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Identification of Potential Areas to Flood Inundation in Shiraz City Using TOPSIS-GIS Title

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1- Introduction

Population growth, industrial expansion, urbanization, and urban construction have led to drastic changes in the morphology of catchments. Land grading and encroachment on rivers and canals have changed the pattern of natural drainage and flow in cities. One of the consequences of this phenomenon is the increase in the risk of flooding and flooded passages and the increase in maintenance costs of cities and has caused a lot of possible human and financial losses in some cities. In our country (Iran), the occurrence of floods is related to the disturbance of the natural balance and the morphological and physiographic conditions of the watersheds than to the heavy rains. One of the reasons for the flood event is the difference in topographic altitude between different regions of the country, according to which runoff is drained from the highlands to the lowlands in the shortest time. Therefore, the importance of research in the field of flood mapping has doubled. Unfortunately, the recent flood that occurred in April 2017 at the Quran Gate in Shiraz was one of the cases in which human intervention and lack of accurate knowledge about the watershed conditions led to irreparable human and financial losses. The floods killed 19 people and injured 200 others. Due to the occurrence of conditions and prevention of similar events, in the present study, to manage the crisis, especially in the prevention phase, floods zones of Shiraz metropolis using TOPSIS method and Geographic Information System (GIS), be identified and evaluated.

2- Methodology

As the capital of Fars province, Shiraz is located on a long plain 120 km long and 15 km wide. The city is geographically located between the coordinates '53 '29 29º to "47 '41 29º north latitude and "36 '26 52º to "02 '37 52º east longitude. The sea level is 1488 meters at the eastern end of the city and about 1700 meters to the west. In this study, a

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flood mapping was prepared using the TOPSIS method in ArcMap10.3 to identify flood risk areas. In this regard, thirteen criteria, including slope, aspect, elevation classes, precipitation, distance from the canal, drainage density, distance from worn-out urban structures, building density, geological formation, land use, groundwater depth, history of floods, and runoff, were used as information layers. In this study, the TOPSIS decision-making method (similarity to the ideal solution) was used. In this method, two concepts of the ideal solution and anti-ideal solution have been used. The concept of the ideal solution is the best in every way, which is generally not the case in practice, and it tries to get closer to it. In order to select an option to resemble an ideal and counter-ideal solution, the distance between that option and the ideal and counter-ideal solution is measured. The options are then evaluated and ranked based on the ratio of the distance from the counter-ideal solution to the total distance from the ideal and counter-ideal solution.

3- Results and Discussion

The most important factor in the study of flood risk areas in the city is identifying and prioritizing effective criteria in creating floods and the study of watersheds in the city, each of which is of varying degrees of importance. The results of the influential factors in flood occurrence can be expressed in the following order; the height criterion is one of the cases with an inverse relationship with the emergence and formation of the flood. The height of Shiraz varies from 1449 meters to 2284 meters. A very steep slope is observed in the northeastern part of Shiraz (Abivardi region towards Chogiah to the Quran Gate), and most of the city is developed in the plains and lower elevations. Most slope directions in Shiraz city are related to the eastern heights of the city (Saadi region 3, Daneshgahian dormitory, Haft Tanan for north and northwest slopes, Shiraz Marvdasht highway, beautiful Quran city gate for west and northwest slopes) (Region 1, Jomhory, Kuhsar Mehdi Abivardi West and Northwest and Chogiah North) (District 6 Mahmoudieh Mansourabad North and West of Drak Heights to the north and northwest slope) (Region 11 Qanat Pisheh North) The western helpers of the North Talaieh Highway (District 10 of Arian Town, Anjireh Town, is the northern and northwestern slopes of Drak). The highest drainage density is related to areas 1 and 6 of Shiraz city. The main geological formations of Shiraz plain with high and low-level sediments are dolomite, limestone with layers of sandstone or marl, limestone, and marl. The lower the permeability of these formations, the higher the score on the map. The final map of the flood-prone areas of Shiraz was classified into five very low, low, medium, high, and very high-risk classes. The results show that areas 2, 3, 11, 7, and 9 are most vulnerable to floods. Also, 2754 hectares of Shiraz city are in the very high-risk category, 6076 hectares are in the high-risk zone, 17390 hectares are in the medium-risk zone, 13418 hectares are in the low-risk zone, and 6658 hectares are in the very low-risk zone.

4- Conclusions

Thirteen effective parameters in flood occurrence were used to identify the flood hotspots in Shiraz. Then, using the TOPSIS-GIS approach combination, ten regions were examined. The TOPSIS integrated model is based on the ideal extraction of positive and negative points and determining the distance of each criterion in order to determine the best spatial option in terms of flood hazards. Using geographic information system (GIS) and ArcMap 10.3 software, the layers were prepared, and the best spatial options in terms of flood hazards were determined from the TOPSIS model. Several phenomena are commonly involved in urban flooding, including the limited transmission capacity of urban canals and rivers, drainage and sewage, and decades of urban development without updating the drainage infrastructure of flood-prone areas of Shiraz. Quran, Shiraz Marvdasht Road, Ayatollah Rabbani Boulevard, Haftannan, Chehelmogham Boulevard, Haftannan Boulevard, Saadi Town, Students' Alley, Saadi Gharb, Fazilat Tunnel, Delgsha Boulevard (underpasses), Fig neighborhood, along dry and coastal river crossings Slope, direction of slope, increase of constructions in the river area, increase of impermeable surfaces and building density), District 11 of Shiraz city: Fazilat tunnel, Parvaz town, Rasoul Azam boulevard, Persepolis boulevard, Sibouyeh town, police force town, Shahid Beheshti town, Talab town, buildings located in the foothills (main factors of slope flood, low groundwater depth, constructions in the river area, and inadequacy of urban sewage disposal systems), District 7: Sharifabad, Sahlabad, 20 meters from the sewer, town Imam Hossein, Mehregan town, Kushkak neighborhood, Nasrabad neighborhood and Abu Nasr (main causes of flood: low groundwater depth and inadequacy of urban sewage disposal systems), District 8 of Shiraz city: Isfahan Gate, Takhti St., Keshavarz St., Teymouri St., Imam Ali Bridge, Ali Bin Hamzeh Bridge (main factors Flood due to slope and inadequacy of urban sewage disposal systems), Region 9: Hojjatabad, Bargh, Darati, Modares, Mehdi, Sultanabad, Rezvan and Fajrnegar towns (main causes of increased floods in the area of Chenar Rahdar road), Region 1: Abivardi neighborhood, Mehdi mountain, next to the passages of the martyrs Emdadgar, Fajr, Bahman, reporter (main causes of slope flood and river flood), region 5: Golha town and Nawab Safavid martyr (main factors of flood low groundwater depth, and Inadequacy of municipal sewage disposal systems) Region 2: Glasswork, pottery (Abuzar), tannery, Zahra alley, Fazlabad, Bahar town (Pai Kata), Vali Asr and Sibouyeh boulevard (main causes of floods: low groundwater depth, and lack of Suitability of municipal wastewater disposal systems).

Keywords: Urban flood, Flood damages, TOPSIS-GIS, Shiraz