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Effect of lands use on flood zoning, and its role on environmental strategic planning

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ABSTRACT

Presenting appropriate solution in the shortest time possible is the goal of a strategic plan to pursue between environmental risk factors and natural hazard. Lands use change is one of the inappreciable dangers and hazards that increase floodwater zone and its return period. In this research Percentage of Lands use changes in Neka watershed, and occurrence level of flood, was determined in HEC-RAS and ENVI software environments, by using satellite images of measuring tools ETM+ (in year 2000) and IRS-1D (in year 2012). Then, obtained results were transferred to GIS environment and was observed that, moreover lands use change, flood level has increased in last decade. This research show that adequate and accurate knowledge of natural environment is required for a strategic planning to deal with environmental dangers; and it decreases uncertainty in planning, by determining and detecting the level of Lands use changes and flood occurrence. Finally, the performance evaluation model to simulate the flow in the Neka watershed is recommended.

KEYWORD

Flood, Lands use, Neka Rood, Planning.

INTRODUCTION

In recent years many attention has focused on land use role on flood zoning and programmers attempts to use different environmental maps and simulations in prevention activities against flood. Strategic programming and evaluation its effects in one of the most important duties of new managers and all organizations should be used this process [4]. Improvement, evaluation and sustaining the effective role of programming are one of the key duties of managers in organizations [33]. Although mathematical and statistical methods in hydrology cannot determine the time of flood occurrence accuracy, but by determining the probability of the occurrence of previous floods can be used in programming [25]. Therefore is not possible to predict and schedule flood and ice danger for rural and environmental program without studying data and variables [34]. In strategic programming process the time and uncertainty have main role [5] (Variations which are observed in region such as land use change cause to losing in future programming, this variations will increase in future, because the technological, economic and social variations are developing) [18]. Uncertainty had dramatically effects on efficiency of edited strategies. Scenario programming is one of the common methods against uncertainty is work area which is amiable for programmer and managers due to its capability in imagine future. To determine the necessary scenario to improve targets such as sustainable environmental ecosystem, sustainable development of sources and activities such as human protection against natural hazards it must be modeled through effective factors or background (land use) and accident (flood).These activities can be theories such as Stochastic programming, Scenario planning, Decision analysis and Game theory [6]. The preparation of land use map is necessary to manage natural resources, environment, determination of land potential and capability. It is an important source for political decision making and edition of programs. Land use changes are an important factor in changing hydrologic flow, watershed erosion and destruction of biodiversity. Therefore the ecosystem can be directed to balance with knowledge about land use change process [32].One of the main pre-provision to use land optimally is awareness from land use pattern and evaluation of variations of uses in time. Integrated Management is a process which affects on water sources and environmental management [29, 42, 8, 16, 27] and land destruction and land use change affects water quality [27]. There are many studies about the determining of land use type and land cover in our country and satellite data such as ETM, SPOT and IRS were used in this field [2].In recent years urbanization have developed at the margin of stream and these society were damaged by flood because they didn't pay attention to environmental potential and abuse from sources. Therefore flood management is necessary in such societies [28]. Maps of flood zoning are very applicable in

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studying flood management [17, 39, 10, 19]. HEC-RAS software, GIS and satellite image are able to simulate water level in natural and artificial channels, negative effects of stream structures such as bridge and culvert using different return periods to prepare three dimensional images from flood zoning [9, 3, 11]. Gichamo et al. [15] used the thermal sensor of ASTER satellite and HEC-RAS and HEC-GeoRAS extension to simulate flood zoning in Tisza stream of Hungarian. Results showed that after evaluation by HEC-RAS the sensor of mentioned satellite had acceptable efficiency. Suriya and Mudgal [38] reported that urbanization and land use change had negative effects on hydrologic process of sub-basin of Tirosolam and Integrated Flood Management and hydrologic model simulation of HEC-RAS are necessary toreduce danger of flood risk. It can be described that the strategic programming in Neka watershed is an important issue to prevent environmental problems and programming is impossible without accident simulation. Therefore the simulation of flood and its relationship with land use change in Neka stream was done to evaluate strategic programs.

MATERIALS AND METHODS

At first the definition and concepts of strategic and hydrological programming are described. Strategic programming is the art and science of edition, operation and evaluation of decisions which can aid to organization to access the long term targets. The strategic programming includes environments assessment (internal and external environment), edition of method, and operation of method, evaluation and control. Therefore the strategic programming emphasize on control and evaluating external fortunes and threats and attention to power and defects in company [41]. (Fig.1) shows the process of strategic programming.

