Vulnerability of Urban Flooding Case Study: Tehran, Darake to Kan

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1. Introduction

Nowadays, population increase, progress in science and technology and development of industrial installations with the shortage of places in metropolitan areas have made considerable changes in the morphology of watersheds. Violation to territory of rivers, channels, and streams causes alterations in natural drainage pattern and overflowing due to the lower capacity of the changed channels and streams. This can increase the risk of flooding and inundation of the streets and also the costs of urban maintenance. Moreover, this will considerably increase the possible financial and life damages.

2. Study Area

Tehran is a city located in the southern slopes of Central Alborz downstream many watersheds. Furthermore, the excess expansion of urban areas to 2200 m foothills as well as uneven development and structural difference in physical texture caused the areas to be subject to serious risks of flooding. Among the Tehran municipality regions, the regions 2 and 5 have be developed to absorb the overflow of population and immigrants from central and southern areas of the region. These areas are in the vicinity of the rivers of Darakeh, Kan, and Farahzad, on one hand, and have high rate of constructions, instable residential areas, relatively high density of population and houses, landuse changes, violation to the territory of rivers, and improper use of the channels, on the other hand. As a result, they are subject to flooding. Thus, the areas are highly important due to the possibility of huge flood occurrences.

3. Material and Methods

The data of this study include elevation data extracted from topographic maps (1:25000), climate and hydrometric data (1995-2012), and landuse data from Tehran municipality. The effective or intensifying variables in vulnerability assessment of physical infrastructures in region 2 and 5 downstream the watersheds of Darakeh and Kan have been selected by field observations. As the variables of runoff, slope, aspect, landuse, elevation classes, curvature, old texture, surfaces perpendicular to slope and those parallel to the slope have different measuring units, they have been standardized

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by pairwise comparison method. For the lands upstream the study area, the runoff has been estimated by SCS (CN) model. Calculation of CN in urban areas has been based on landuse type and percentage of open spaces. The old texture is used in the method because of its influence in flood occurrence due to inadequate drainage, sound management, and permeability of urban structures. The integration of the data has been carried out by fuzzy functions using the weights obtained from the pairwise comparison. For vulnerability assessment, the gamma maps of 0.9, 0.85, and 0.7 have been prepared to compare their correlations with other variables. The gamma 8.5 had the highest correlation with the principal variables. To detect the role of effective factors, we have used water profile and hydrograph with the coefficients using the analysis of Multi-Layer Perceptron Network (ULP).

4. Results and Discussion

The vulnerability map resulting from comparison weights and fuzzy integration functions has indicated that the most vulnerable areas are near the channels; particularly those increase the risk of flooding in urban areas through higher discharge. The comparison of the vulnerability map with the transportation networks indicates that most of the vulnerable areas are coincident with the west-east networks crossing the natural slope of the streams. It also indicates that the most vulnerable areas are intersections of the transportation networks of north-south and west-east. These intersections impede the flow of water over the natural north to south slope of the area. Due to the importance of the volume of runoff upstream, the proportions of the runoff were determined based on the area of each region. The results have also represented that the proportion of runoff from Kan watershed on urban areas was more than others. To assess the entry of Kan watercourse into the city, the Soleghan precipitation station has been selected. Three time series of precipitation has been drawn from 27^{th} to 30^{th} October 2000, 2007, and 2012. Based on the data, flood discharge was calculated in three different states and its long profile and hydrograph was depicted. According to field observations, the Kan valley is 3 meters wide and 1.5 meters high. According to long profiles, water flows are increased with an increase in rainfall; this is along with peak discharges and likely flooding on the hydrograph of Kan watershed.

5. Conclusion

The results of vulnerability assessment in the study area indicated that a combination of upstream natural factors and urban agents make these areas vulnerable against the floods. Although outside the urban areas the lands near the channels and streams are more vulnerable, as also confirmed by field observations, there are some other factors affecting the vulnerability of urban areas. The old texture is greatly important in the vulnerability because it does not have a suitable drainage ability and the available drainage networks are also mainly in the ending part of the areas. Thus, the inundation can intensify the floods or even cause them. The vertical slope surfaces and the curvature in north and northwestern areas of Tehran also show conformity and non-conformity with the drainage and watercourses. The jumps of peak flow in the hydrograph of October 2012 make it necessary to pay more attention to the runoffs of

Kan drainage basin as the city of Tehran is experiencing events related to the watershed.

Key Words: Vulnerability, Urban flooding, Tehran, Kan, Darake

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