weights from minimum weight to maximum weight, which can be seen in the following tables.

Table 1: Relative weight of layers for earthquake risk zoning

(V1)	(V2)	(V3)	(V4)	(V5)	(V6)	(V7)
HEIGHT	V2	V3	V4	V5	V6	V7
	1	0.87	4	0.57	0.93	0.87
SLOPE	V1	V3	V4	V5	V6	V7
	0.8	0.63	0.96	0.382	0.73	0.64
LAND TYPE	V1	V2	V4	V5	V6	V7
	1	1	1	0.32	1	1
SOIL TYPE	V1	V2	V3	V5	V6	V7
	0.85	1	0.7	0.82	0.79	0.74
TYPE OF LAND USE	V1	V2	V3	V4	V6	V7
	1	1	1	1	1	1
DISTANCE FROM THE FAULT	V1	V2	V3	V4	V5	V7
	1	1	0.92	1	0.53	0.92
GENDER OF THE EARTH	V1	V2	V3	V4	V5	V6
	1	1	0.99	1	0.64	1

Source: Authors' calculations, 1397

Table 2: Final weight of layers for earthquake zoning

Normalized weight	Abnormal weight	Options
0/146	0/57	Height
0/136	0/53	Slope
0/097	0/38	Type of land use
0/082	0/32	Soil type
0/164	0/64	Type of land use
0/257	1	Distance from the fault
0/190	0/74	Gender of the earth

Source: Authors' calculations, 1397

Then, after weighting the variables in the form of weights in Table (2), the final overlap layer was prepared, for which the Weighted Overlay analytical box in the form of Arc GIS software was used.

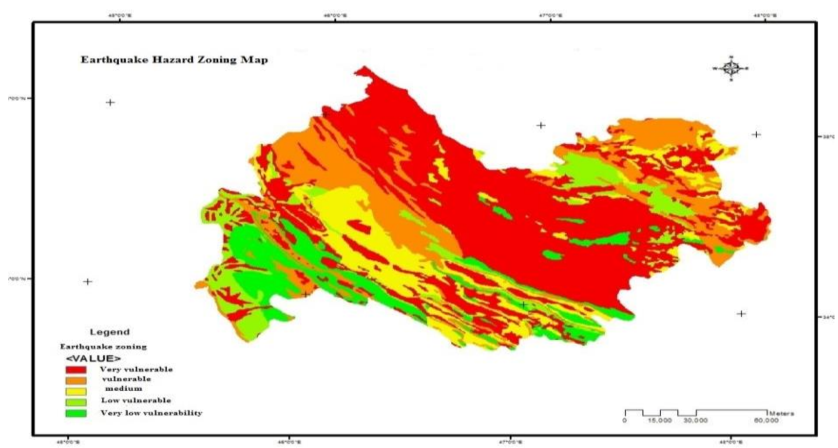

Figure 4: Earthquake vulnerabilities Source: Writers drawing, 1397

According to the map obtained from the zoning of effective indicators on earthquake vulnerability in the study area, cities that are less distant from active faults have a high potential for earthquake vulnerability, in fact, the results of Figure 4 It shows that the northern and central areas of the province, which have been built and developed along fault lines, will not be safe in the event of strong earthquakes. Due to the fact that most of the population of the province has settled in this area and also the center of the province is in this area, in case of an accident, this city will face many problems.

Investigate flood risk areas

Kermanshah province has always been one of the flood-prone provinces of the country due to its topographic situation and special geological and climatic conditions.

Therefore, in the present study, an attempt has been made to determine the vulnerable points against possible floods by using layers (geology-vegetation, height, slope, distance from the river, type of land use and soil condition).

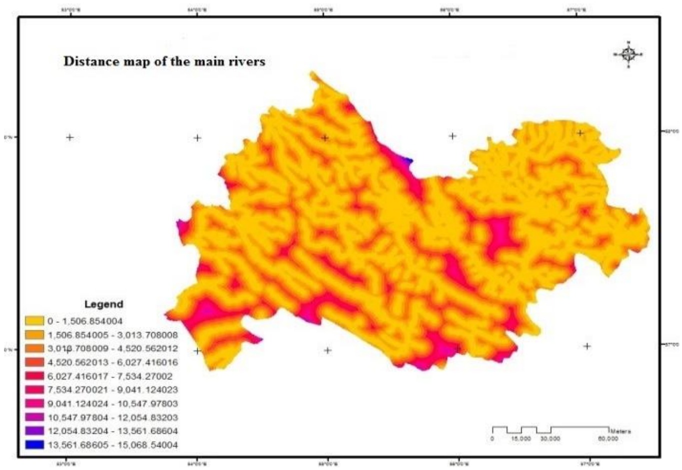

Figure 5) From right to left vegetation map and distance from main rivers

Source: Writers drawing, 1397

Following are the calculations of the FAHP model for weighting the proposed layers and extracting the final map as shown below:

