Determination of Flood Distribution Fields Using AHP Process and Fuzzy Logic in County Shariyar, Tehran Province

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Abstract: Storage and operation of runoff by flood distribution operations in case of heavy rainfall on a large scale can help increase groundwater storage and water supply for agriculture and drinking water. also, by controlling floods as a management solution for floods and water resources, especially in arid and semi-arid regions of Iran, many negative environmental consequences can be reduced. The most important and first step in implementing a flood distribution plan is to locate areas prone to flood distribution and water infiltration into underground aquifers. The present article is taken from a research project that has been done by using one of the multi-criteria decision making methods using geographic information system technology and fuzzy model to determine suitable flood distribution areas in Shariyar county of Tehran province. The study selected six indicators: slope, geology (quaternary), land use, alluvium thickness and electrical conductivity. Finally, using the geographic information system tools and using the Analytical Hierarchy Process (AHP) and with the relevant weight and calculations in the fuzzy model of flood-prone areas in Shariyar county of Tehran was determined.

Keywords: Flood Distribution, Location, Analytical Hierarchy Process (AHP), Fuzzy Logic, Shariyar County, Tehran Province

Introduction:

Iran is located in an arid and semi-arid region, where destructive floods, which are characteristic of arid regions, occur every year, causing great financial and financial losses. Therefore, flood management is very important. On the other hand, the development of agriculture has caused an excessive increase in groundwater aquifers and their sharp decline in most of the country's plains, so that many of the country's plains are among the forbidden plains. Irregular exploitation has caused land subsidence, reduced groundwater levels, and ultimately the destruction of agricultural land. For this purpose, the use of flood distribution, in addition to feeding groundwater aquifers, also reduces flood damage and soil conservation. In this regard, location is one of the most important issues in artificial feeding of aquifers (Bouwer, 2004). Success in artificial feeding programs requires the collection and completion of a large amount of data and information, and the first condition for creating a nutrition program is to identify the appropriate location for flood distribution (Kalantari & eat al, 2009). Dry areas include: (1) Using natural artificial feeding resources from rain and runoff, (2) by table irrigation commanders, (3) monitoring of water management by sewage, (4) enabling natural manure from rain and runoff, (3) Aboutaleb, 2003). Meanwhile, the problems caused by droughts for many years on the one hand and the destructive floods on the other satisfy the need for proper management of water resources. In this sense, collecting surface water, groundwater feed, and regulating the proper use of water are the most important strategies for managing water resources (Moroati et al., 2007). In Iran, with the increasing use of aquifers, measures should be taken to compensate them, so that without the formation of problems, the spring does not use more water resources and especially winter and spring floods (Ghahari et al, 2007). Various researches have been carried out in the field of locating suitable areas for the construction of flood distribution systems abroad or inside the country.

Krishnomurthy et al. (1996) used remote sensing technology and GIS to determine suitable areas for flood distribution in southern India. They studied the factors of surface water, drainage, water and slope density, geology, topography, and weighed each of the factors based on their importance, and finally obtained the appropriate logic map. The results of this study indicate that suitable areas for this purpose are the Quaternary range and slopes less than 5% (Kirshnomurthy& et al.1996).

Saraf and Choudhury (1998) in the Madhya Pradesh region of central India used suitable sites to spread floods using remote sensing and maps such as land use, vegetation, geomorphology and geology, and their combination with other layers of information. Finally, they determined the appropriate areas for flood distribution.(Saraf & Choudhury. 1998)

Ramalingham et al. (1997) used remote sensing and GIS to identify potential areas for artificial feeding of groundwater in the Tamil Nadu region of India. They used the parameters of slope, runoff, fault density and fractures, geology, geomorphology, soil hydrological groups, land use and drainage density, and classified and classified them as suitable feeding areas(Ramalingam &, Santhakumar ,1997).

Chen (2011) has developed a flood risk mapping study in a study by integrating AHP and GIS and field research using satellite imagery in a semi-rural area around the town of Taiung in Taiwan (Chen ,2011:2).

Rahman (2012) with Multi-Criteria Space Decision Analysis (SMCDA), a combination of several multi-criteria valuation methods and modern decision-making analysis techniques, in order to manage the distribution of flood to pay location (Rahman et al., 2012: 61).

Lone (2013) in a research using Remote Sensing and in the Missouri area, India. Has been identified and identified as artificial feeding areas (Lone& et al., 2013: 92).

