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Monitoring and Forecasting the land use Change using HEC-HMS model and Remote Sensing Techniques GIS (Case Study: Ardabil 1984-2024)

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ABSTRACT: Land use change and an increase in impervious surfaces due to increased residential area, is one of the main causes of floods. Since the city of Ardabil, like other cities in recent years were faced with increasing population, we see substantial changes in land use, in this city. This study sought to change the land border of the city of Ardabil during 2014-1984 and then anticipated changes by the year 2024. To anticipate this trend by the year 2024, a combination of Markov chains and automated cells have been used. In addition to investigate the changes in land use and determine its impact on the flooding area using satellite images, maps of land use related to the years 1984,1994,2004,2014As well as changes in population between the years 1984 to 2014 were analyzed that The results of this study represents an increase of a 1.5 times of population, which is mainly caused by human activity Including the expansion of settlements and land built on agricultural land around the city. Then, using a map of the of land use, the soil hydrological and vegetation and mapping curve number (CN), has been prepared for mentioned years The amount of (CN) for the years 1984,1994,2004,2014, is, 84, 87, 92 and 96 respectively that during those years, is increasing. Using HEC-HMS software, basin hydrological model is also executed for the region (Ardabil) that Sensitivity analysis of the model indicates that the CN has direct relationship with peak flow rates, And since the rate of CN is directly related to change of land use with increasing urbanization, rate of CN increases It can be concluded that urban development, leading to increase in runoff and flood of area.

Keywords: land use, urban floods, Markov chains, automated cell, HEC-HMS, Ardebil watershed

INTRODUCTION

One of the main factors in the torrential regime change in catchment areas, is Changing land use in the watershed. Land use changes, have significant impact on the quantity and quality of runoff from the catchment areas (Roghani *et al,* 2003). In urban watersheds, on smooth, impervious surfaces that are made by humans, high-speed flooding occurs; therefore, getting a city mode of natural catchment areas, have a negative impact on performance and the increase in volume and intensity of watershed runoff and cause flood the downstream regions (Borumand Nasab, 1381). In parallel with the development of cities, impermeable surfaces such as roofs, streets, sidewalks, parking lots and runways, replacing the natural and permeable land and precipitations which have been influential in the soil and cause vegetation growth, because of the expansion of impermeable surfaces, changed into urban floods, causing damage to buildings and facilities and Water logging in city pathways (Jens and McPherson, 1964). Blocking or redirecting streams without regard to principles of geomorphological at the intersection of the main and secondary streets with less width and height leads to water rejection (Giorgio Kamvrany *et al.,* 2005). Based on previous research, we also can include Khalighi that in year (2004) evaluated the effect of land use change on hydrologic characteristics of surface waters, In West of Azerbaijan province in Barandoz Chay basin by using model number curve to change rainfall to runoff and change Masyngam in HEC-HMS software for routing.

After modeling process, calibration and Validation, to simulate the behavior of the basin hydrological modeling system was used. The results show that the because of the change occurred in the studied basins, flood peak flow increased more than of the flood volume and time focus and latency time reduced to the peak. Motiee in the year (1388) with research in the field of hydrological parameters with HEC-HMS model based on land use changes increased urban growth and development, and impermeable surfaces. In this regard, Karim Khodaee *et al* (2010) using HEC-HMS software investigated the effects of land use changes on flood hydrograph and concluded that the by land use changes and increase in impervious surface, the flooding in the region has increased. On this basis Maryam Ashoori *et al.* (2007), in a study carried out in the catchment area of Darabad in Tehran By with assessment of satellite images of the area before and after of urban development, they calculated the amount and type of land use changes in the watershed and soil CN values in both cases. Then, using the HEC-GeoHMS extension and model HEC-HMS, rainfall-runoff phenomenon in the area for before and after of urban development simulated and flow peak of floods were achieved in each period with different return periods. For the results of this research we can mention to urban development by 8% and an increase of urban flood peak by 9 percent, Reduce the flood hydrograph base time of 10 minutes and increasing the amount of 10% of the development's flood also according to foreign experience of Pijanshi (2007) they studied the impact of land use change on surface vegetation and runoff in the area in China. Their selected method for estimating runoff was SCS method, because the parameters used in the above were type of soil and land use in addition, it used potential adaptation as the input data for remote sensing studies. They showed that with increasing urbanization and loss of vegetation and land use change, discharge peak flow rate and runoff increases effectively. Also WENG in year (2010), with studying the growth and development of an urban area in southern China, has reported that the growth of the metropolitan area in two decades caused several problems in the management of water resources in practice, the height of surface runoff have increased at a rate of 1.8 mm. In this study, a combination of a distributed runoff model using remote sensing (Remote sensing) and geographic information system techniques (Geogeraphic Information System) and utilizing three maps of the metropolitan area changes, land use and surface runoff during the years 1989 to 1997 was done. The aim of the present study was to investigate the effects of growth and development of the city of Ardebil in years 74-80, 80-86 and 86-92, on the hydrological behavior of the basin using HEC-HMS model and GIS techniques.

