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The effect of land use planning on agricultural productivity capability (case study: Azaran watershed, Kashan, Iran)

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Key words: Land use planning, Capability of agricultural productivity, Azaran watershed in Kashan.

Abstract

The objective of this study was to analyze the enhancement of agricultural productivity capability with reference to land use planning programs at Azaran watershed in Kashan,Iran.For this purpose, first land use map of 2007 has been generated using Landsat satellite images and Land use map for future(Land use planning) generated using Systemic and Makhdoum (1987) evaluation model. Then, agricultural productivity data of this region in 2007 was collected by related questionnaire and cluster sampling. As result of this study, If land use planning programs will perform, the Gross income in the study region will increase by 36.1% and 36.19% and the Net income will increase 36.19% and 35.1% in a semi-mechanized and a mechanized way respectively.

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Introduction

The world's population is expected to grow from 6 billion today to at least 8 billion in the year 2025. The main activity of agriculture is the production of food, so increasing agricultural development in a sustainable manner will be crucial in responding to these challenge(De Wrachien, 2003). In many developed and developing countries, agriculture plays an important role in food production, employment, and commercial exchanges , moreover due to its width and its strong links with other economic sectors, acts as an initial motivator of economic growth (Nouri and Jozi, 2002). Agricultural practices determine the level of food production and, to a great extent,the state of the global environment (Tilman and *et al,*2001). The supply of agricultural products and ecosystem services are both essential to human existence and quality of life. However, recent agricultural practices that have greatly increased global food supply have had inadvertent, impacts on the environment and on ecosystem services, highlighting the need for more sustainableagricultural methods (Tilman,2002). As soon as land is used by humans, the question arises as to what extent human Extraction and disturbance interrupt the ecosystem's capacity to evolve (Fresco, 1992). Land management planning, with an ecological or land use planning view in national, regional, and local scale, is the only logical way to break the vicious cycle of poverty in the society and environmental crisis and to create the necessary conditions to achieve sustainable development (Nathan , 2011). The intermediatelevel of land use planning is the evaluation of ecological capability of the land for various land uses development in the planning condition (Ownegh , 2005). The importance of evaluating ecological capability of the land is so that if a land lacks suitable potential for a particular application (even if there is a socio-economic need to that application) ,the execution of the plan not only does not lead to an improvement in the environmental situation of the region, but also will bring along more destruction in the environment (Dasman, 1984; Elreay, 1997; Tabibian,1998; Nouri and Jozi, 2002).

In the recent years, evaluation of ecological capability has been raised in Iran and many parts of the world as a necessity in the planning made for land use planning.

Reyahi Khoram et al (2005) in their research, evaluated Hamadan Province, from aquaculture point of view and capabilities of the lands to fulfil aquaculture activities. They concluded the suitable surface area for aquaculture activities was equal to 13.1 percent of Hamadan Province. According to the their evaluations, this province has limited potentials for aquaculture activities. Therefore, it is necessary to pay attention to these limitations in development plans.Qiao (2008) in a research in Fengquan ,China, Offered a suitable model for tourism development in urban country region. In this research he used AHP Model. The result of this study showed that this region is suitable for tourism development of 89%.Babaie-Kafaky *et al* (2009) in evaluating of ecological capability of Bane city forests, which is located in the west of Iran,used a (GIS)-based MCDM approach for multiple-use planning in order to reduce degradation and improving sustainability. The results of this study showed that various land uses meaning multiple-use can be exist in area study that executing of those will be cause decreasing of foresters dependence to forest trees, decreasing of degradation and forest sustainability. Thus, this integrated approach could be benefit forest planners and decision makers. Yong *et al* (2010) in a research on Ecological Evaluation for Large Conurbations in Less Developed Regions in Foshan, china, obtained the three-level land-use zoning for Foshan. Four areas, 11 sections, and 78 cells designed within four main classifications of function zones: ecological conservation area, ecologically sensitive area, ecological construction area, and ecological regulation area. Accordingly the overall land-use pattern of Foshan has been clearly improved in terms of urban sprawl control, landscape pattern optimization, industrial layout redesign, and ecological conservation.Nathan L,Engle,(2011) reviewed the concept of adaptive capacity and various approaches

to assessing it, particularly with respect to climate variability and change. She found that adaptive capacity is a relatively under-researched topic within the sustainability science and global change communities, particularly since it is uniquely positioned to improve linkages between vulnerability and resilience research. She identified opportunities for advancing the measurement and characterization of adaptive capacity by combining insights from both vulnerability and resilience frameworks.Ahmadpour and Alavi (2014) carried out a research based on local conditions to identify stimulus and effective factors of farmer's land use changes and to provide practical solutions. Based on the results, provision, implementation, and support of applied-economic plans such as land integration, permission, and establishment of processing- supplementary industries near the agricultural production fields, paying attention to agricultural insurance, and so on, to create a sustainable balance between the income of the agricultural field and other fields might noticeably reduce or abolish farmers' motivation to change their land use.Gutzler *et al* (2015) in sustainability impact assessment for Brandenburg, Germany Concluded that a considerable potential for agricultural intensification exists. The intensification is accompanied by adverse environmental and socio-economic impacts. The assessment approach and the Brandenburg case study may stay exemplary for other regions in the world where similar economic and policy driving forces are likely to lead to agricultural intensification. Land use planning and necessary supporting data are crucial to developing countries that are usually under severe environmental and demographic strains (Bocco,2001).