Generino (2014) in a study, Analytical Hierarchy Process (AHP) method is combined with a Geographical Information System (GIS) for flood risk analysis and evaluation in the town of Enrile, a flood-prone area located in northern Philippines. Expert opinions, together with geographical, statistical and historical data, were collected and then processed through fuzzy membership. The AHP results showed the relative weights of three identified flood risk factors, and these results were validated to be consistent. (Generino P. et al.,.2014:4).

Germezcheshmeh,& et al, (2000), in a case study to locate suitable areas for flood distribution in Maymeh plain of Isfahan province with five factors: transmission capacity, alluvium thickness and alluvium quality, slope, surface permeability and by combining suitable layers. They determined the flood to spread (Germezcheshmeh,& et al., 2000).

HamedPanah et al. (2001) used land use maps, vegetation cover, slope, geomorphology and soil in a study to determine the areas prone to flood distribution in Qom's Toghrod watershed and determined the areas by combining the maps. The results of the evaluation of the used models show that the gamma operator = 0.1 to gamma = 0.3 of the Fuzzy Logic model have the highest percentage of overlap with the control areas (HamedPanah, 2000).

Hashemi Tangestani and Raoof (2001) conducted a study on the application of the Boolean Logic logic model in the geographic information system with the aim of managing natural resources in the Ashkanan Lamerd desert region. In this research, AND and OR operators of Boolean analysis model were used and after combining the layers, suitable areas of flood distribution were identified (Hashemitangestani & Raoof , 2001).

Mehrvarz Moghanloo (2004) has identified potential quaternary sediments for flood distribution in Tasuj plain in Tabriz city. Based on expert opinion, classification and scoring have been combined with fuzzy method and gamma functions of this method. It has been concluded that fuzzy combination with 0.5, 0.6 and 0.7 gamma has the best overlap with control fields (Meahvarz moghanloo. 2004).

Research Methods:

Shariyar county is located in the western margin of Tehran province. This city is limited from the northwest to Karaj city, from the west to Siah Kooh heights and from the east and northeast to Tehran city and from the south to Robat Karim city. The highest point of 1283 meters is the lowest point of 984 meters and an average height of 1068 meters above sea level. The average annual rainfall in the region is estimated at 187 mm per year. The average volume of precipitation and considering the area of the studied catchment area (equivalent to 739.5 square kilometers), the average volume of precipitation in the studied basin is estimated to be about 170 million cubic meters per year (Tehran Regional Water Company, 2011).

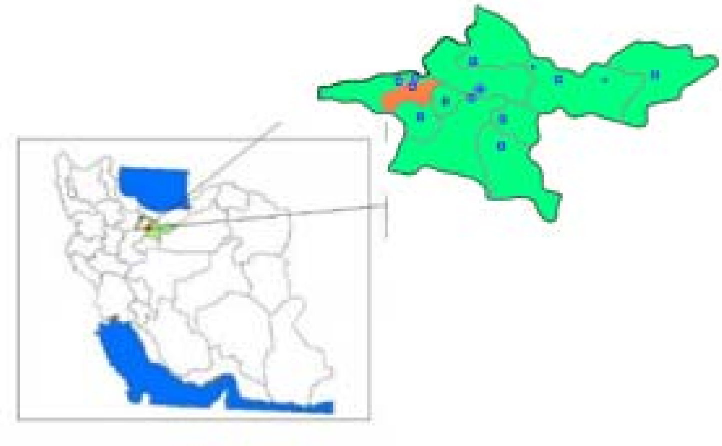


Fig. 1 Geographical location of Shariyar city in Tehran province

In this study, the combination of (Fuzzy / AHP) model has been used to evaluate the land for flood spreading. The Analytical Dynamic Analysis Process is one of the most widely used multi-objective decision-making tools for complex situations with multiple and conflicting metrics that are considered as robust and yet robust decision-making tools. First time by Thomas Al. Saati. An hour was devised in the 1970s. This model is based on a two-way comparison that facilitates judgment and indicates the degree of compatibility and incompatibility of the decision (Ghanavti, 2013: 45).In this research, the location of flood distribution is emphasized by the emphasis on fuzzy logic and the process of genetic analysis in GIS. The ability of GIS to store information, analyze them, perform calculations and display them as precise maps, tables and charts in a short time, put it in a special place.To do this, topographic maps of 1:50,000 of the mapping organization of the country were used. In ArcGIS software, meter curves for flat and plain areas, Elevation points. It was also used to generate maps such as DEM, ArcGIS software, and EXCEL software was used to calculate and plot the graphs. (Mahdavivafa.2016:24).

