ENVIRONMENTAL EVALUATION FOR AGRICULTURAL ACTIVITY BY GIS; A CASE STUDY

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ABSTRACT

Land evaluation analysis is an interface between land resources survey and land use planning and management**.** This research was conducted during 2005. At the first step the Makhdoum's model is introduced, then Hamadan province in the west of Iran is evaluated from agricultural point of view and capabilities of the lands to fulfil agricultural activities and range management. The capabilities are categorized in to nine classes. The Geographic Information System (GIS) with a scale of 1/250000 was used .The used software was Arc View (version 3.2a), with the UTM projection. For evaluation we have used eleven data layers of digital map in the model utilizing Mc Hark method of Maps overly. Based on the results, the capability of the studied area was shown on the map in different types of land uses applying Makhdoums model. According to the results, the extent of wet agricultural land, dry agricultural land and rangelands were identified. Based on the evaluations, the studied area has limited potentials for agricultural activities. Therefore, in development plans it is necessary to pay attention to these limitations.

INTRODUCTION

Land evaluation is defined as "the assessment of land performance when used for specific purpose". It involves the execution and interpretation of basic surveys of climate, soils, vegetation and other aspects of land in terms of land use (FAO, 1981). Before the beginning of development, it is better to select the suitable developing site in terms of ecological capability in order to prevent reduction of natural resources, which may happen for the reason of illogical usage (Nouri and Sharifipour, 2004).

In recent years Geographic Information System (GIS) have been used for various applications. Because of its ability, GIS has become an indispensable tool for land and resource managers. The GIS allows the overlaying of data layers as diverse as satellite imagery, plant surveys, and bird abundance data. Different data layers can be queried simultaneously, providing deeper insight than might be possible with traditional analytical approaches. (Biagi *et al*., 2002)

A recent study in India has shown that GIS and remote sensing approach in prioritization of sub basins and erosion susceptibility zone mapping was more appropriate and very useful in evaluation of basin erosion characteristic (Obi Reddy *et al*., 2004). Mitra and Ilangovan, (2004) have reported that GIS has a very strong role to play with the site selection for suitable harbor facilities. GIS is typically used to store and analyze extensive information in a map – based format (Amarsaikhan *et al*., 2004).

Hamadan Province covering 19493 square kilometers is located in west of Iran, 320 km far from Tehran has a population of about 1.6 million. Due to the low investments in industrial activities, the development of the area is built upon the improvement of agriculture and aquaculture (Reyahi Khoram *et al*., 2004).

This research has been conducted in Hamadan province in the west in Iran during 2005 for evaluating the capability of the studied area to regarding agricultural activities and range management, with the aim of optimization management of the studied area, using the GIS.

MATERIALS AND METHODS

In the present research, the evaluation of studied area has been accomplished using Makhdoum's model. Therefore, it is necessary to introduce mentioned model briefly.

Makhdoum's model

In fact, it is a linear, multi unknown quantity model to evaluate and recognize the potentials and

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capabilities of the land for agriculture objectives. In this model, 28 parameters, related to different factors, or related to 28 informational layers used and each informational layer is consisted of several classes. In this model, the capabilities of the lands in agriculture and range management are defined in 9 sections for 9 lands usses, where each section is explained by using a formula. Considering that different parameters are used in designing these parameters, each formula denotes the characteristics of that selection (Makhdoum et al., 2002).

Case study

The process of land evaluation in this research is presented in three parts.

A - Collecting information was fulfilled in two ways, one by library studying where information resources, libraries, companies, research institutes and ministries were needed for digital information. Second, it was necessary to update the collected information by ground truthing of the essential areas and analyzing as well as collocating comparison of natural conditions of the lands (Reyahi Khoram et al., 2004).

B - Analyses: The characteristics and environmental parameters of each area were numerous, and these characteristics could define an ecological system. Therefore, the important aspect of the survey was the evaluation of the land and studying and analyzing the environmental characteristics, (Burrough, 1996). To analyze the data, Makhdoum's model has been used (Makhdoum et al., 2002).

C - Evaluation: This is the ecological capability in determining or forecasting the potential capability or type of natural usage of the land. Although methods such as check list, matrix, network and overlay have been used for environmental impact assessment, in this research, overlay method has been used to evaluate the capability of the land (Mc Harg, 1971). In addition, GIS has been used as main tool to evaluate the land. The software used was Arc View (version 3.2a) with the Universal Transverse Mercator (UTM) projection and scale was 1/250,000 (Karen and Brain, 1998). Eleven GIS data layers have been used to evaluate.

After preparation of the above-mentioned layers, it was preferred to unite the projection system of all of the layers and the UTM projection system was selected. All layers were on the scale of 1/250,000. Meter was defined for the software system as the unit of the scale and the unit of the map (Biagi et al., 2002).