Table 1: Changes in population from 1984 to 2006 in Ardabil (in person).

Census year	1984	1994	2004
population	281.973	340.386	412.669

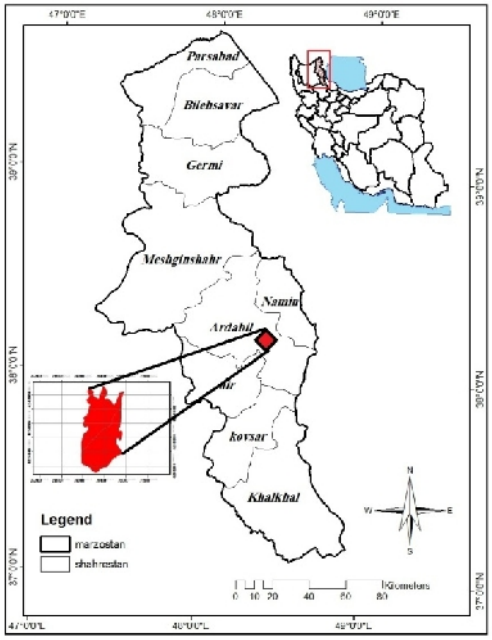

Fig. 1. The location of Watershed in the province of Ardabil.

METHODS

At first, using Landsat satellite images and IRS, Google Earth software and the existing user maps, land use maps for the years 1984, 1994, 2004, 2014 of Basin has been prepared. Then using software Arcgis, the area of each of the different users were determined and the amount of land use changes over those years, were studied. Then, using a land use map as well as maps of soil hydrologic groups and basin vegetation, CN plans for three years provided And CN changes in those years were examined. Finally, to assess the flood zone and to prepare flood hydrograph of the mentioned years, the software HEC_HMS was used.

RESULTS AND DISCUSSION

A. Population changes and Physical expansion

The development of the city is in relation to urban population growth And in this connection of natural increase in urban population, the rate of net migration to the city, making the transfer of rural communities to build the city population are considered as key factors. Immigration as well as the effect of economic and social policy, which is a major influence in the creation of new economic-social structure, plays a major role in the physical development of cities (Iraqi Khalili, 1988: p. 106). Rapid physical development of the city of Ardabil in recent years due to its transformation into a provincial capital for the city caused numerous problems that one of the most important, is the destruction of agricultural lands surrounding it that can be seen on satellite images in different periods (Fig. 2). The demographic changes in Ardebil also indicate that the population of the city from 1984 to 2006, is increased nearly one and a half times (Table 1) And because increase in the urban population need physical expansion, therefore the most changes has been made in agricultural land use to built user. That this issue demands serious consideration of managers due to the amount of change from agriculture to the built user to apply the appropriate solutions to prevent these changes. Another important component that is effective in physical development of the city of Ardabil is role of the government and political decision-making. Political decisions can be set to make a city attractive or without charm and can change investment and replacement of other situation. Among these decisions, setting boundaries and its impact on growth and development of the city as well as the transfer of administrative guidance to the cities is effective on the dynamism of urban areas (Hosseinzade ,Dalir, Hoshyar, 2006, p. 221). One reason for the rapid growth and expansion is city's selection as the provincial capital of Ardabil in 1994 that it would focus on administrative, economic in the city And in other words we can say that this political decision had the most impact in increasing the population of the city and consequently has caused the user changes around the city.