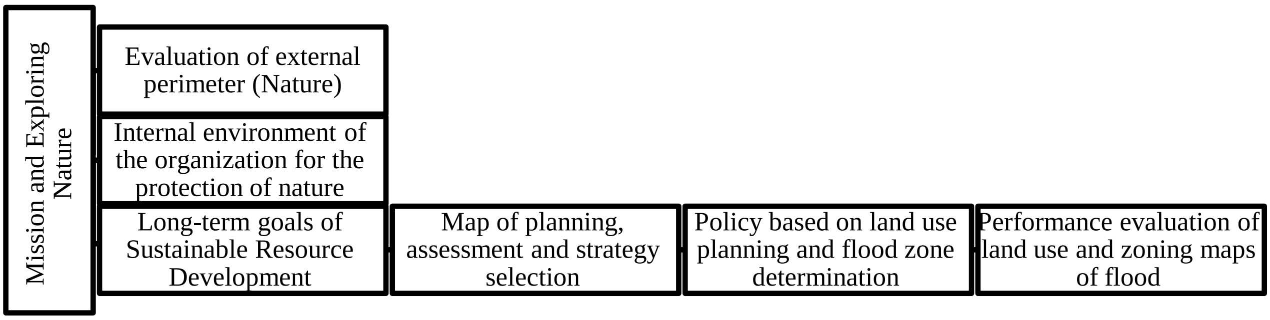

Fig.1. General process of strategic programming based on land use and flood zoning map

After the heavy rainfall or melting snow and large ice peaces and stream overflow the discharges increases rapidly and the flowing water in watershed overcome to water absorption capacity in watershed and consequently the water strew from its bed and runoff is appeared on flat lands and its surroundings. This large flow is called flood. Different factors affects on flood occurrence which are attack to stream bed and its surroundings, lack or reduction of vegetation cover due to land use change, converting rangelands to agricultural lands, plow cultural lands in direction of slopes which prevent from water penetrating in soil and the flood is occurred. The purpose of flood prediction is to estimate flow discharges and flood level which may be occurred in determined return period (such as periods of 25, 50 and 100 years). The result of this prediction which is called planning flood is as the prime of method selection against flood. Planning flood is usually selected based on the necessary costs for controlling flood and the risk level of the system destruction. Informing about flow properties, volume, intensity, duration, location and time of occurrence is very important in planning and protecting engineering structures especially water structures and prediction of risk and its damages. In our country the flood in shapes of spring melting snow and/or sudden rainfall, consists of the large amount of surface flow in most of the streams because of the climate conditions.

STUDY AREA

The watershed of Neka stream is one of the Caspian Sea watersheds and is located in eastern longitude from 53 17 to 54 44 and northern latitude from 36 28 to 36 42. This watershed from northern aspect is limited to Gharehsoo and small watersheds of Gorgan gulf, from western aspect is contacted to Tejen watershed and from east is contacted to Gharehsoo watershed in Gorgan and from southern is contacted to Tejen watershed and watersheds of Semnan province. The area of this watershed is equal to 1922 km2 and its surrounding is 406 kilometer [11]. The elevation of the highest point in the watershed was 3500 meter (elevations of Shahkooh) and the elevation of the lowest point in external region (Ablou station) was 50 meter and in connection to Caspian Sea it reaches to -20 meter. 61% of the watershed is located in Mazandaran province and 39% is located in Golestan province. The Gorgan plain is located between two main fracture of Alborz and Mazandaran-Caspian with have completed row of sedimentary, igneous and metamorphosis stones with thickness of 2.5 km. the direction and general aspect of the structures in region was north western and south eastern. Figure 1 shows the geographical position of the study area (Fig. 2).

