

Spatial Modeling for Reducing Earthquake Disaster Damages in Iran

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Abstract: Earthquake is one of disaster that when happened causes many problems in economic and society in Iran, so earthquake disaster management is necessary for decreasing these problem effects. Because of most related data with earthquake and its effects have spatial properties, so GIS can be used as effective tool for managing and decision making in disaster. In some countries such as Iran, disaster experiences show that managing and decision making before occurring earthquake is more effective than doing some activities after occurring earthquake, therefore pre-disaster phases in the disaster management cycle is much more important. Purpose of second phase of disaster management cycle that is called mitigation is planning for creating a resistance urban against earthquake. In this study, we designed and implemented two efficient models for entering earthquake zoning rules in urban planning using GIS modeling tools. At first we will define problem structure, then we introduce different models using for earthquake zoning, finally we implement these models on the FRAHZAD (that is a part of Tehran) case study and we will discuss about results.

Key words: Earthquake % GIS % Mitigation % Model and planning

INTRODUCTION

Earthquake is one of the natural disasters that when it happened, causes many problems and difficulties in economic, environment, human's life, then earthquake disaster management is necessary for decreasing these problems effects and decision making in disaster condition. Because of most data related with earthquake disaster have spatial properties, so GIS can be used for better planning and decision making in earthquake disaster management. Disaster management cycle can be divided in two section; after an earthquake and before of an earthquake. Before of an earthquake section divided in to three phases, that they are planning, mitigation, preparedness, and after an earthquake section divided in to two phases, that they are response and recovery [1]. In some counties such as Iran, disaster experiences show that managing and decision making before occurring

earthquake is more effective then doing some activates after occurring earthquake, therefore pre-disaster phases is much more important [2].

We said that disaster management cycle divided to three phases, in planning phase we assess potential of disaster occurrence, if there is any Earthquake disaster risk, we should go to mitigation phase. Purpose of this phase is to plan for creating a resistance urban against earthquake [3-4]. In preparedness phase, we create necessary preparedness against earthquake (e.g. we store food and water in special place).

One the most important task, which must be done for creating a resistance urban against earthquake, is to enter earthquake zoning rules in urban planning [5]. We designed and implemented two efficient models. First model is applied to check land suitability with related application and second model estimates road obstruction with respect to damaged buildings debris.

Model of Checking Land Suitability with Related Application:

In this stage, with respect to the kind of an application, its importance and different geological properties of region and earthquake a model has been designed, which can answer the following question. Does

each land use with respect to earthquake risk agree with the related parcel?

Then, by using we can able to identify which applications are exposed to danger, and after that we can decide for creating stable situation or moving application. Another case of using this model is for given authorization to different applications. The case study is divided to four sites based on geological and earthquake properties as Table 1.

Using JICA approach [6], probability map of subsidence, liquefaction, landslide and distance of active fault were provided consideration of above criteria. It is necessary to be mentioned that determination of geological and earthquake properties, spatial modeling and layer composition have been done in GIS environment.

According to suitability matrix [7] that it has been shown in Table 2, amount of land suitability for each application was checked based on its location.

However, roads are important for the rescue activation. Their obstruction is one of the important problems for rescue in the earthquake situation [8-10].

Road obstruction models are developed based on probability approaches [8] or Empirical approaches [4]. An empirical model has developed using observations of Manjil Earthquake in 1990 [4]. In this model with respect to buildings height, roads width and materials which used in the closet structures, We can able to produce a map for representing danger of road obstruction in three levels which called low coefficient of danger, medium coefficient of danger and high coefficient of danger. Therefore, we can decide about the resistance of buildings, widening roads and assigning authorization for construction.

This model is designed based on the width roads, height of blocks and materials. The coefficient of danger that mentioned in Table 3 and 4, are pulsed together. If the result is two o three, obstruction danger is low, if it is equal four and five, obstruction danger is medium, and for six, seven and eight, we have high obstruction danger.

Case Study and Result: A part of Tehran that called Farahzad, was recognized suitable because of closing to active faults, and it has a high potential of destruction. This region is considered as a case study and models was done on it, because of the large volume outputs, we just represent some of them in Fig. 1-3.

Table 1: Site classification based on geological and earthquake properties

Site Code	Site Characteristics
Site A	- Very low probability subsidence of soil
Site B	- Low probability subsidence of soil
Site C	- Medium probability subsidence of soil - Having a liquefaction potential - Distance of sites from fault between 300 and 500 meters
Site D	- High probability subsidence of soil - Having a liquefaction potential - Having a landslide potential - Distance of sites from fault less than 300 meters

Table 2: Suitability matrix Obstruction zoning model

Land use	Site			
	A	B	C	D
One Floor residential	suitable	suitable	suitable	un suitable
2 and 3 Floor residential	suitable	suitable	un suitable	un suitable
More than 4 Floor residential	suitable	un suitable	un suitable	un suitable
Commercial	suitable	un suitable	un suitable	un suitable
Educational	suitable	un suitable	un suitable	un suitable
Religious	suitable	un suitable	un suitable	un suitable
Medical	suitable	un suitable	un suitable	un suitable
Official	suitable	un suitable	un suitable	un suitable
Culture and Sport	suitable	un suitable	un suitable	un suitable
Lifeline establishment	suitable	un suitable	un suitable	un suitable
Industrial	suitable	un suitable	un suitable	un suitable
Entertainment	suitable	suitable	suitable	suitable

Table 3: Danger coefficient with respect to proportion of width to height

Proportion of width to height	Coefficient of danger
$w/h < 0.5$	4
$0.5 < w/h < 1$	3
$1 < w/h < 2$	2
$w/h = > 2$	1

Table 4: Danger coefficient with respect to proportion of width to height

Material Type	Coefficient of danger
Weak	4
Semi strong	3
Strong	2
There is no block	1



Fig.1: Map of one floor residential building that are in danger of earthquake

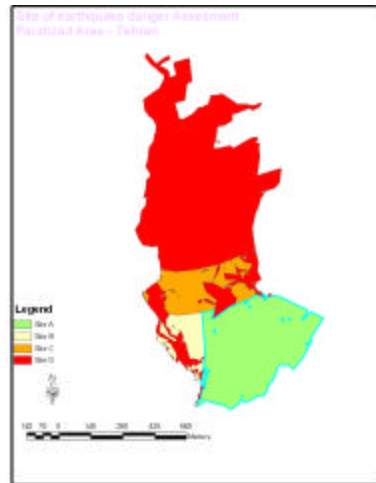


Fig. 2: Map of difference sites have been divided based on geological properties and earthquake danger



Fig. 3: Map of road obstruction

CONCLUSION

With respect to the harmful effect of earthquakes in human societies, disaster management is very important problem. Then GIS as a science and technology for managing, representing, retrieving, saving and modeling of spatial and non-spatial data is efficient tool for decision making and planning for earthquake disaster management.

Using some models in GIS environment, we can help having a resistance city against earthquakes. For example, if we use the results on our case study, we will be able to reduce earthquake damages. Finally, design and implementation of GIS is necessary for reducing effect of earthquake in Iran.

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