Based on the outlook document of Islamic Republic, establishing an appropriate mechanism for production factors growth (energy, workforce capital, water and soil, etc.) and improving the villagers' and farmers' income and removing poverty by strengthening production infrastructures, are the main goals of preparation planning.

Though land use planning affect on agriculture productivity at all spatial scales, studies at regional and local scales and it is more relevant to provide important information to local economical and societal developments and environment protection. Also, due to the fact that this area is a major supplier region of agriculture products for Kashan, the importance of implementation land use change based on potential at land area is Characterized. The objective of this study was to quantify the impacts of land use planning and evaluation of ecological capability on agricultural productivity capability in Azaran watershed, Kashan,Iran.

Materials and method

Study area description

The Azaran watershed is the unit of consideration for this research which is located in northwest of Esfahan, Iran (see Fig.1). Geographically it extent on 33° 39′ 57″N to 33° 44′ 45″N and 50° 59′ 46″E to 51° 15′ 07″E and encompasses 9601(he). Elevation is ranged from 2030 to 3400 m based on mean see level. Predominant land use of Azaran is rangeland (Akbari *et al*,2014).

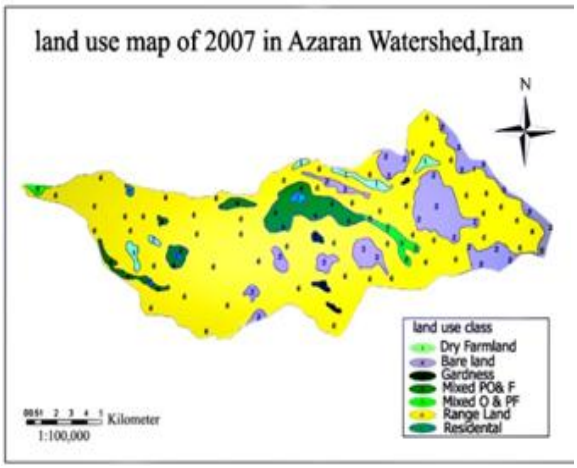

Fig. 1. Layout of the study area.

Methodology

This study set out to implement land use planning program by a systematic and Makhdum evaluation models and to investigate the amount of agricultural production of Azaran Kashan watershed area ,the wheat production based on its cultivation area have been chosen. All production costs, including the cost

of cars, the costs of inputs used, labor, and lands were calculated. Based on cluster sampling and survey research, the required data was gathered through the related questionnaire in the field.

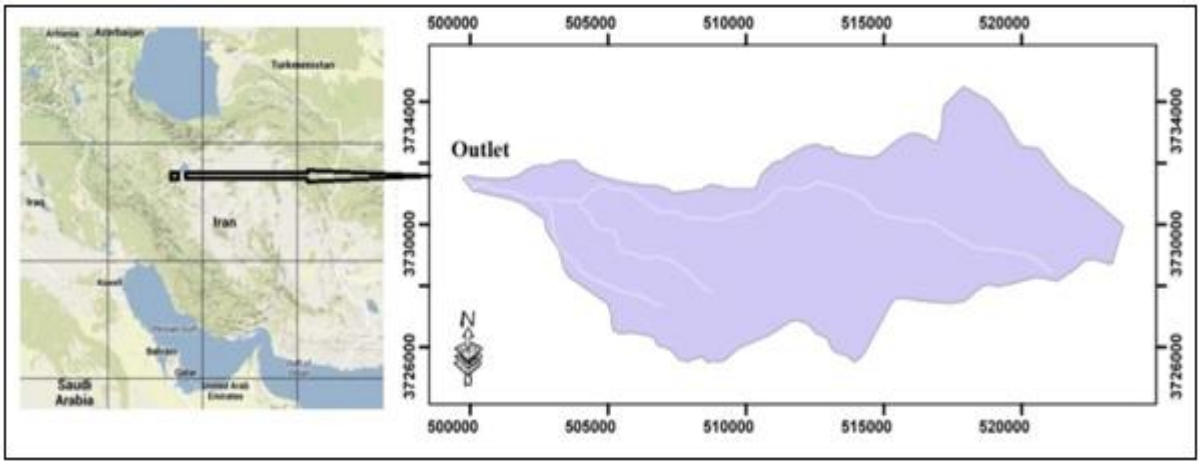

Fig. 2. The land use map of Azaran Watershed in 2007.

