

# Locating Temporary Settlements in Earthquake Crisis Using AHP and GIS (Case Study: Damavand Region)

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**ABSTRACT:** Planning before crisis occurrence is a key problem which managers are dealing with these days especially in the field of crisis management. The aim of this research is optimum locating of temporary accommodation for those injured after earthquake using model AHP and also by applying geographical information system GIS in Damavand Area. It is worth to mention that due to presence of main faults of Moshā, this county is a seismic one in Tehran Province. The research method used is descriptive-analytical method. In the first method a brief review of theoretical definitions of the research was provided and then AHP model was analyzed. After studying factors which are effective on environment, and population of Damavand, we dealt with weighting to parameters using analytical hierarchical process AHP. Finally, with the results we gained and by combining layers in software GIS we conducted a fine locating for setting up temporary accommodation resulting from earthquake.

**Keywords:** Locating, Temporary Accommodation Basis, GIS, AHP

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## INTRODUCTION

Men's effort for fighting against earthquake lead to research "crisis management resulting from earthquake" which itself includes too many steps. In fact, after an earthquake occurrence for limiting disaster range and normalizing condition all need organized behaviours which are effective in spite of prior preparation. One of the steps in crisis management is "temporary accommodation". Experiences show that if criteria are not determined in advance, some unpredicted factors may interfere during beginning of a plan for establishing temporary settlement and it may influence on the quality. According to morphological condition of Iran and its position in one of the most seismic areas of the world, it is better to make an effort for applied achievement to organized ways and methods for minimizing disaster size. Hence, considering various steps in crisis management of damaged areas, rescue operation, temporary accommodation, and rebuilding, current research tries to deal with locating of right spaces for establishing camps of temporary accommodation.

## MATERIAL AND METHODS

The research analyzed the topic applying analytic descriptive method. To do this it gathered data with library and field methods and using books, journals, papers, maps, websites and field studies. The research method in this research is descriptive-analytical. The research is an applied one and according to the way of gathering data, it is a descriptive and survey research.

In this research, for space analysis, GIS knowledge was applied using software ARC MAP, and also for preparing maps, three factors of faults, earthquake backgrounds and soil resistance were used and AHP model is used to locating.

### Review of literature

Locating is process of finding and selecting position according to the criteria. Each place has capabilities and abilities and their activities are different. Sometimes indices and criteria of choosing places can be different, but at the same time all of them will become united when it is about gaining the best result. Factors such as economic, quality and quantity of environmental effects, communication networks, level of geographical access, type and level of urban infrastructure services and other factors which are determined based on control type under locating are all influential parameters (Shahabian, 1997)

### Crisis management

Crisis management is science, and art of planning organizing, leading and guiding in a united and comprehensive way which by employing tools it tried to control risks resulting from various crisis based on various steps of crisis. (Abhari, 2007)

### Geographical information system

This system is a set of hardware, software's geographical data, experts and methods of information processing. They are all applied for receiving, maintaining, restoring, modifying and processing of

different types of space and non-space data in order to make a decision as best as possible. (Mansourian, 2008)

### Center of temporary accommodation

Iran has been facing different types of accidents because of its wide area and since it is located on earthquake belt. Earthquake has a key role in devastating urban and rural houses. What is clear is that after devastating earthquakes, it is necessary to have a temporary shelter. The need for quick provision of a shelter is possible according to environmental, geographical, cultural, social condition and many other factors where various methods are considered. E.g. in Bam Earthquake in 2003, using pre-fabricated shelter was on the table of the Iranian authorizes due to occurrence of accident in the winter and also long time of rebuilding process. But in the earthquake of Lorestan City in 2006, the time of temporary accommodation was removed since it occurred in the spring and due to presence of nice climate condition for rebuilding, so they decided to provide tent as a shelter for those left behind.

However what is clear in previous accidents is that after each devastating earthquake, some challenges may appear regarding emergency and temporary accommodation condition. In some cases they can overcome such problems by integration and innovative methods, and these methods can make life condition easier at that time.

In temporary accommodation centers some goals should be thought of according to critical condition and need to use the maximum facilities available. Some of the goals are as follows:

Security from aspect of natural risks and hazardous centers for men, efficiency from aspect of street network and land`s being fine, effectiveness from aspect of domains` vulnerability and being close to areas with accommodation areas and being equipped from aspect of lands` control (Mahmoudzade, 2009). Every activity has its own certain condition. It is necessary to recognize

areas in line with studies and to specify position of employing each activity. (Sahami, 2007).

After accident (disaster) those injured will be provided with temporary, emergency and permanent shelters. Emergency shelter is for protecting against heat, cold, maintaining properties and so on. In such a condition we can use tent or other pre-fabricated things.

## RESULTS AND DISCUSSION

### Standards of temporary accommodation place

✓ Lodging must provide health and welfare security.