Table 3: Relative weight of layers for flood risk zoning

(V1)	(V2)	(V3)	(V4)	(V5)	(V6)	(V7)
HEIGHT	V2	V3	V4	V5	V6	V7
	1	0.82	1	0.60	0.93	0.92
SLOPE	V1	V3	V4	V5	V6	V7
	0.8	0.70	0.89	0.38	0.70	0.67
GENDER OF THE EARTH	V1	V2	V4	V5	V6	V7
	1	1	1	0.32	1	1
SOIL TYPE	V1	V2	V3	V5	V6	V7
	0.85	0.93	0.7	0.89	0.79	0.75
TYPE OF LAND USE	V1	V2	V3	V4	V6	V7
	1	1	1	1	1	1
DISTANCE FROM THE RIVER	V1	V2	V3	V4	V5	V7
	1	1	0.97	0.95	0.60	0.85
VEGETATION	V1	V2	V3	V4	V5	V6

1	1	0.96	0.87	0.69	1

Source: Authors' calculations: 1397

Table 4: Final weight of layers for flood zoning

Normalized weight	**Abnormal weight**	**Options**
0/126	0/59	Height
0/120	0/56	Slope
0/135	0/63	Gender of the earth
0/105	0/49	Soil type
0/128	0/60	Type of land use
0/214	1	Distance from the river
0/168	0/79	Vegetation

Source: Authors' calculations: 1397

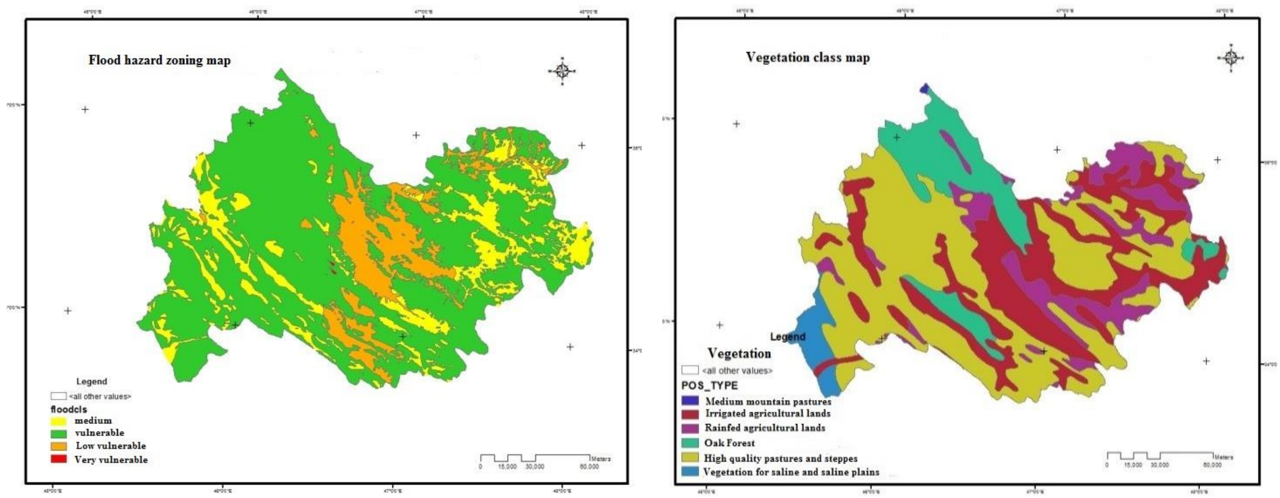

Figure 6) Flood vulnerable areas Source: Writers drawing, 1397

The study area is one of the flood-prone areas of the country due to its mountainous nature and climatic and geological conditions; This issue has caused several floods to occur annually in Kermanshah province. The study of the relationship between environmental factors and the location of urban settlements and finally the zoning of natural hazards in Kermanshah province shows that due to the existence of several permanent and seasonal streams as well as the existence of relatively high altitudes and slopes has a high potential for flooding. Therefore, as shown in Figure 6, a large area of the provincial capital has a high flood potential, which is due to the topographic and hydrological conditions of this area.

Conclusion

Natural hazards are threatening accidents that cause a lot of human and financial losses. These risks are unique It is not about time, but because of the social consequences that will plague the people of the region for years to come. At Such cases where the effects of natural hazards are manifested in human life are referred to as natural disasters. It becomes. Although the occurrence of these hazards prevents any immediate reaction from the victims, but in any case The probability of their occurrence is predictable. Natural hazards such as floods and earthquakes have certain geomorphological effects on the surface They create the earth and are themselves influenced by geomorphological forms and processes. Geomorphological factors of Such as weathering, river erosion, wind action, human performance, etc. are the source of the formation of some natural disasters such as Landslides, creeps, occurrence of sandstorms and so on. In the meantime, man and his human settlements as It is a geomorphological factor and is also considered as a major part of vulnerability (human vulnerability). Since the Urban settlements are more vulnerable due to large population concentrations, and the identification and zoning of urban settlements in relation to natural hazards is of great importance. In the present study, this issue was also addressed and the urban settlements of the province were studied in relation to the two natural hazards of flood and earthquake. The results show that in the process of locating and creating cities in the province, less attention has been paid to factors such as distance from fault lines and landslide points, and this causes a lot of insecurity and vulnerability in the event of natural disasters.

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