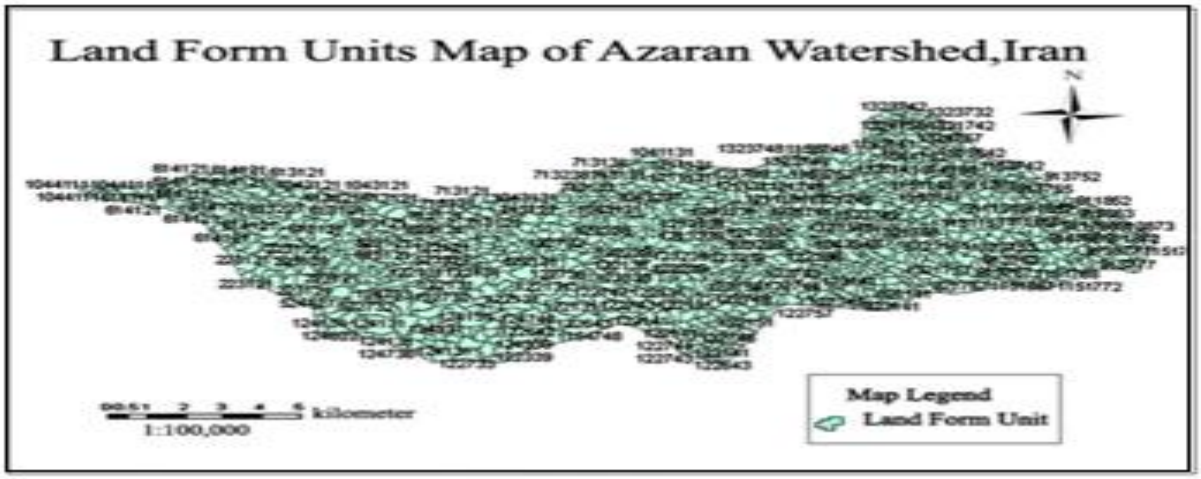

Fig. 3. Land Form Units of Azaran Watershed.

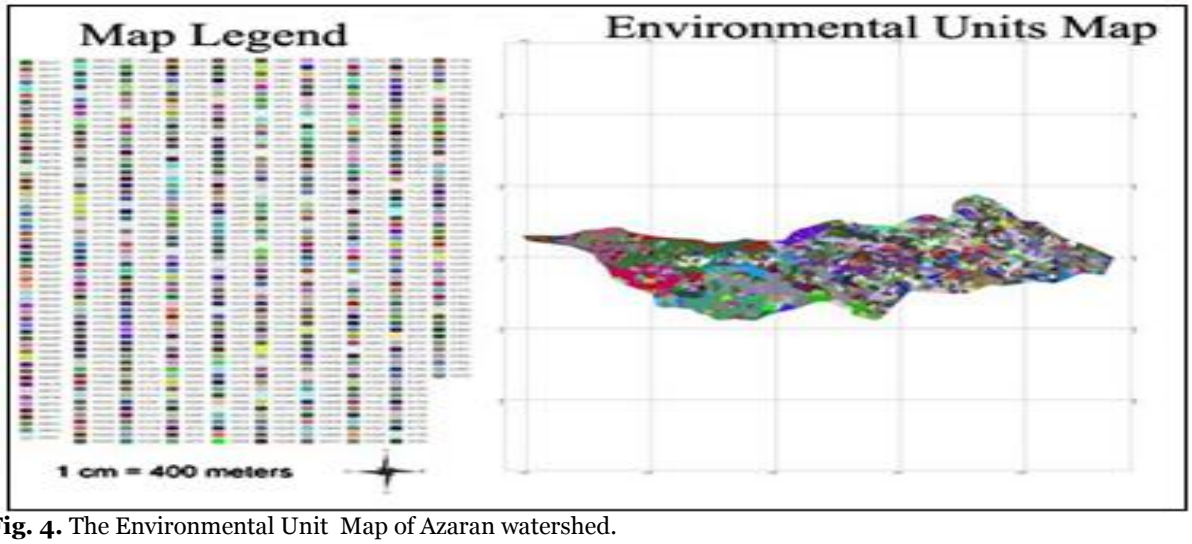

Fig. 4. The Environmental Unit Map of Azaran watershed.

The study was conducted based on the following general steps:

-The preparation of basic maps in the area including, topographic maps, vegetal cover, geology, and lithology in the index of 1:100000.

-The use of survey research methodology for investigating agricultural products and for gathering the related data with the related questionnaire in the field and by cluster sampling.

-The comparison between the agricultural production rate based on land use in 2007 and land use planning.