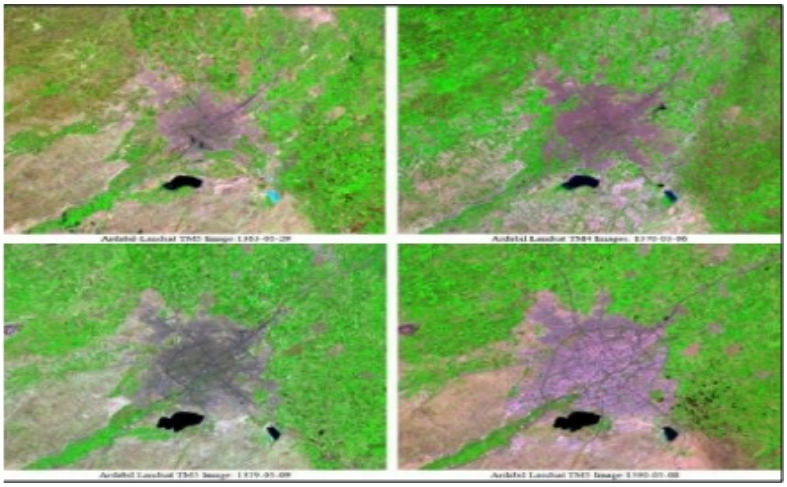

Fig. 2. Landsat TM satellite imagery of the study area for the years 1984,1994,2004,2014.

B. Land use changes

On the basis of preparation of land use map for the years 1984,1994,2004,2014 (Figure 3), the area of land use in the four period, was calculated (Table 2). According to the results, it can be said that in the studied area, there has been a change of the user, but the rate at any time, is different to other sections,

During the 30 years of the study the land use because of population growth and the need for for housing and other municipal required applications, in the 1,796.22 hectares in 1984 reached to 5225.04 hectares in 2014 Which represents an increase of 2.9 times built user in the 30 years.

Table 2: Area of users in the study area (area in hectares).

Row	User	1984	1994	2004	2014
1	Built land	1796.22	2434.86	3355.04	5225.04
2	Aqueous agricultural land	21600.5	23284.71	21640.32	18427.77
3	Aqueous zone	168.7	182.61	213.03	224.73
4	Arid lands	2460.3	740.52	1227.87	2848.59
5	gardens	1005.4	388.44	594.18	305.01
total		27031.1	27031.1	27031.1	27031.1

Reference: extraction of satellite images Landsat (TM)

