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OPTIMAL SITE SELECTION FOR TEMPORARY HOUSING AFTER AN EARTHQUAKE IN URBAN AREAS USING MULTIPLE CRITERIA DECISION MAKING METHODS AND GIS: A SAMPLE OF DUZCE IN TURKEY

Keywords: Earthquake, multi-criteria decision making, TOPSIS, Geographic Information System, Duzce

Abstract

It is an appropriate to choose site for temporary housing of the population that is affected by natural disasters. There have been among the issues that have been taken to the attention of organization and authorities responsible for crisis management. In Turkey, finding a location for temporary accommodation of citizens is usually introduced by aid agencies regardless of the standards and in an experimental manner after the occurrence. It is clear that inappropriate site selection could end in a disaster even worse than the initial phenomenon. Having discovering the site-selection criteria for temporary housing after a probable earthquake in district of Duzce, in the previous investigations we try to review the crisis management steps in an earthquake known area, and provide some guidelines for choosing suitable locations for temporary housing of people affected by earthquake in Duzce environments. In general, site selection and placement of temporary housing areas is a complex subject that is a function of multiple criteria and variables. Thus, given the technical properties of multi-criteria decision making (MCDM). It is known that making use of such methods to determine and measure the importance coefficients of criteria and indices effective in location of activities is regarded as one of the appropriate methods. Given the high construction and population density in the Duzce area, it is necessary to conduct accurate studies and planning to minimize the damage and injuries caused by natural disasters and cataclysmic events. Utilizing some indices and TOPSIS method, the present paper has been discussed the optimal site selection method for temporary housing areas in Duzce.

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1. Introduction

In terms of natural position, especially geological features, Turkey is placed on a primary folded belt and lies in the middle part of the belt between the Alps and Himalaya rugged and hilly areas [1]. Placed in arid and semi-arid climatic conditions, Turkey and particularly the cities in the area have become the most important hazard point for occurrence of natural hazards. Accordingly, Turkey is seen as one of the top 9 disaster-prone countries in the world. Events that could become critical in urban areas are: floods, earthquakes, sea-quake, etc., in general, natural hazards, technological crisis, political and ecological crisis [2]. Located on Alpine Himalayan seismic belt, Turkey has experienced about 100 earthquakes which measured 7.5 or higher on the Richter scale [3]. Given the geographical conditions, Turkey is constantly under threat by events such as earthquake. Man's efforts to deal with earthquakes have opened a door called "crisis management". Crisis management includes some measures following an earthquake, that largely limits the crisis range and makes it administrable. In other words, preparedness, crisis management and the way Turkey could deal with natural hazards and events are always among the major concern of officials, experts and investigations [4]. Thus, considering for prevention, preparedness and urban crisis management are placed at the focus of these communities. Municipal District of Duzce with an area of 10 Km² having almost 80,000 inhabitants in 2017 is one of the major districts of Duzce [5]. Taking concentration of foundations like ministries, higher education institutions, health care centers and public hospitals, large incorporations, etc., well implements the particular importance of the area from urban and state perspectives [6,7,8,9,10,11]. This, in its turn deals with paying due to attention to issues of crisis management. In the past few years, a significant number of studies regarded to temporary housing of people affected by earthquakes have found in the literature [12].

2. Study Area

Study area is just situated between Ankara and Istanbul; Ankara is 240km away to the East and Istanbul is 228km away to the West. The road of D100 passes through Duzce and TEM Highway passes around it. Duzce is placed into the plateau of The West Black sea coast. The city is surrounded to the West by Sakarya, to the Northeast by Zonguldak and to the East by Bolu. The distance from East to West is 23 km and from North to South is 20 km. The city of Duzce is situated in the middle of the plain on a pressure ridge-type hill and is probably tectonically controlled (Fig. 1).