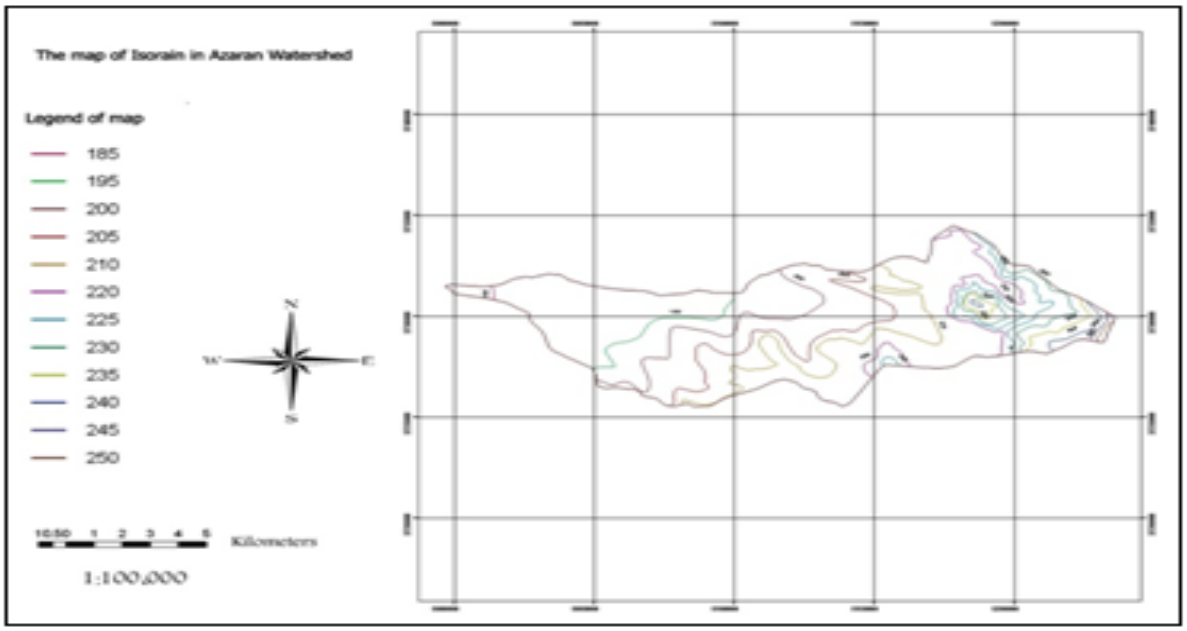

Fig. 5. The map of water resources of Azaran watershed.

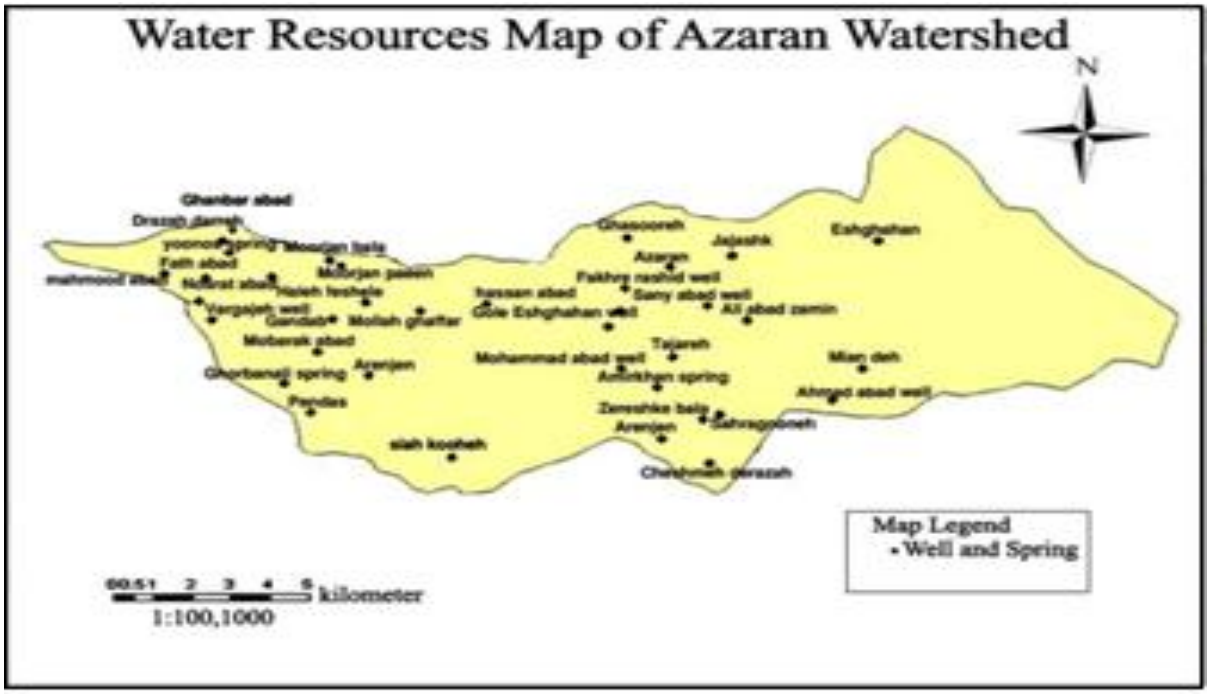

Fig. 6. Climate map of azaran watershed.