Following the preparation of the layers, each eleven layers accompanied with the base layer of the province itself were presented in a file in Arc View and the related classification of information was done according to the applied model. In the second step, the above-mentioned layers were changed from their vector data to raster data by using convert to gird command, and to the next analysis in Arc View soft ware. In addition, the amount of the cell sizes was selected as ten meters. This selection caused the operation to be very exact. Then using Structured Query Language (SQL), data layers were overlyed and mapped (Nouri and Sharifipour, 2004).

Out of nine, two selections related to the model over lapped each other. These two selections included selections of two number wet farming areas and three number wet farming areas. After land studying, it was decided that these covering be considered as related to two number wet farming areas. Consequently, the above vastness of the lands was deleted from three number wet farming.

RESULTS AND DISCUSSION

Based on the literature review and field patrolling, eleven GIS data layers were obtained and are presented in Fig. 1 to Fig. 11. The titles of these layers are; Climate condition (Cc), Relative humidity as percent (Rh), The rate of fodder as kilogram per hectare (Rf), precipitation as millimeter per hectare per year (P), soil erosion by water (Se), Air Temperature as centigrade degree (At), Water capacity as cubic meter per hectare per year (Wc), The sensitive plant habitats (Sph), Over-all slope as percent (Os), The value of the protective species (Vps) and Vegetation cover as percent (Vc) (Table 1).

Considering some limitations such as water capacity, erosion and precipitation, first grade wet farming, first grade dry farming, first grade and second grade range management was not observed in studied area. According to this model, favorite areas for second grade wet farming in studied area is equal to 70,000 hectares (3.6 percent of the province), favorite areas for third grade wet farming is equal to 500,000 hectares (25.7 percent of the province), favorite areas for second grade dry farming is equal to 300,000 hectares (15.5 percent of the province), favorite areas for third grade range management is equal to 13,000 hectares(less than 0.7 percent of the province), and the favorite areas for fourth grade range management is equal to 1,060,000 hectares (about 54.5 percent of the province). All of these locations are shown on the Fig. 12.

In a study the evaluation was accomplished by GIS in the East Mediterranean region of Turkey, where, land characteristics were compared with land use types. Three major soil series and twelve different land use types were identified. Corn and citrus were the most planted land use types in the assessment period. The results indicated that Canakci and Mursel soil series were found to be highly suitable for all land use types while Arikli soil series was determined to be moderately suitable citrus, vegetables and watermelon. Citrus plantation maps overlaid on soil series maps demonstrated that the citrus has not been planted completely on suitable areas. (Ozcan et al, 2003)

Ceballos-Silva and Lopez-Blanco (2003) used a multi-criteria evaluation (MCE) approach, within a GIS environment, was used to identify suitable areas for oat crop production in Central Mexico. The results of this research identified 6663 ha with a high suitability level, which represent 57% more than the territory presently being used for oat cultivation in Central Mexico.

CONCLUSION AND RECOMMENDATIONS

Based on the evaluations, the studied area has limited potentials for agricultural activities.

According to the evaluations, the Hamadan province has limited for wet farming activities, to the extent that there is no favorite area for first grade wet farming, Furthermore, second grade wet farming areas in Hamadan province is limited and the basic reason is the cold weather, and climate conditions of the province. Dry farming in Hamadan province faces a lot of limitations, which accompanies such agriculture with a very high risk. This risk is because of the low possibility of precipitation in the months of April and May. Also, Hamadan province is too poor in its pastures and favorite area for first grade and second grade range management can not be founded. Due to low relative humidity of the weather, precipitation less than 500 millimeters per year, extra grazing of the animals, coldness of the weather, bad use of the pastures and the some shortage of pasture management. These findings show that the studied area faces a lot of limitations in executing agricultural and range management activities, so in development plans it is necessary to pay attention to these limitations.

Because of the limitations of the studied area, it is recommended to run appropriate management of the pastures and to take the necessary precautions such as declaring a timed program for grazing the cattle and limiting that. Also, it is recommended to raise the income of the peasants, which this in turn will stop them in grazing their cattle there. Finally, it is recommended to conduct researches about planting some crops that match the weather and capability of the province,

Table I. *Detail of data layers used in this research*

No.	Vc	Rf	Vps	Sph	Rh	At	P	Wc	Se	Cc	Os
1	76-100	*	*	*	*	-18	*	*	NO	a3	0-2
2	51-75	*	**	*	40.1-60	*	*	10000-6000	-0.25	a4	2.1-5
3	26-50	250-349	-	wetland	*	*	200-500	6000-3000	0.25-0.70	a5	*
4	6-25	-250	-	*	*	*	*	-3000	+0.70	a6	8.1-12
5	1.1-5	-	-	*	-	*	*	-	Rill E	a7	12.1-15
6	0-1	-	-	*	-	-	*	-	*	b3	15.1-20
7	-	-	-	Forest	-	-	*	-	*	b4	*
8	-	-	-	Others	-	-	-	-	-	b6	25.1-40
9	-	-	-	-	-	-	-	-	-	*	40.1-65
10	-	-	-	-	-	-	-	-	-	*	+65