Fig.1. Study Area and its Environs

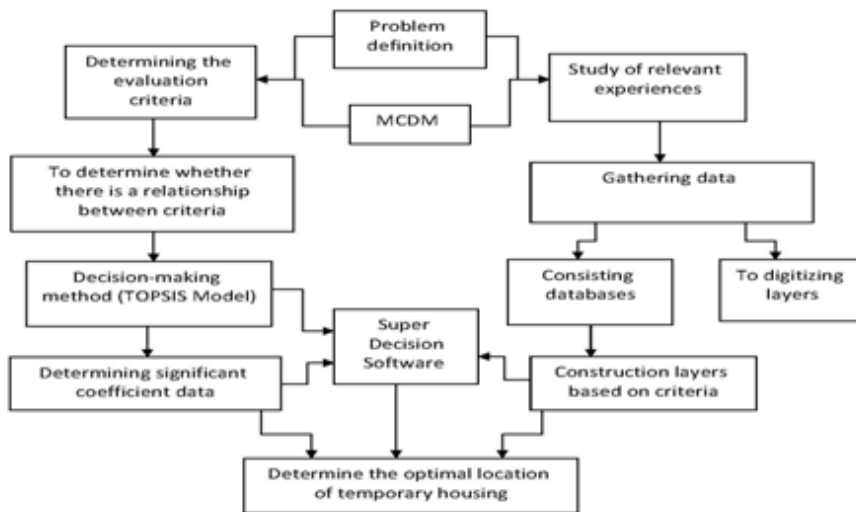


3. Materials And Methods

This investigation was treated in a descriptive-analytical method. Site studies, library investigations, interview with experts, and studies of questionnaires between relevant experts were utilized for data collection and gathering the primary data. The population of the study implemented municipal district of Duzce. For this study, TOPSIS model was utilized for detailed analysis and has been found as a multi criteria decision-making procedure. This method was introduced in 1992 by Chen and Huang [12]. Chart 1.0 delineates the research process. In this investigations, to avoid bias in determining the significance level, the effective criteria in site selection and homogenizing the criteria were adjusted through Shannon entropy technique, and has been taken advantage of the population through distribution of questionnaires between the experts. The population incomplicated all experts of crisis management those are familiar with municipal district Duzce Environs. A synthetic method including Shannon entropy technique and TOPSIS model was utilized for data analysis. That is why, after selecting the suitable places for temporary accommodation and with respect to experiences and records of the investigations and recommendations made by the experts, the relevant criteria necessary for site selection and the value of each criterion for any of the selected places were supplied. Having computed the values of the criteria in site selection stage, based on expert suggestions in crisis management, the scoring of these criteria was adjusted by Shannon entropy technique. Then, using

TOPSIS Model and MS Excel, the potential sites for temporary housing of the earthquake sacrifices, would be graded in terms of precedence, (Chart.1), [11].

Chart 1. Research process [11]



4. Discussion And Data Analysis

Large cities like İstanbul those are facing overpopulation might never deal with the crisis and hazards without a plan. Urban planners and managers would make preparations for the periods before and after the crises so that they can minimize the losses and provide the sacrifices with relaxation and security. In this concept, it is necessary to forecast some places for emergency housing so that survivors can reach primary care in their temporary camp. Finally, the most important requirement for planning and urban management is to look for places and areas which are the best site to supply shelter, support and effective relief for the sacrifices. Different criteria and factors might be intersect to discover and choose the most appropriate emergency housing for earthquake sacrifices in critical conditions. In this investigations, locations like university campus with an area larger than 10,000 square meters, large parks and green spaces, large sport complex, subway station have been investigated for temporary housing of the sacrifices. Accordingly, the criteria and standards used for finding appropriate places incorporated land use area, distance from the fire stations, the age of buildings, distance from fault line and main roads. The

table of data matrix and weighting of the criteria are procumented for this investigations (Table 1-Table 3.), (Figs.2-4).