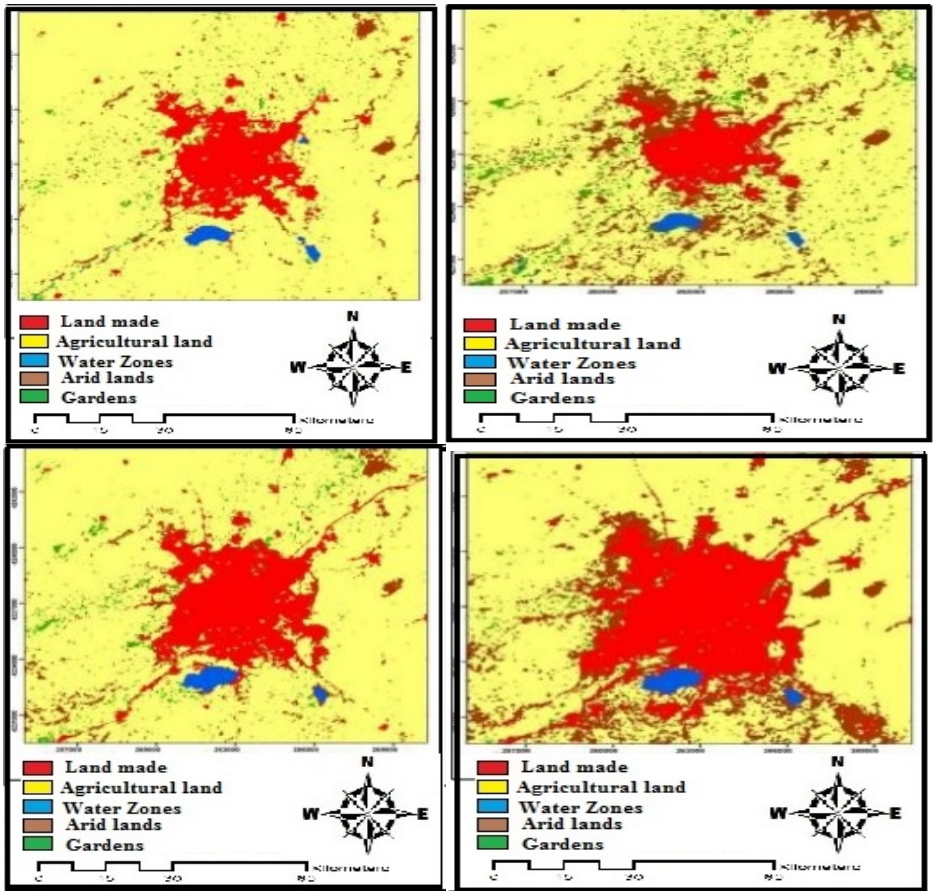

Fig. 3. The land use map of the study area in (1984,1994,2004,2014).

C. Trend of curve number change

Map of soil hydrologic basin, for each period is provided that is not shown any change. By combining maps of land use, soil hydrologic groups and vegetation, curve number map (CN) for basin in the four period, is calculated by the weighted average method The results suggest that amount of CN in years 1984 to 1994 is reached from 84 to 87 and 87 to 92 during the years 1994 to 2004 and During 2004 to 2014 to 92 to 96 (Table 3); The resulting numbers reflect rising trend of CN.

Table 3: The values of the curve number (CN) for the years 1984,1994,2004,2014.

2014	2004	1994	1984	Statistical year
96	92	87	84	Curve number

D. The impact of urban development on the amount of curve number

According to the results, as well as constant attention to soil hydrologic groups in four times, a factor that has a direct impact on the amount of CN, is the development of urban areas That show the impact of residential change on CN.

E. Predicting the trend of land use

There are various methods to predict the trend of land use and in this study Markov chain methods and its combining it with the automated cells are used. To analyze better and more accurate the prediction of land use trend for the year 2024, first a population prediction is done for the city of Ardabil In this research linear growth prediction is used for predicting population of Ardabil. According to the projections made population of Ardebil in 2024 will reach to 485,284 people and this represents an increase of 48,000 people in the city over a period of 10 years. The number of people in need of housing and urban land use can cause changes in the area studied This issue requires serious attention of managers to have a comprehensive plan To prevent land use changes, especially agricultural land use over the period 1984 to 2014. In this study, Markov chain method is used for predicting possible changes of users. The approach to this is that a couple of prepared user maps were compared with each other in two different time periods That represents the likelihood of a the user changes, as well as convert it to other uses is. (Ahadnejad et al.2009.p6). In order to use Markov chains in this method the prepared user map in 1363 as the base map and the user map in 2014 as follow are considered as model inputs Then with regard to the duration of 10 years to predict changes, year 1403 is considered as the year of predicted changes in model so that matrix of possible user changes is achieved. The result of the using Markov chains as input data used to perform automated cell method in this study. Figure (4) shows results predicted for trend of change in the year 1403 using the Markov chains. The Figure (5) shows predicted land use map for the study area using a combination of methods, Markov chains and automated cell. According to the predictions made amount of built land in 2014 from 5225.04 will be reached to 6431.04 hectare in 2024 (Table 4).

