

Urban Flood Hazard Zonation Using GIS and Fuzzy-AHP Analysis (Case study: Tehran city)

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Abstract

Accelerated process of urbanization and global warming make urban flood one of the most important issues in urban planning. Tehran recently has been affected by the flooding and its damages. High intensity rainfall and uncontrolled urban development and main inefficient networks of drainage system are the main reasons. This research uses an efficient approach for flood hazard assessment in Tehran city. This study is to develop an urban flood hazard zonation based on multi-criteria decision analysis and GIS. This model was developed using the following five criteria: distance to the drainage network, flow accumulation, slope, height, and built or not built land areas. Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method as one of the most efficient multi-criteria decision-making systems was used for this study. The final hazard map obtained using the weights of criteria and each of their classes in GIS. Urban flood hazard maps indicate that the waterways and their privacy and central to the southern city area have the highest potential of overflowing and flood rise.

Introduction

Flood is one of the most destructive natural hazards that offset its effects; especially in areas where there are aspects of human development, such as cities, it can impose high financial damages. Urban development, especially along the rivers has increased the flood damage in recent decades. Thus, knowledge about the risk of different areas and attention to urban flood management as one of the major themes in addressing urban issues, with an emphasis on the urban environment, is important consideration for urban planning and policy makings.

Flood hazard maps can be used as an effective tool in planning for future development of the city and also identification of the areas where infrastructure development is required for flood drainage. In this study, Tehran, as the capital of Iran that is in danger of flooding, has been studied.

Materials and Methods

Procedures of this study are presented in Figure 1, which includes provision of primary data, preparing them in GIS, multi-criteria decision analysis and mapping of flood hazard.

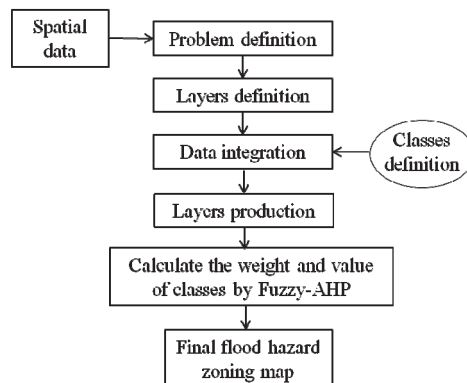


Fig.1. Flowchart of research procedure

Three major sources of data to provide layers were used as follows:

1. Digital elevation model to provide the run off aggregation layer, slope and elevation of the study area,
2. Landsat TM images (summer of 2011) to derive permeable and non-permeable land and
3. Digital files of surface water drainage in the city.

The layers used in this study are shown in Figure 2.

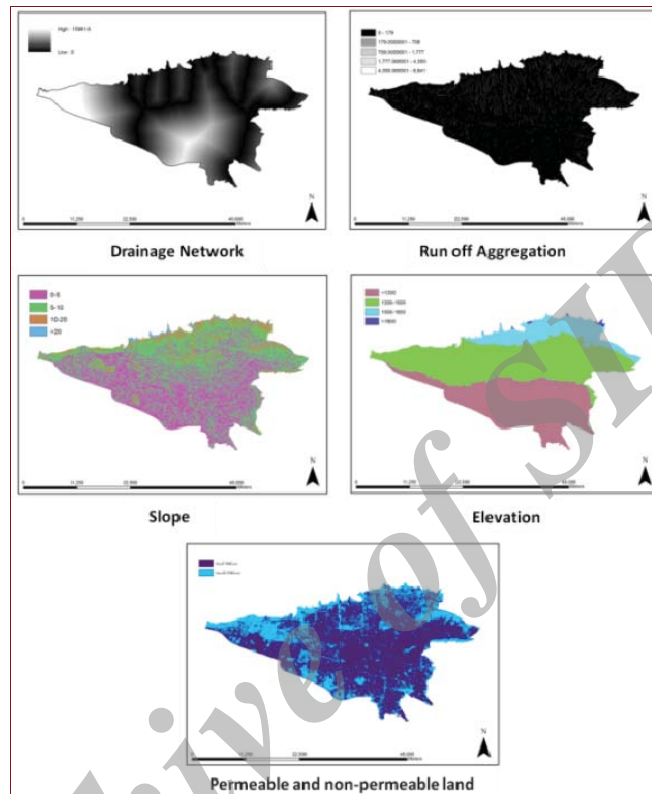


Fig.2. Layers used in the study

Then, the weight and value ratings were assigned to layers and classes of layers. The process of assigning weights and values ranking was performed by AHP-Fuzzy method. Weights calculation was performed using Matlab software programming environment.

Fuzzy Analytic Hierarchy Process

Fuzzy AHP method, proposed by Buckley, as a generalized form is classic AHP method. In this method, a couple of options for gaining weight and priority of fuzzy numbers and the geometric averaging method are used. Because this method can easily be generalized in fuzzy and also unique solution for pairwise comparisons matrix can readily be determined. In this method, the decision maker can compare pairwise each of the options in the form of trapezoidal fuzzy numbers to express.

Results

The methodology used in this paper is the analysis of flow variables at the time of peak rainfall and the drainage network capacity control. Here, we focus on the establishment of appropriate correlation between model and GIS, enabling the desired changes, modifying and updating them easily and with minimal cost and time. Such a system has considerable potential for management of floodplains or flood crisis management and rescue during flood sand rebuilding after the flood management and relevant to subscribers. Applying weighted layers in GIS, flood hazard zonation map of Tehran was prepared. The map at the end was classified in five categories: very high risk areas, areas of high risk, moderate risk areas, risk areas and low risk areas was very low (Figure3).

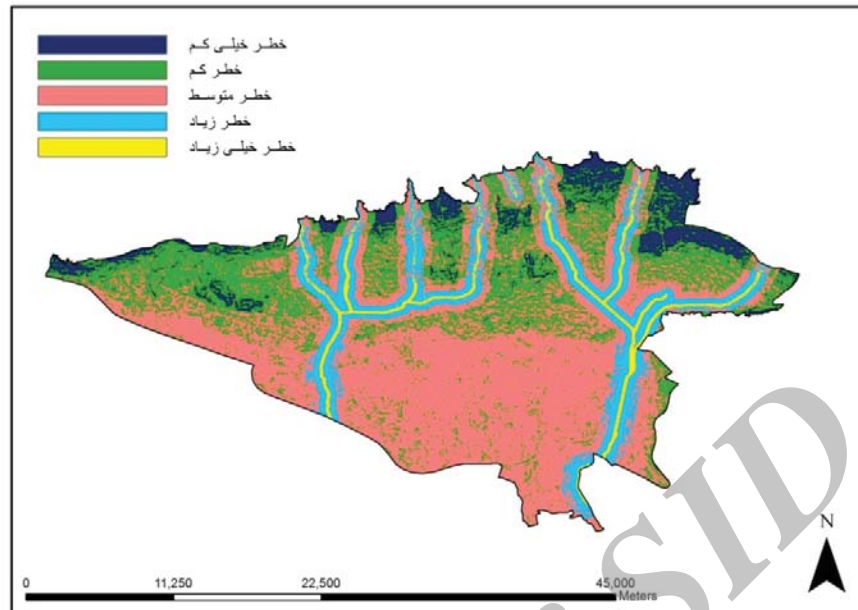


Fig.3. Final classified flood hazard map of Tehran

Discussion

Urban flooding risk map is a new tool that can help urban planners and decision makers, for example, in evaluating the effectiveness of drainage infrastructure and development efforts. These are needed to reduce the risk of flood damage for the urban population.

Keywords: AHP- Fuzzy, flood, hazard zoning, GIS, Tehran city.