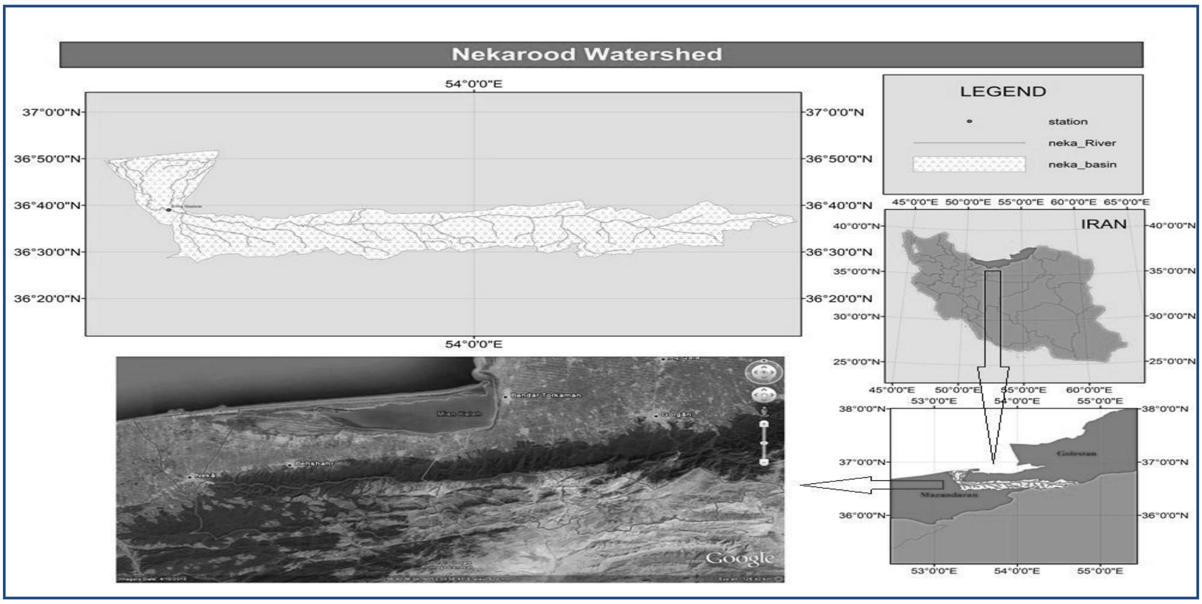

Fig.2. position of the study area

Two satellite images ETM+2000 and IRS-1D 2012 was used to investigate the land use changes. The stages of pre-processing such as atmospheric, elevation and geometric corrections was done in user team of ENVI and the preparing GIS layer and processing in HEC-geo-RAS to inserting in HEC-RAS software was done in GIS department. Also, the field survey was done to determine required stubby coefficients in HES-RAS software and calibration of required discharges values with return periods of 2, 5, 10, 25, 50, 100 and 200 year. The Ablou stations in the region was used to calibrate and evaluate the stubby coefficient and observed discharges (Tab. 1).

Tab.1. Geographical position of the Ablou station

Station	*Stream*	*Code*	*Elevation (meter)Sea*	*X*	*Y*
Ablou	Neka	150321025	50M	53°41´17´´	54°36´38´´

.

The Maximum likelihood with 132 training region was used to classify the 5 land use in watershed including agricultural lands, forest, city, rangeland and unusable area. This method is the most precision method to classify basic pixel which has been accepted by many researchers [2, 3]. Then the accuracy of the evaluation was controlled through operational team in the field and the layers were sent to GIS to apply in HEC-geoRAS to calculate flood plain. Finally the based on the criteria of general accuracy, the Kapa coefficient, user precision, precision of the producer, the precision of the image classification was calculate and the digital elevation of flood and the precision of the application of stubby coefficient in composite sections. All stations can be observed in (Fig.3).

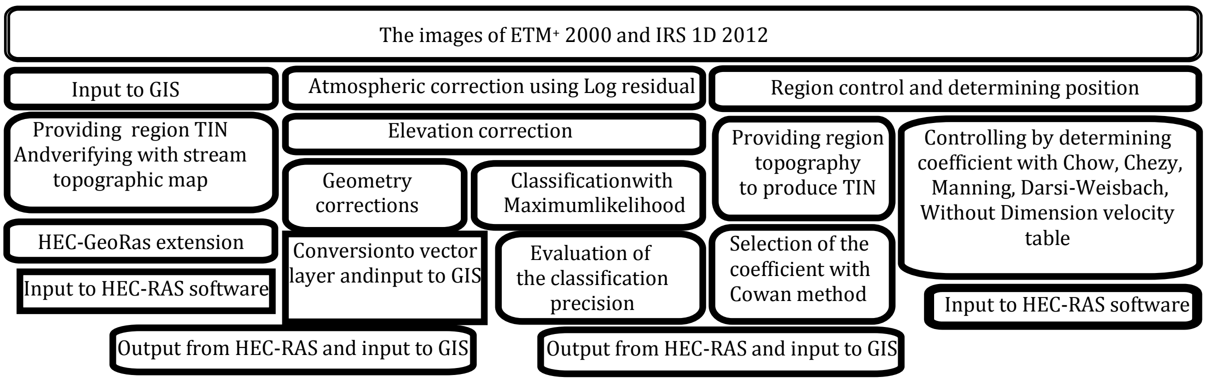

Fig.3. All of the stages and the method of determining of land use and flood plain

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RESULT AND DISCUSSION

Results of the ENVI software are shown in (Tab. 2). The general accuracy of the image is more than that of the Kapa coefficient and this shows that the satellite image with acceptable precision are able to produce land use maps. The values of general accuracy are usually more than that of real values while the Kapa coefficients calculate the precision value in relation to a random classification [24].