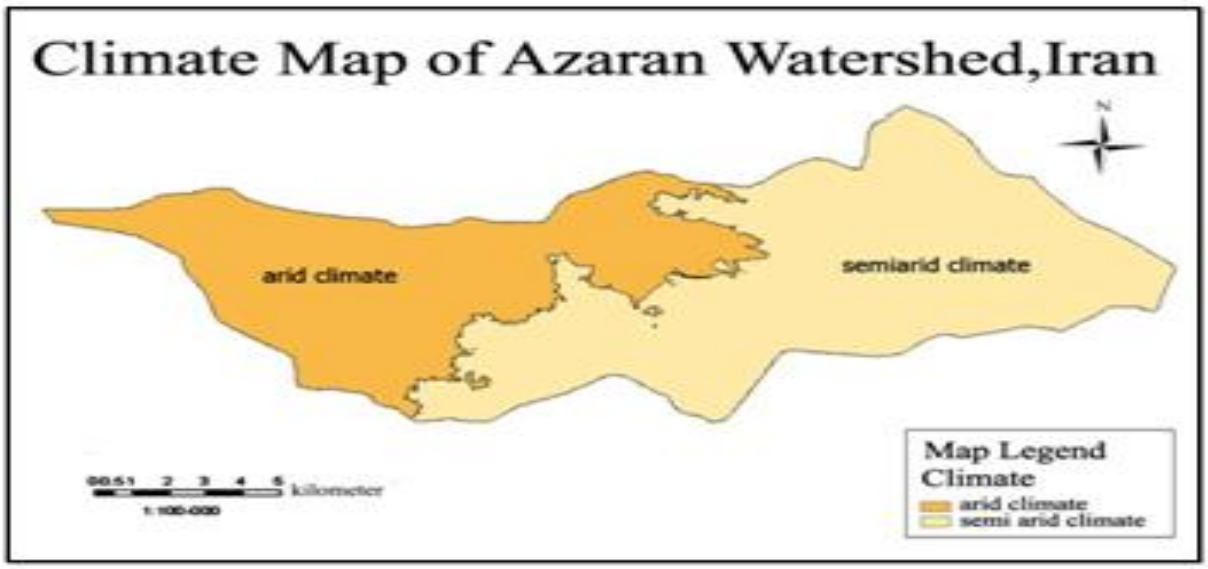

Fig. 7. The Iso Rain map of Azaran Watershed.

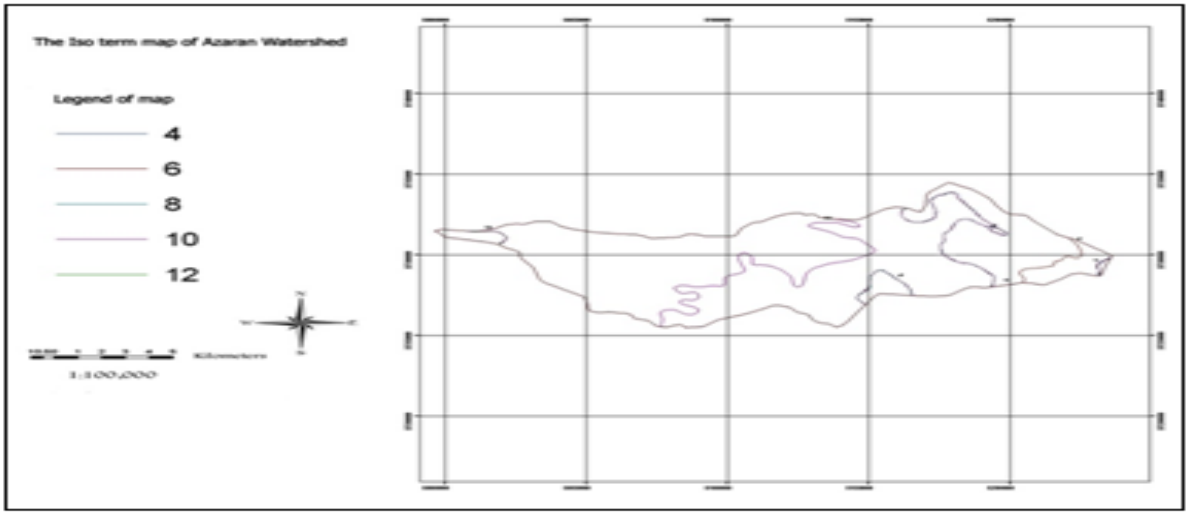

Fig. 8. The Iso Term map of Azaran Watershed.