The multi-criteria analysis method is a framework that helps decision makers to choose the best option among various policies and projects with multiple goals. In fact, in this method, in addition to quantitative criteria, qualitative criteria are also used and do not only require the use of quantitative data (Ajaje, 2002). Multi-criteria analysis is an important analytical tool that has gained great popularity in the context of multidimensional analysis of evaluation. This tool has been evaluated as a toolbox for complex issues and is widely used in environmental studies (Nanez, 2005). This multi-criteria analysis method introduces some degree of analysis into the decision-making process. Also, multi-criteria analysis is an important tool in evaluating that provides decision makers with different information about the complexity of the problem (Brouwer and Vanek.2004). On the other hand, multi-criteria analysis includes a set of methods designed to identify and organize information related to different stages in the complex decision-making process and is considered as the most useful tool of the time. The criteria are different (Gilpin.1999).

The analytical hierarchical process (AHP) method is based on the three principles of analysis, adaptive judgment and synthesis of priorities. In principle, it is necessary to analyze the problem of decision-making in a hierarchical way, in which the elements at a certain level have a hierarchical structure, taking into account its origin at higher levels. The AHP method includes the following main steps:

A- Preparing a pairwise comparison matrix: In this method, a basic scale with values of 9 to 3 is used to determine the relative priority of two criteria. (Table .1)

Table .1 Quantitative value Saaty AHP model weighting

Preferences	Numerical values
Entremely preferred	1
Very strongly preferred	2
Strongly preferred	2
Moderately preferred	7
Equally preferred	9
Between corrections	6 ‹8 ‹4‹ 2

B- Calculating the weight of the criteria

This step includes the following steps:

-The sum of the values of each double matrix comparison column

-Divide each component of the matrix by the sum of its columns

-Calculate the average of the components in each row of the normalized matrix

C- Estimating the ratio of agreement

-Determining the total weight vector by multiplying the first criterion in the first column of the main comparison binary matrix, then multiplying the second criterion in the second column, the third criterion in the third column of the main matrix and finally adding these values in rows

-Determining the vector of agreement by the vector divider of the standard criteria that has already been determined (Ghodsipour, 2005). In this study, hierarchical analysis method and geographic information system have been used to locate flood distribution.

Discuss:

In this study, location indicators were determined according to the available information. Therefore, six factors of slope, geology (quaternary units), land use, alluvium thickness, dewatering status and electrical conductivity are among the factors affecting the location of flood-prone areas in the city. Shariyar of Tehran province is selected and examined and evaluated

-Slope layer

The spread of floods on slopes of more than 8% causes erosion of sheets and grooves in the area and increases the cost economically because the distance between the embankments is reduced. Existing experience of flood distribution in 34 flood distribution stations in Iran, the slope of 2-0% is considered the most suitable slope for distribution and has not given a positive answer in slopes of more than 8%. Table (2) shows the slope classification based on the flood distribution talent(Jihad Water and Watershed Management Research Company, 1997).

Table 2 - Slope classification based on flood distribution talent

Suitable for flood distribution	Class range(%)	Slope class
Very convenient	0-2	I
convenient	2-5	II
To some convenient	5-8	III
non convenient	>8	IV

According to the slopes map, about 958706 hectares (47.9%) of the total area of the watershed of Tehran province have a slope of less than 5% . the distribution of which is mostly in the southern regions of the province, which is the area for the slopes below 5% in the province of Tehran, about 9 times the area of 103,000 hectares in the contract, these studies are. (Table 3) and (Fig.2)

Table 3: Area of land with appropriate slope in county Shariyar of Tehran province

county name	Area of susceptible areas per hectare	Percent
Shariyar	110162	12
Provincial total	942662	100

-Geological layer (Quaternary units)

Half of Iran's country is covered by fourth- or quaternary deposits, among which there are alluvial deposits that can be used as production areas while having the ability to store flood water. Based on a brief study, at least 33 million hectares of alluvial aquifers and 11 million hectares of medium quality alluvium can be exploited in these deposits (Mehdian, 1999).