✓ Physical plans should be done in a way that they can provide emergency shelters, facilities and services. Shelters should be set not very close to each other (due to privacy worries).

✓ The environment should be covered.

✓ They must be according to security principles and provide the maximum possibility of livelihood (crisis management organization of Iran, 2009, 23-118). To specify fine locations, it is necessary to use a method which can assess significance of factors which are effective in selecting location; therefore those factors were assessed through weighting method. We achieved our objective by following ways: criteria comparing, weighting to each of the criteria and calculating consistency ratio, planning, organized principles and criteria, GIS and our objective was finding locations for employing temporary accommodation centers in Damavand Area. After identifying fine and bad domains for employing these centers, some locations were found inside fine domains.

As a result, too many various options were identified for employing centers. It is worth to mentions that GIS is only a utility for decision-making in the process of planning and final decision-making should be done by a good planning.

Duties of planners in main steps of crisis management:

**Table 1.** Level of inferences of urban planners in main steps of crisis management

Title of interferences of urban planners			Certain duties of planners	Explanation	Crisis management steps
Low	average	high			
			Building codes, land control management, preparing risk map and analyzing vulnerability	Removal or reduction of long-term risks	Discount of risk reduction
			Databank, agreement for collaborative effort, resources management, analyzing risks	Developing operational capabilities and increasing capacities in respond to crisis	Preparation
			Public guidance, equaling centers of emergency operation, organizing facilities and resources	Fast operation during and right after crisis	Reaction
			Databank, reassessing crisis plans, establishing temporary settlement, basic rebuilding for future crisis	Life restoring with standards, committees of improving its level	Regeneration

Source: Saedi Khamene, 2010

### Providing temporary living space after an earthquake:

Accommodation is one of the main needs of human. So after every accident, we may see some damages to permanent habitat. Since it is impossible to make houses in a short time, the idea of temporary accommodation was raised.

Sociology studies of disasters and experiences available show that those injured have some willingness regarding shelter locations which are as follows:

1. At first hand, those injured would rather stay near their own house, even if their houses are destroyed. The most suitable shelters are those near the house of those injured.

2. Some of those injured would like to visit their friends and relatives according to their families and usually one person stays there to help protect their properties.

3. Thirdly, it is very important for those injured to have their shelters next to their main houses. They are

worried to lose their main house forever by leaving it during crisis. Therefore, if the shelters are close to their main house, maybe they show more willingness to stay in shelters.

### Process of locating

This process was done based on modeling of the current condition. Based on the method introduced here, right locating is done for areas and for emergency accommodation.

### Analytical hierarchy process (AHP)

The model process starts by specifying elements and decision-making and their prioritization. These elements include various methods of operation and prioritization to measures.

First step: in the first step, hierarchy structure which is related to the topic is determined. Hierarchy tree includes three mains of objective, criteria and options. Criterion level can be divided into various sub criteria.

Second step: calculating criteria and sub criteria significance ratio: to do this, we compare them two by two. Judgment basis which is presented in the table is a clock which has values of 1-9. Based on it and according to study goal, priority of criterion  $i$  to criterion  $j$  is specified.

Third step: combining significance ratio of the options: by combining weights, final score of the points will be achieved.

$j$  final score of option formula (1)

$$\sum_{k=1}^n \sum_{i=1}^m w_k w_i (g_{ij})$$

In which  $w_k$  is significance ratio of criterion  $w_i$ ,  $k$  is significance ratio of sub-criterion  $i$ ,  $g_{ij}$  is score of option  $j$  in line with sub-criterion  $i$

Forth step: consistency test: the mechanism where a clock was considered for examining inconsistency in judgments, is calculating a ratio called (inconsistency ratio (IR)). By dividing inconsistency ratio in judgments, calculating a ratio is gained called (Random Index (RI)). If this index is less than 1 or equal to 1, consistency in judgments is acceptable, otherwise we need to consider judgments against. This index can be calculated as follows:

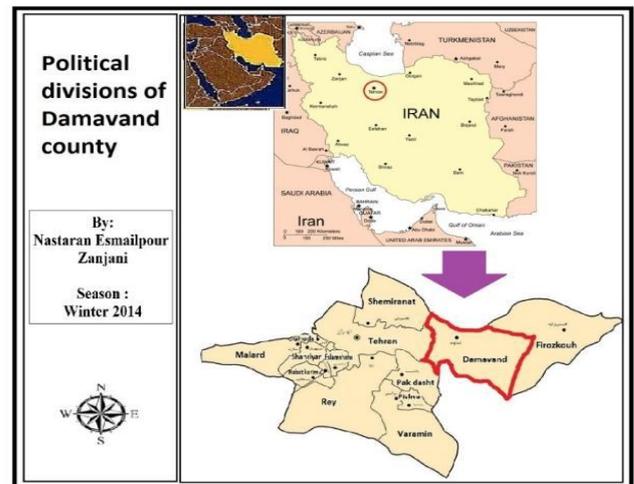
Formula (2): inconsistency ratio

$$\lambda_{max} - n / (n - 1) = I.I$$

### Locating temporary accommodation basis in Damavand County

The county has two areas of Roudhen and central part. It also has four cities called Roudhen, Damavand, Absard and Kilan. Moreover, it has 5 villages called Abali, Mehrabad, Abrshiveh, Taroud and Jamabroud. Ratio of villages with population in Damavand is 55/1 percent demonstrating evacuation of around half of the people from villages to cities to 1998. Some of the reason of the evacuation is looking for a desirable life position. This ratio is 67.4 percent across Tehran. Ratio of villages with population in Damavand County is around 8 percent of total villages with population in this province. Rural population of the county in 1988 was about 22 thousand people. Total population of Damavand in 1988 was about 65 thousand people which were more than the province population. It took the eleventh place regarding population

size of the province and after Firouzkoh it is has the lowest level of population. This county connects counties of Shemiranat, Tehran and Pakdasht in west of the county. Semnan Province is connected to Mazandaran Province by Damavand and Firouzkoh Counties.



**Table 2.** Feasibility study of density increase for various area of Damavand County and results of statistical enumeration (2010)

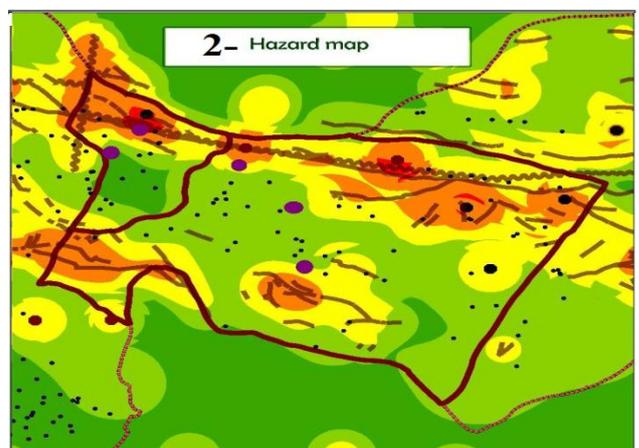
Population	Square (hectare)	Average Family size	Gross density of population	Square of residential function to hectare	Number of residential No	Ratio of residential function to area level
65219	1997	3,8	34	8203	1403	%82

According to what mentioned in the research literature, criteria of locating for temporary accommodation basis can be classified in three main parts of physical, social and environmental.

### Environmental factors

Ground steep: steep of 5 to 10 percent is suitable for choosing ground. It should not be more than 15 percent.

Soil type: organizing plan for Shemiranat specified 1.5 to 2.2.5 kilo pound per centimeter as minimum level of soil resistance. Distance to large faults: grounds specified for centers of temporary accommodation should have a logical distance from fault.



**Figure 2.** Hazard map of earthquake in Damavand County.

**Physical factors**

Open space: presence of unmade piece with Fine Square is of key issues in locating of temporary accommodation camps. According to population and capitation of the land needed, the land should have the least square possible.

Communication and the way of adjacency of users in different parts of city(residential, access to roads, open spaces, hospitals and relief centers, fire station, urban services centers, urban installations and risky urban equipment.

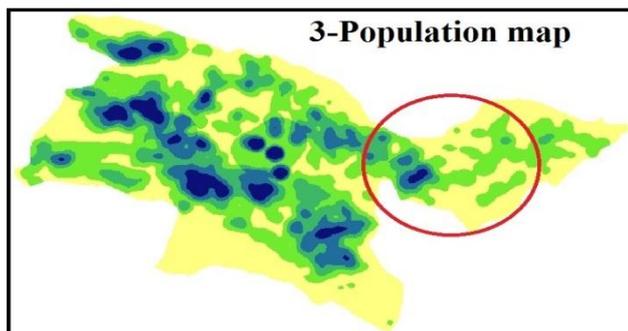
Temporary accommodation centers should be placed in a distance of 2 kilometers of residential users. Also, the distance of such centers from risky equipment's and installations (storage and combustible materials, fuel storages and so on) should be at least 1000. Shelters (camps) must be built near hospitals or clinics. Fire trucks must be employed so that they can be on the scene ASAP when needed, (especially during emergency case). Public standards suggest distance of 5 kilometers. Building quality or building resistance: the weaker materials, the more vulnerable the buildings. So, camps should be put next to roads whose quality of walls is more desirable.

Building density: the most the building density, the more vulnerability. So camps must be placed whose walls have more building density. This way more people can stay in the camps. The distance from main urban entrances, railway and airport and adjacency and communication with main roads: access to roads is a key criterion for such camps. This way providing necessary things would be provided. Therefore, it is recommended that camps to be placed near arterial streets of first and second class. Besides, ratio of walls width to their height should be more than 2 or equal to 2.