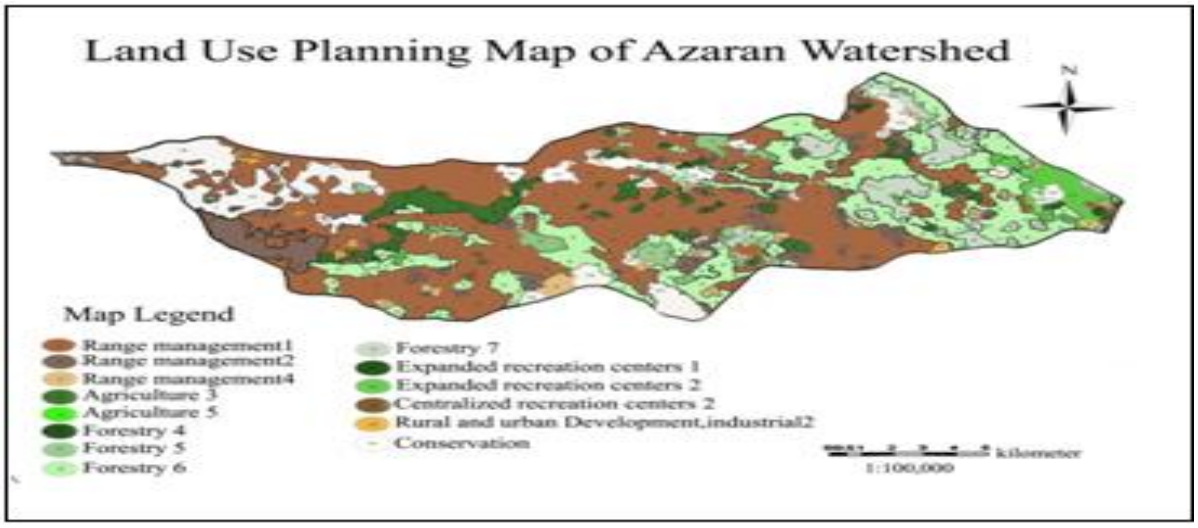

Fig. 9. The land use planning map of Azaran watershed.

Results

(Rebember)

Evaluation of ecological capability is an appropriate tool for predicting and recommending the suitable land use pattern of expected capabilities.In this study, The effect of land use planning on agricultural productivity capability in Azaran watershed, Kashan, Iran has been investigated.

The Land Use Map of Azaran watershed in Kashan

The Land use map for 2007 generated using Landsat satellite images (Fig.2) and Distribution land use classes for Azaran watershed of 2007 show in table 2.

Table 1. Distribution land use classes for Azaran watershed (2007).

Landuse class	2007	Polygon count in the map	Average Area of polygon
	Area(he)	Area(he)	
Dry farm	339.79	339.79	17.25
Bare lands	1359.45	1359.45	12.40
Gardens *	146.11	146.11	-53.76
Mixed predominate Gardens and Farm *	351.91	351.91	-56.01
Mixed predominate Farm and Gardens*	489.85	489.85	-47.77
Fair to poor Rangelands	6854.45	6854.45	14.46
Residential area	59.44	59.44	0.00

The map of Land Form units

The map of slope classes of the Azaran watershed was generated by using topo map at scale of 1: 50000 and 20 meters line spaces and based on evaluation of ecological capability models. This map was classified into seven classes that each class indicates special potential. The map of height classes was also prepared by the topography –base map of the region. In the next stage the map of geographic aspect by using Geographic information system(GIS) was provided by the topo map. Then the maps of land form units were generated by overlapping slope, aspect and height level maps(fig 3). Each of the units indicates specific characteristics from the point of view of the class, the slope percent and height class. These units were named with a special code. Naming of the unit was carried out using Makhdum Model (Makhdum, 1996).

Table 2. Percent of the area of the various classes of suggestive land uses in Azaran watershed.

Land use classification	percent	Area(ha)	The number of polygons in the map
Agriculture 3	5.54	532.58392	30
Agriculture 5	0.58	55.62679	5
Range Management 1	39.76	3817.46127	183
Range Management 3	6	580.33435	58
Range Management 4	1.6	154.384741	19
Supportive wood plantation 4	0.06	5.91107	1
Supportive wood plantation 5	1.2	119.59327	14
Supportive wood plantation 6	2.84	272.580166	27
Supportive wood plantation 7	4	384.41294	47
Expanded recreation centers1	0.2	19.50643	4
Expanded recreation centers 2	23	2209.36687	144
Centralized recreation centers 2	0.17	16.58639	3
Rural and urban Development,industrial 2	0.73	70.01319	5
Conservation	13.57	1302.63855	42

The Environmental Unit Map

Vegetation maps was prepared by using Aerial photos (ETM, Jun 2002), Field work and sampling based on Blanquet method.

The environmental unit map was prepared by overlapping the soli type and vegetation maps.

In this map, all of stable characteristics including: slope percent, elevation above sea level, geographical direction, soil type and its depth , vegetable type and density are different from its adjacent units .Then, a table was adjusted and each unit coded and determined the characteristics of them including ecosystem stable sources (Fig 4).