The watershed of Tehran province is located in the area of 13 geological zones: 1: 100000. Major digital maps produced by the Geological Survey could not be used for various reasons. For this reason, geological maps that were not digital were digitized by this company, and other digital maps taken from the Geoscience Database were modified and after merge the map Quaternary areas (Qal, Qt2, Qf2, Qt3 and Qf3) were selected and used in combination. These areas cover about 33 percent (665469 hectares) of the total area of the province's watershed. Table 4 shows the area of land with suitable geological status in the province for county of Shariyar. (Table 4)and(Fig. 3).

Table 4: Area of a prone field from the point of View of geology at the level of the county of Shariyar

county name	Land area with favorable geological status per hectare	Percent
Shariyar	89000	23
Total	654000	100

- Alluvium width layer

The thickness of the alluvium is one of the important factors in flood distribution and groundwater supply. It prevents the infiltration of water and makes the distribution area permanent. Table (3) shows the classification of alluvial thickness from the perspective of flood distribution (Biboardi, 1993). According to the map, the thickness number of alluvial plains of Shariyar plain starts from 250 meters northeast and decreases to southeast and reaches 100 meters (Table 5)and(Fig.4).

Table (5) Alluvium width Classification Based on Flood Distribution Talent

In terms of groundwater storage	Alluvium width (m)
non convenient	<90
medium	90-40
convenient	40-60
Very convenient	> 60

-Land use layer

Land use plays an important role in the selection of flood-prone lands because flood management is generally not cost-effective in the area where agriculture is used, and even lands that are currently free and unused should be used as much as possible.In the field use of the watershed of Tehran Province, a map drawn up by the Soil and Watershed Management Research Institute, which uses the same layers used in the combination, is presented. Describes the area of the land in question in the province of Tehran based on covering the county of Prakash. (Table 6) and (Fig.5).

Table 6: Area of a prone field from the point of view of land use at the level of the county of Shariyar

county name	Area of prestigious arena	Percent
shariyar	74000	6
Total	1203000	100

-Drainage layer layer

Due to the fact that the map (fig.6) of groundwater is taken from the Atlas of Iran's water resources, which are marked with areas with suitable water levels, relatively suitable and unsuitable. On the map. The water supply status of Shariyar County has been given.

-**Electrical conductivity layer**:

Water salinity is usually the most important limiting factor in drinking, agriculture and industry. In order to prioritize the values of electrical conductivity, common classification has been performed (fig, .7)

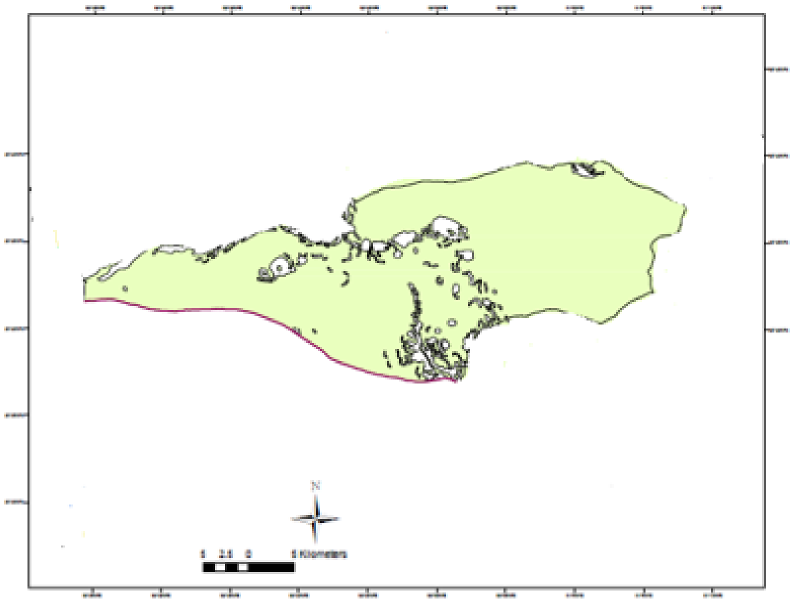
Conclusion:

According to the research method and specified criteria and by observing the necessary characteristics and classifications provided regarding the six factors of slope, geology (quaternary units), land use, alluvium thickness, dewatering status and electrical conductivity, the desired layers were prepared.In order to prioritize the criteria for combining the AHP and FUZZY models, the aim of the research, which is to locate the flood spreading areas, is at the highest level and is determined at the second level. A matrix method has been used in the software to compare the pair. According to the knowledge of the bachelor with mastery and recognition of the studied area, weighing was carried out to each of the criteria (weighting criteria for each of the elements in each layer and Also, the weighing scale of each unit of information in that layer is based on the amount of the role played within that layer and the effect on the distribution of the flood and the greater penetration of the water into the earth. After weighing and doing the calculations in the Expert Choice Software and according to the compatibility rate and index weight, the following result was obtained. Therefore, with the integration of the mentioned layer, finally the areas prone to flood distribution in Shariyar city were identified.