**:this class not found in studied area*

***:plant species such as Juniperus polycarpus , Biota orientalis , Juniperus eommunis , Rhizophora mucronata , Acer cinerascens , Prunus avium , Quercus persica , pirus communis*

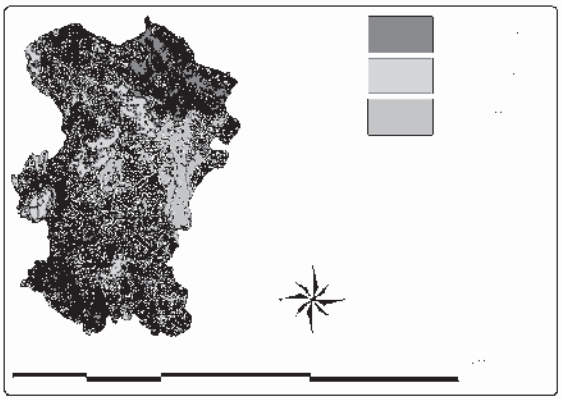

Fig. 1: Characteristics of Water capacity in the studied area

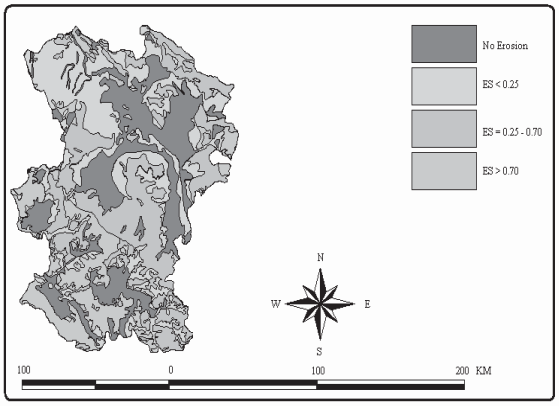

Fig. 2: Characteristics of Soil erosion by water in the studied area

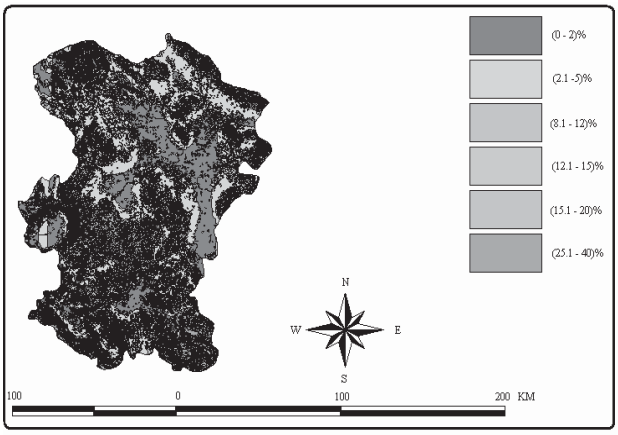

Fig. 3: Characteristics of Over- all slope in the studied area

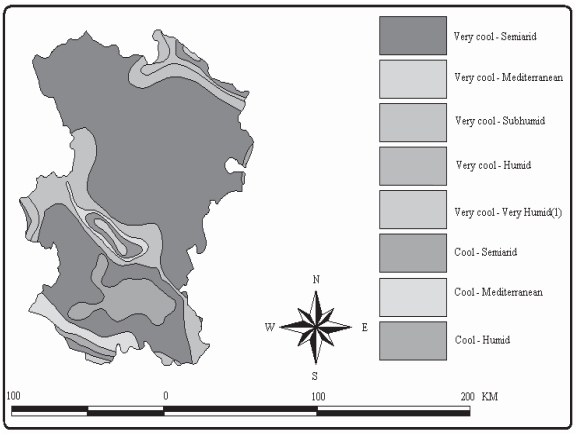

Fig. 4: Characteristics of Climate condition and classification in the studied area