Fig. 2. Duzce and situation of municipal district

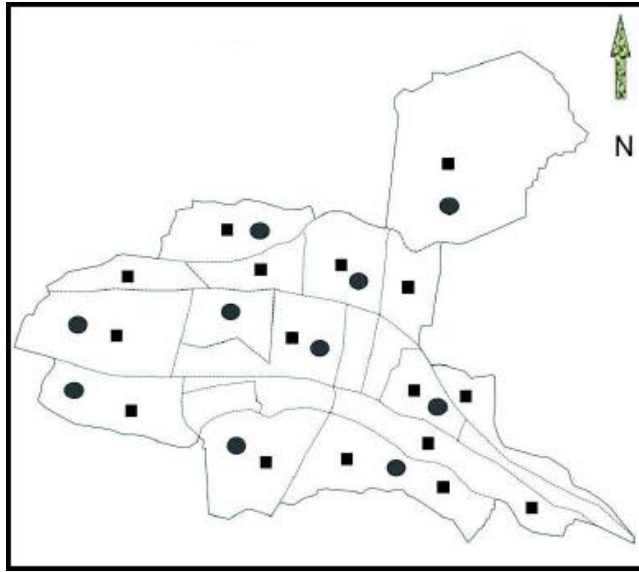


Fig. 3. optimal site selection maps for temporary housing of earthquake victims

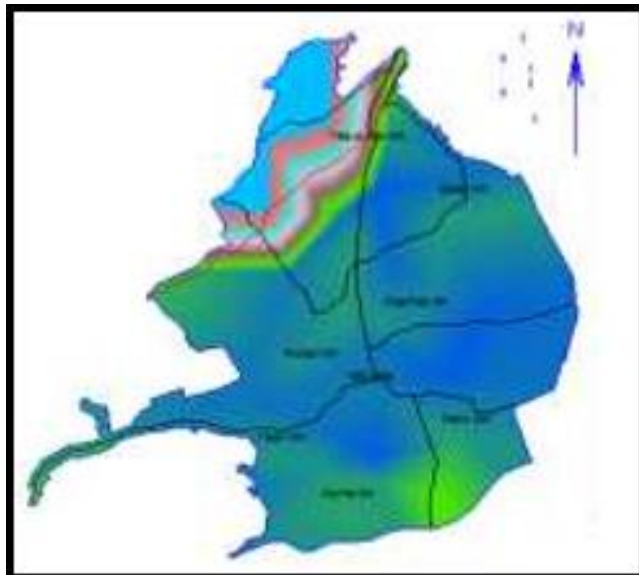


Fig. 4. Optimal site selection map for temporary housing based on TOPSIS model

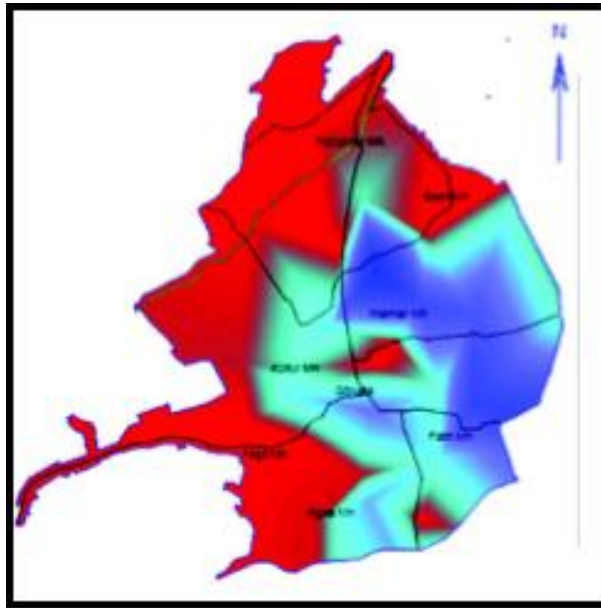


Table 1. Results of risk assessment for 12 districts of Duzce

Areas with relatively low risk	Medium risk areas	Medium risk areas	Areas with high risk	Type of Risk Model
20,19,6,5,4,3,2,1	12,9,8	20,19,18,14	16,15,13,12,11,10	Ray Fault model
19,18,15,6,5,4	12,11,20,8,7	3,2	-	Duzce Fault Model
21,20,19	16,15,13	3	16,15,12,11,10	Floating models

Table 2. Homogenization and calculating the standard deviation and weighing of the indices using Shannon entropy model

Entropy	0,742	0,929	0,832	0,847	0,971
SD	0,258	0,0703	0,137	0,105	0,203
Weighing	0,439	0,119	0,191	0,189	0,039

Table 3. Positive and negative distances, relative distance, ranking and TOPSIS value for each item

Housing locations	Rank	TOPSIS value	D -	D +
University campus	4	0,35765	0.0768	0.149
Parks and open spaces	3	0.37432	0.077	0.143
Sport grounds	2	0.31145	0.123	0.203

5. Conclusions

Duzce is an important city in Turkey, as it is developing area and has a strategic position. However, given the relative earthquake risk, Duzce is located on one of the most dangerous areas of Turkey. Placed in such a dangerous position, Duzce needs definite planning for crisis management. Suitable site selection for temporary accommodation is part of such a plan. The aim of this investigations were to suggest a scientific and accurate skeleton in planning and site selection system for providing the existences with safe shelter. Making use of theoretical foundation and experiences of temporary housing, this investigation has tried to compile the relevant indices and apply an suitable method in multi criteria decision making for site selection of temporary housing in district of Duzce. In this investigations, TOPSIS model as a multi criteria decision-making procedure was utilized for detailed analysis. After selecting suitable locations for temporary. Accommodation, the criteria for site selection and the value of each criterion were appointed with respect to the literature and experts' suggestions. Due to the physical and spatial characteristics of the municipal district of Duzce, incorporated existence of distinguished buildings such as ministries, outstanding institutes of higher education, health centers, public hospitals, large corporations, etc., which are well deleneating the importance of this district in urban and national grade, after studies and interviews with experts and stakeholders, university campus larger than 15,000 square meters, large parks and green spaces, large sport complex, subway station were suggested and investigated for temporary housing of the earthquake existences. More important and effective criteria for temporary housing in times of crisis, and specific physical characteristics of district were chosen and evaluated qualitatively and quantitatively. In the end, subway stations got the first precedence, parks and green spaces got the second precedence, sport fields and grounds got the third precedence and university campus, and higher education institutes

got the fourth precedence for temporary housing for sacrifices of earthquake and other crises.

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