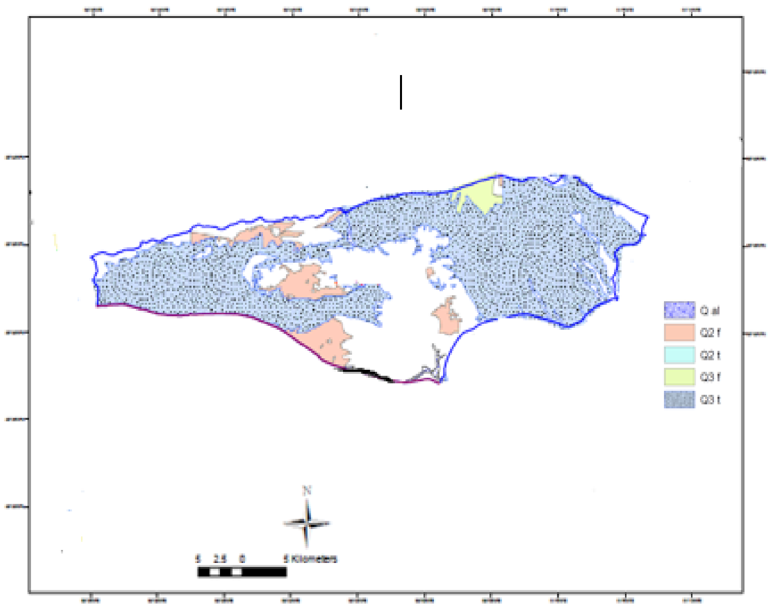
Spreading is about 4.2% of the total area (2,000,000 ha.) of the province's catchment area, which is about 78000 ha. of the total area of the area. According to The scale of the maps used in the areas below 100 hectares was eliminated. The total area of the land suitable for flood spreading is 78000 hectares. by integrating this map in county of Shahryar of Tehran province, the area of favorable areas according to Table 6 was 29000 hectares (Table 6 and fig. 8).

Table7: Areas prone to flood spreading in the area county of Shahryar

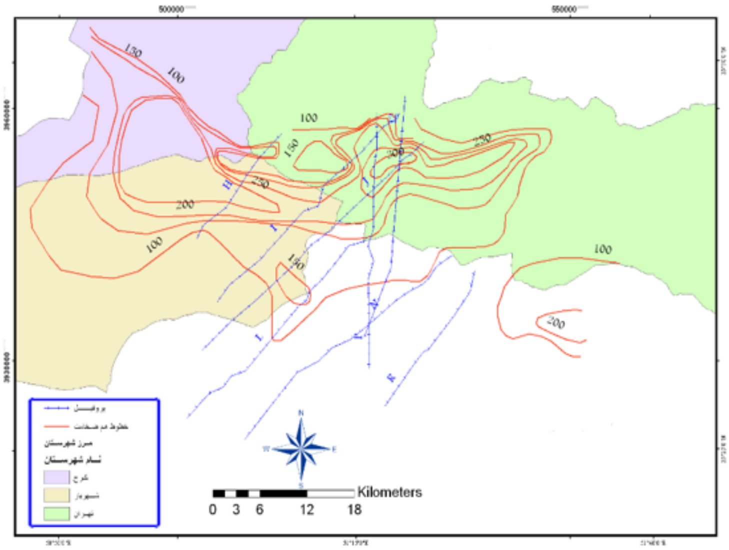
county name	Area - hectare	Percentage of total area
Shahryar	29000	37
Whole province	78000	100