Table 3. The machinery costs divided based on the type of operation for one hectare of wheat production in both semi-mechanized and mechanized ways (Rial per hectare).

Production method	Type of operation												total
	Transport	Threshing	Combine harvester	spraying	seeding	Fertilizer application	Boundary formation	creek	Relative leveling	Disk harrows (once)	Furroe		
semi-mechanized	1,030,000	190,000	300,000	-	80,000	-	-	-		80,000	80,000	300,000	
mechanized	1,410,000	190,000	-	500,000	80,000	60,000	60,000	60,000	80,000	80,000	300,000		

(Resources: The resulted from a study in Azaran watershed in Kashan, 2007).

None-sustainable Ecological Characteristics

None-sustainable sources are the ones that their exact boundaries cannot be determined on earth and these boundaries would change over time (like climate, waterways canals). The climate map was prepared by using meteorological data from the nearby stations in High altitudes. The waterway maps was also prepared by using the topography map , field visit and determining permanent and seasonal waterways by using the topography –base map. By using the existing data in the above mentioned maps and overlapping environmental unit maps with each of these maps together, was determined the characteristics related to each unit including, the type of climate, the existence or non-existence of the water (Figures 5,6,7,8).

The evaluation of ecological capability and the determination of various land usage

In this stage, analysis, coding and deduction to assess the characteristics of land usage potential were

carried out and the concerned maps of application potential classes in the area of rural and urban development , services and industria l, centralized recreation centers , expanded recreation centers , supportive wood plantation , agriculture , range management , lake establishment, aqua culture and environment preservation in the prepared and the classes which had application potential were extracted. Then, by using Makhdum's method (Makhdum, 1996) and qualitative-comparative evaluation, the evaluation of ecological capability was done. Furthermore, the best land usage was prioritized and finally, the land use planning map of Azaran watershed, was prepared (Fig 9).

Table 4. The costs of work force used for one hectare of wheat production in a semi-mechanized way.

Type of operation	Costs(Rial per hectare)
Boundary creek formation	240,000
Fertilizer application	90,000
seeding	40,000
Irrigation	250,000
harvest	500,000
Collect the product in the field	100,000
Total	1,220,000

(Resources: The resulted from a study in Azaran watershed in Kashan, 2007).

Accuracy assessment and adaptation of maps

In order to investigate the accuracy of land use maps and their adaptations with each other, Kappa index was utilized. This index showed that the adaption between land use map of 2007 and land use planning map is 29% that it represents Severe ecological manipulation.

The evaluation of ecological capability

Based on land use planning map, 532.58392 hectare(5.55%) of the whole area has agricultural capability (class 3,5) , 4552.180361 hectare (47.41%) of the lands has the range management capability (class 1,3,4) , 782.49744 hectare (8.15%) of the lands has the forestry capability (class4,5,6,7) , 2245.46569 hectare (23.39%) of the land has tourism capability (centralized and expanded recreation centers), 70.01319 hectare(73%) of the land has rural-urban industrial development capability and 1302.63855 hectare(13.57%) of the land is suitable for the conservation capability.

Table 5. The costs of consumer inputs for one hectare of wheat production in both semi-mechanized and mechanized ways (Rial per hectare).

Production method	Input Type					Total
	Irrigation water	seed	Fertilizer	Poison	Bag	
semi-mechanized	2000,000	450,000	700,000	260,000	60,000	3470,000
mechanized	2,800,000	450,000	700,000	260,000	-	3690,000

(Resources: The resulted from a study in Azaran watershed in Kashan, 2007).

Table 2 shows Percent of the area of the various classes of land use planning in Azaran watershed.

The difference between the number and the area of the polygons of Land use planning map with different classes was tested by Chi-square analysis. In this analysis, there is a significant difference in the level of 5% and it means that there is a significant difference between the number of polygons and their area.

Table 6. Production costs and their percent in both semi-mechanized and mechanized.

Input	Cost(Rial per ha)		Cost(percent of total cost)	
	semi-mechanized	mechanized	semi-mechanized	mechanized
Mechanical	1,030,000	1,410,000	15.3	21.1
consumble	3,470,000	4,210,000	51.6	63
work force	1,220,000	60,000	18.1	0.9
Agricultural land	1000,000	1000,000	14.9	15
total	6,720,000	6,680,000	100	100

(Resources: The resulted from a study in Azaran watershed in Kashan, 2007).

Table 7. The comparison between production economic index in both semi-mechanized and mechanized ways.