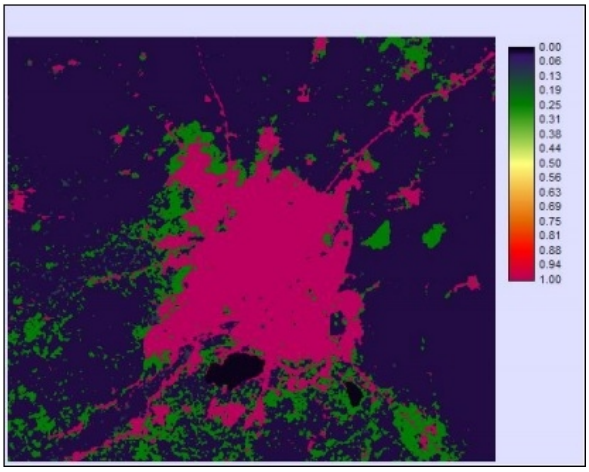

Fig. 4. Land use map of the study area predicted by Markov chains for the year 2024.

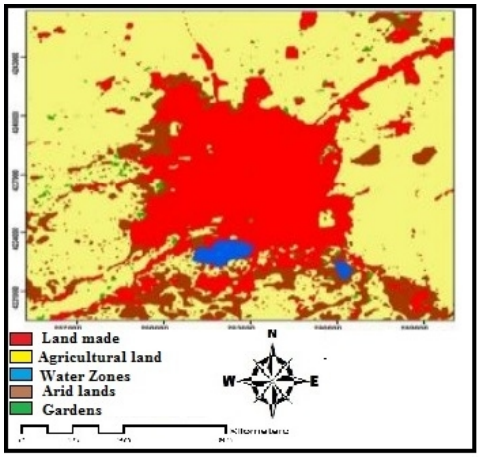

Fig. 5. Predicted land use map of the study area using a combination of automated cell and Markov chains for the year 2024.

Table 4: User Area in the study area by the year 1403 (area in hectares).

Row	User	1984	1994	2004	2014	2024
1	Built land	1796.22	2434.86	3355.04	5225.04	6431.04
2	Aqueous agricultural land	21600.5	23284.71	21640.32	18427.77	17273.97
3	Aqueous zone	168.7	182.61	213.03	224.73	224.1
4	Arid area	2460.3	740.52	1227.87	2848.59	2825.55
5	gardens	1005.4	388.44	594.18	305.01	276.48
total		27031.1	27031.1	27031.1	27031.1	27031.1

F. Evaluation of the results of the HEC-HMS model

Therefore, by using software HEC-HMS, the number of curves and the delay time in each area of study were more or less and the output results in the area is examined. The results suggest that the model is more sensitive to CN changes, so calibration is done based on this parameter.

CONCLUSION

Land is the most important element in urban development. Hence control and how to use it and calculate the real needs of the city In order to meet various users in the present, extend and implementation of numbers and quantities obtained will be effective in solving the problem of land, housing and proper growth of the city (Khakpur *et al*, 2007: p. 47). Considering that growth in Iran, growth control and urban development policy (master plans circumlocution) is done by government The most important state policy in the field are distribution of land, increasing density in existing construction, performing project preparation And in relation to housing policies for society we can name the urban land, housing policy support, social housing, mass-housing, downsizing, apartments and rental housing policy (Pour-Mohammadi, 1993: p. 134). Forecasts carried out in relation to Ardebil and it should be noted that over the next 10 years 48,000 people will be added to the population of the city of Ardabil that Urban development plans need to control number of housing with different strategies (preparation of land in the right places, vertical policy making, population control, etc.) control. According to the forecasts made in this article, in the absence of proper planning for the city according to area conducive to physical development of the city, in not far future, we will observe the loss of agricultural land around the city of Ardabil and their convert to urban areas. The results of this study are as a warning for urban planners to be able to do a proper planning, including vertical policies prevent over development of the city. Also, due to the changes in land use and change of CN in this area, and the effect of user change on CN and CN impact on the flood peak flow It can be concluded that urban development, has a direct impact on the increase in peak discharge. The result corresponds with the results of study of Khalighi Sygarvdy (2004) in the watershed Barandoz Chay in West of Azerbaijan province, and Kamvrany *et al.* (2005) in Renault watershed in northern Italy.

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