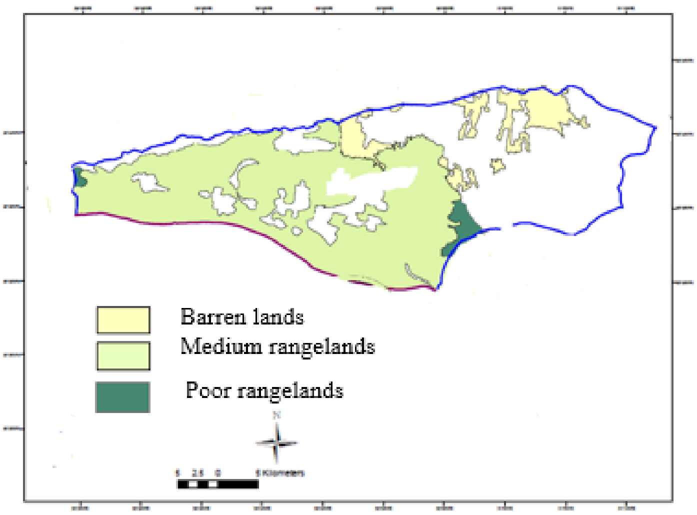
(Fig. 2)Map of Proper slope county of Shahryar Tehran province



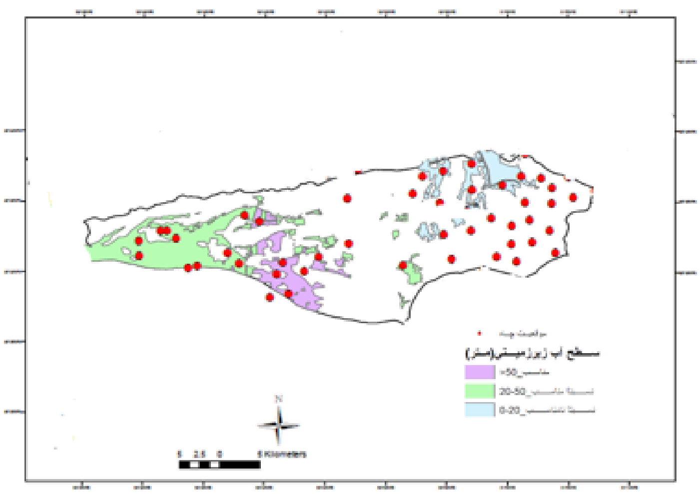
(Fig. 3) Geological map county of Shariryar in Tehran province



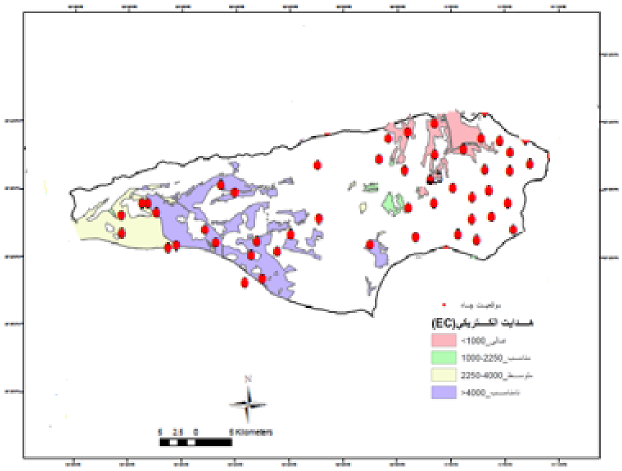
(Fig. 4)Map of Alluvium width county of Shariyar in Tehran province



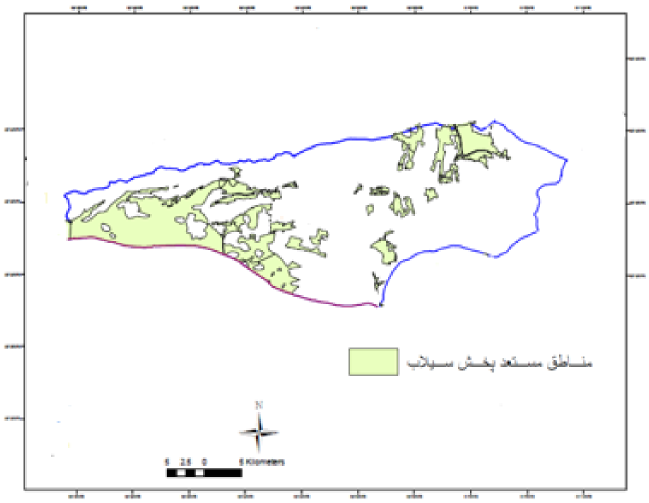
(Fig. 5)Map of land use county of Shairyar Tehran province



(Fig. 6)Map of underground water county of Shariyar Tehran province



(Fig. 7)Map of Electrical conductivity county of Shariyar Tehran province



(Fig.8) Aras is prone to flood spreading in the County of Shariyar in Province Tehran

Source:

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