Production method	Gross income (Rial per hectare)	Net income (Rial per hectare)	Mechanical cost (percent of Gross income)
semi-mechanized	8976,000	2,256,000	45.6
mechanized	12,794,400	6,114,000	23.06

Economic assessment of wheat production in Azaran watershed

Considering the fact that in agricultural production, different types of inputs like machinery inputs, etc. are used, therefore, the cost of agricultural productions was investigated in four different parts including: machinery costs, the costs of inputs used, the costs of labor, and the cost of cultivated land. As mentioned in the introduction, the costs of wheat production were studied and selected in the city based on the area under cultivation. In this study, of the selected farmers according to their ownership, the investors were preferred, which means the farmers who did not own water and land but they rented them. For data collection purposes, questionnaires and in order to complete them cluster sampling (city, district, village, and owner) were used. After collecting the related data, some economic indexes like Gross Income (Rial per hectare), net income (Rial per hectare), and also machinery costs (% of net incomes) were used in order to compare semi-mechanized and mechanized production. The results of machinery costs, consumer inputs, labor, and agricultural fields in both semi-mechanized and mechanized ways are as follow:

a. Machinery costs (Table3).

b. The labor force costs

In a mechanized way, the only case in which the labor force is used is the step of Top –dressing fertilization which included a cost equal to 30,000 Rial per hectare. In other production levels, as the mechanization degree is 100 percent, therefore the cost of labor operation is almost zero (Table 4).

c. The costs of consumer inputs (Table5)

d. The costs of agricultural (cultivated) lands

The cost of renting agricultural land in both semi-mechanized and mechanized ways was the same and for renting acres of the land in order to cultivate wheat, 1000000 Rial must be paid. It should be noted that the cost of purchasing wheat in 2007, according to the Ministry of Agriculture Act is 2200 Rial per kilogram and the cost of purchasing wheat straw is average 416 Rial per kilogram. However, averagely, the wheat production in a semi-mechanized way was 3000 kg and in a mechanized way, 4500 kg per one hectare.

The wheat straw production in a semi-mechanized way 5500 kg, and in a mechanized way was estimate 6700 kg per one hectare. The results of production

costs in both semi-mechanized and mechanized ways are presented in Table 6 and The economic index in both semi-mechanize and mechanized ways are presented in Table 7.

Based on Table (1) and land use map of 2007, area of agricultural lands in order to cultivate wheat for using, was 339.79 hectare and based on Land use planning map, it is 532.58 hectare.Table (8) shows The comparison of the income from wheat between Land use in 2007 and landuse planning.

Table 8. The comparison of the income from wheat between Land use in 2007 and landuse planning.

Land use	Land use of 2007		Land use planning	
Production method	Gross income (Rial per hectare)	Net income (Rial per hectare)	Gross income (Rial per hectare)	Net income (Rial per hectare)
semi-mechanized	3,049,955,040	766,566,240	4,780,438,080	1,201,500,480
mechanized	4,347,409,176	2,077,476,060	6,814,041,552	3,256,194,120

Conclusion

To assess the ecological potential of Azaran watershed, in first place, the sustainable and none-sustainable ecological sources were identified and social-economic studies were carried out for the region. In next stage, the sources were analyzed by GIS and then the land shape units as well as environmental maps were prepared for the region. Last stage consisted of coding the information and data in the tables of environmental units and to accord them with the applied ecological models for Iran and subsequently, special ecological models were suggested for different classes of usage in the form of a mathematical model. In continuation, the data, table and models were fed into GIS and the maps of different application classes were prepared. Finally, Economic assessment of wheat production in Azaran watershed was done.

The results show that

1. The region has potential 3(desirable) and 5 in terms of agriculture and potential 1 and 3 in terms of range management. It Reveals that this region is suitable for production of Pasture and forage plants. These results correspond with the results of the investigation of Karamian and *et al*(2008).

2. There are potential 4, 5 (Average) and 6,7(weak)for supportive wood plantation. In the applied ecological models of supportive wood plantation in Iran potentials 1,2 and 3 are suitable for industrial wood plantation while the region lacks this capability due to environmental limitations.

3. The region has potential 1 and 2 in terms of expanded recreation centers. It is because of Beautiful pastures around the Azaran village and the mountains in the eastern part of the region .

4. Azaran watershed is unsuitable for aquaculture. The steep areas, is the reason for this characteristic. These results correspond with the results of the investigation of Babaee and ownegh(2006).

5. The Kappa index was then used to estimate the conformity of the 2007 and future land uses. slight agreement between Land use in 2007 and land use planning indicates the change of land-use(for example conversion of rangelands to agricultural and horticultural lands in the central part of region) and the results are compiled with Rahimi's results (2012) in the evaluation of Chehl- Chai Watershed of Golestan Province.

6. Comparing the percentage of income enhancement between 2007 and future land uses, shows that in semi-mechanized method with Gross income, it is equal to 36.1%,with Net income equal to 36.19% and in mechanized method with Gross income, it is equal to 36.19%, with Net income equal to 35.1%.

7. Attaining development especially sustainable agricultural development requires a principled and efficient planning and exact implementation of the planning. Management and proper planning is based on the evaluation of ecological capability and the recognition of them. Therefore, due to this subject and results in paragraph 7,, Characterized the necessity of the implementation of the land use planning in order to use of region according to its capability, income enhancement and preventing immigration.

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