Tab.2. General results of the classification precision in IRS images (2011) and Landsat (2000)

Row	Image	Image (year)	General precision (%)	KAPA coefficient
1	Landsat	2000	90.8121	0.8470
2	IRS	2012	94.0027	0.8908

There is relationships between the Kapa coefficient and general accuracy with all classification and don't report the information about the spatial distribution of classes. To investigate the accuracy of the image, the precision of the classes are calculated separately from the user and producer parameters (Tab. 3).

Tab.3. Precision of the image and user in IRS images (2011) and Landsat (2000) in%

IRS			Landsat		
Precision of user (%)	Precision of image	Class	Precision of user (%)	Precision of image	Class
76.56	73.67	Agriculture	86.51	80.66	Agriculture
88.50	89.56	Unusable	86.23	99.76	Unusable
65.67	69.56	Rangeland	89.85	67.75	Rangeland
96.56	90.07	Forest	95.85	99.07	Forest
82.45	69.45	City	80.50	78.98	City

Results of the (Tab.2 and.3) showed that the precision of the IRS images was lower than that of the images of Landsat ETM$^+$. The percentage of land use changes has been illustrated in (Tab.4). The images of 2011 shows the increasing trend in urban and unusable areas and decreasing trend in forest and rangeland areas as compared to images of 2000.

Tab. 4. Trend of land use change in images of IRS (2011) and Landsat (2000)

Difference of variations in percent(+increasing) and (-reducing)	IRS (2012)		Landsat (2000)	
	Sum of class (%)	Class	Sum of class (%)	Class
+8.39	14.15	Agriculture	5.76	Agriculture
+3.14	43.62	Unusable	40.48	Unusable
-1.44	5.50	Rangeland	6.94	Rangeland
-13.24	31.35	Forest	44.59	Forest
+3.15	5.38	City	2.23	City
-	100	-	100	-

Results of the map of land use in GIS was related to years of 2000 and 2011 and shows that the agricultural lands was 2.27%, unusable lands was 7.31%, the city 1.91% increased and the forests 10.22% and the rangeland 1.27% decreased. After the investigation of the stubby coefficients and map of land use, the results of the simulation showed that the Cowan method had higher precision as compared to other methods and this parameter was inserted into GIS to determine the flood zone (Tab.5).

Tab.5. The estimation of the stubby coefficient using different methods and comparison to observed discharge in Ablou station

Estimation method	Chow	Cowan	Manning	Without dimension velocity	Chezy	Weisbach	Estimated discharge
Precision(%)	R^2=0.92	R^2=0.98	R^2=0.96	R^2=0.91	R^2=0.92	R^2=0.93	R^2=0.100
2	60	98.2	40.01	136.3	65.3	57.4	90.8
5	52	175.2	192.3	134.4	124.2	193.5	167.3
10	201.6	218.3	202.1	173.3	169.5	202.4	222.1
25	267.4	281.5	260.2	203.5	184.3	256.4	293.2
50	399.1	333.3	331.2	294.4	199.4	303.9	346.8
100	400.7	390.9	375.4	333.3	202.4	306.2	400.4
200	440.5	438.2	402.6	397.4	245.6	386.4	454.2

The Neka stream profile was simulated using the coefficients of Cowan equation and the data of HEC-GeoRAS extension (Fig. 4).