**Population factors**

These factors include population density. The more population density, the more vulnerability against earthquake. The minimum spaced needed for each person in temporary accommodation is 35 square meters. This space includes roads, health tools, and offices, water provision systems, saving installations, shelters and markets.

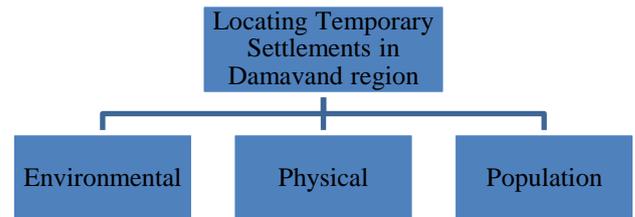
Age-sex combination of population: based on the experiences, children, women and old people are more vulnerable against earthquake than other people (Jica, 2000/331). Therefore, shelters must be put in places where number of women is more than men. Also number of children to old people must be more than other age groups.



**Figure 3:** vulnerability map of Damavand Population

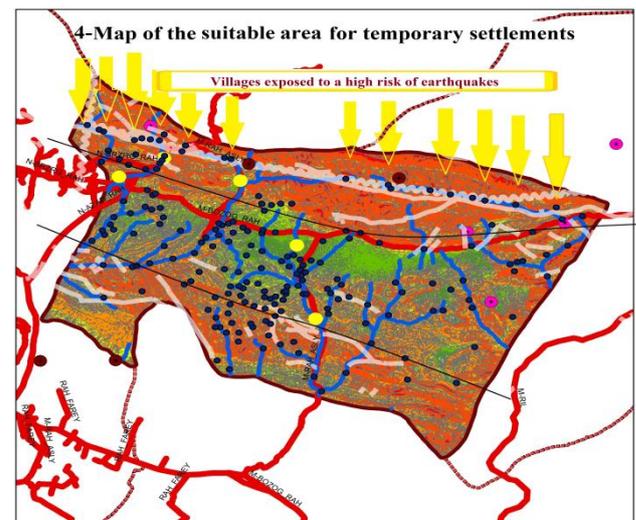
**Locating temporary accommodation basis in studying domain (Damavand)**

The results gained out of paired comparison of criteria by experts, and weighting to criteria are all expressed in chart no (1). As it can be observed, access to open piece of land with Fine Square has the maximum weight (205.). Shemiranat City is located near a wide plain and it has a uniform steep. Different parts of this county are equal and steep criterion has weight of (013.). According to the area population and the minimum space needed for each individual in temporary accommodation and based on the area limitations (10) square meters,. Totally we need 1213390 square meters of land. This level was provided in four pieces of land.



**Chart 1.** Locating of temporary Settlements across Damavand

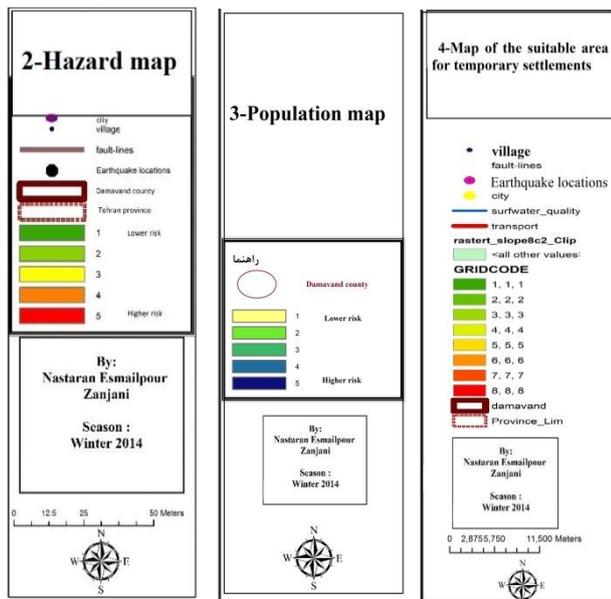
Date needed in GIS are overlapped with data layers and according to weight of criteria gained. The results gained are shown in the picture below.



**Figure 4.** Suitable area for temporary settlements



**Figure 5.** suitable area for temporary settlements



## CONCLUSION

A key issue in crisis management, especially on unexpected accidents is optimum locating for locating citizen when they face crisis or after crisis. Due to interference of various factors and parameters in this problem, locating of such places is so complex. Due to interference of various factors in optimum locating, using GIS is important. In order to use GIS and model AHP, we divided locating criteria of temporary accommodation basis in this research into three parts of physical, social and environmental facts. Due to weight and significance of the criteria mentioned in process of locating these bases, AHP and GIS were applied.

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