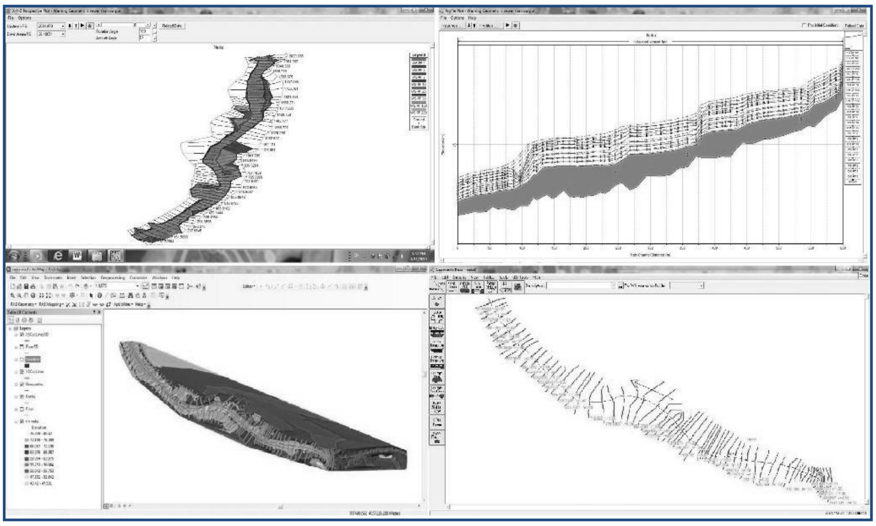

Fig. 4. The profile of Study stream and flow direction

After the preparation of profile the results of HEC-RAS software with return periods of 2, 5, 10, 25, 50, 100 and 200 year were determined and critical and upper critical discharge was considered. The results of the calculations of water level in different return periods was again entered into GIS and the flood zone was determined for each periods which two return periods are shown in (Fig. 5).

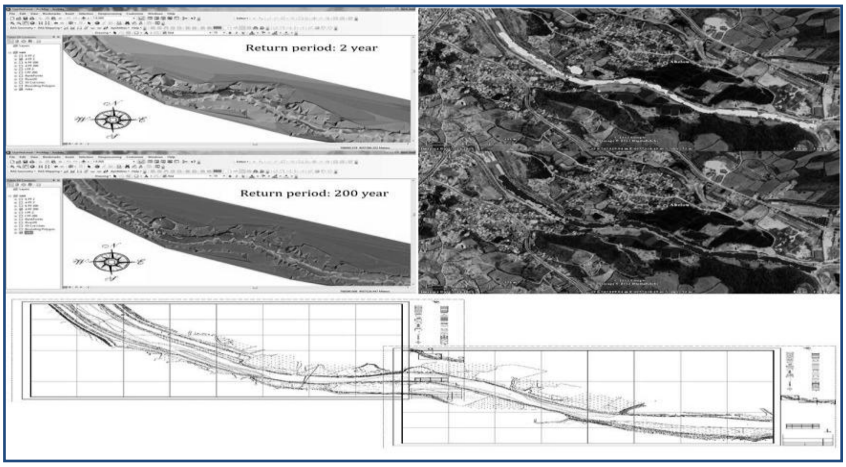

Fig.5. Cross and longitudinal sections and The flood zone in return periods of 2 and 200 year

Results showed that of total area of flood zone in 200-year return periods approximately 73% of them were under the influences of 25 year flood or lower.

Results shows that 563 m2 of region in 2-year return period, 590 m2 of region in 5-year return period, 1236 m2 of region in 25-year return period, 1602 m2 of region in 50-year return period, 1650 m2 of region in 100-year return period and 1804 m2 of region with 200-year return period will go under the water. Findings of this research shows that the most of the land use change was done in direction of reducing forest area and converting usable area to unusable regions. The flood zoning with different return periods shows the increasing procedure such as the findings of [43].

CONCLUSIONS

Remote sensing data are the useful tool in recognizing environmental hazards especially flood. Nowadays remote sensing methods are considered as the base of all strategic programming across the world. Achieved data are used in projects such as flood control to prevent damage. Moreover, the threshold of flood can be estimated and simulated directly or indirectly. With integrating remote sensing data, field study and softwares such as HEC-RAS it is possible to determine the flood area and allowable limit of construction and the criteria for zoning flood and flood insurances. Findings of this research show that with use of the satellite images and flood simulations it is possible to show flood zone maps, return periods and the effects of land use changes.

The environmental programming requires reducing uncertainty, reduction of project and environmental plan defects. Strategic programming with use of the maps of land use changes and flood zoning in different return periods can prevent from large cost and loss of fortune in reaching to final target. Land use change is the danger for management with sustainable development aims. Therefore strategic programming is not possible without pay attention to environmental changes. Other researchers reported that the strategic programming is necessary in an organization and operational scheduling and as the internal and external environmental effects in model [26, 30].

Fazeli reported that the strategic programming is important to access national aims and data collection methods and analysis of environment are the suitable tools to access this aim [12]. Many researchers attempted to provide flood zoning by simulation and this study integrated the satellite images in HEC-RAS software to reduce defects in strategic and environmental programming in decisions [22, 21, 31, 37, 36, 1, 14, 13, 40, 23, 20]. It is recommended that the managers in decision making pay attention to programming and evaluation, simulation of environmental process especially flood maps, flood zoning and remote sensing to improve the management and operations in projects and plans.

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