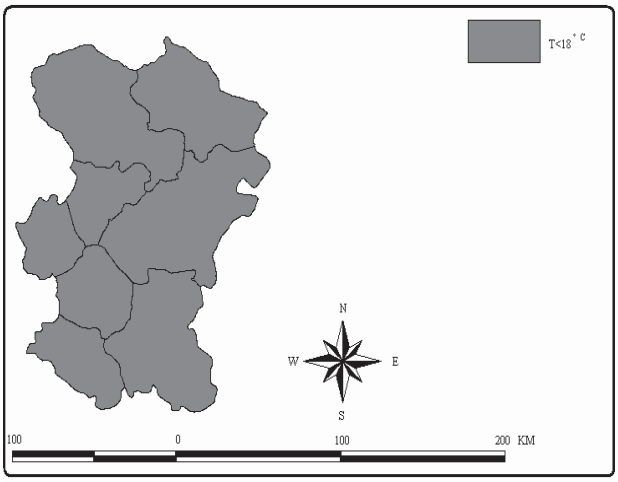

Fig. 5: Characteristics of Air temperature in the studied area

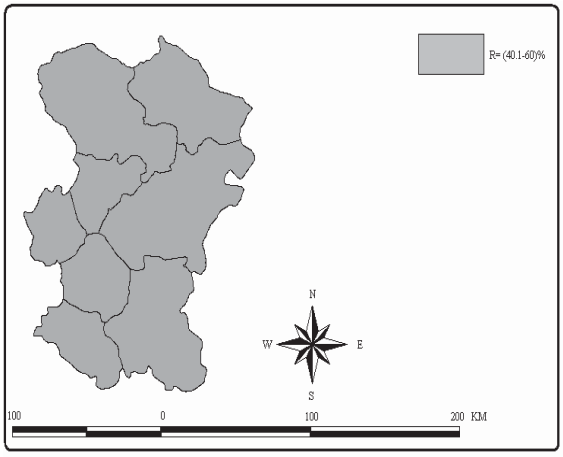

Fig. 6: Characteristics of Relative humidity in the studied area

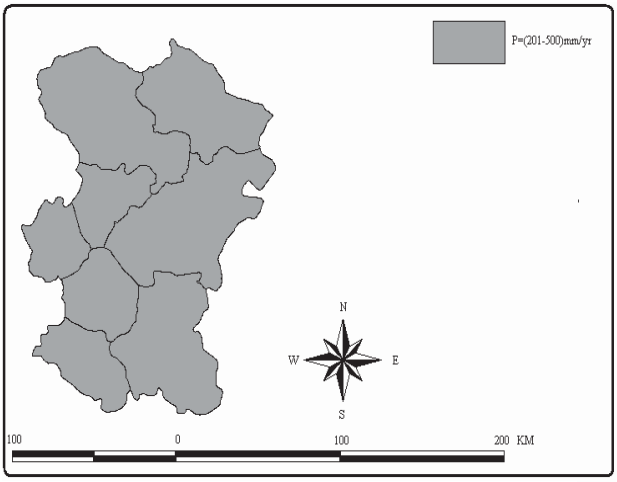

Fig. 7: Characteristics of Precipitation in the studied area

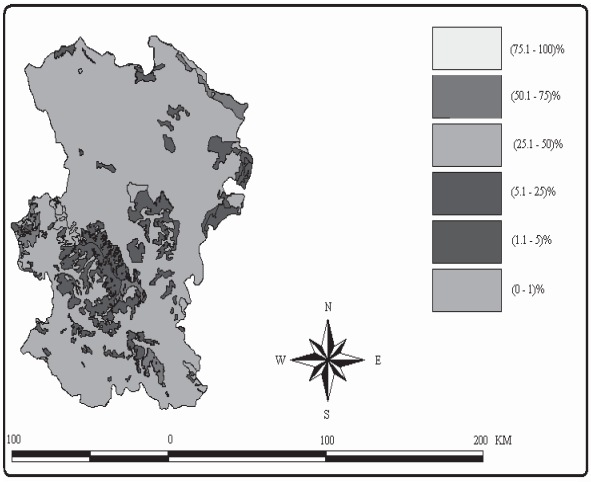

Fig. 8: Characteristics of Vegetation cover in the studied area

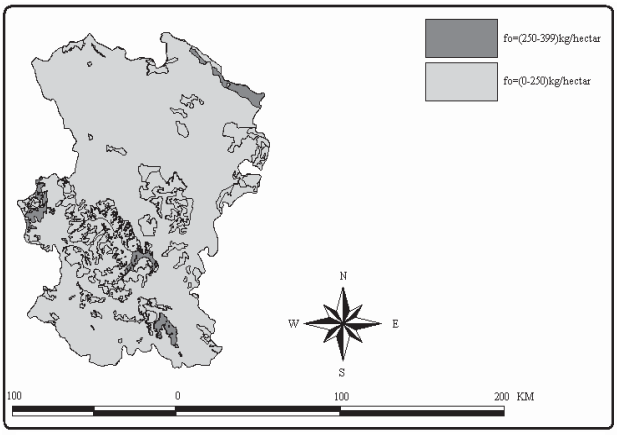

Fig. 9: Characteristics of Rate of fodder in the studied area

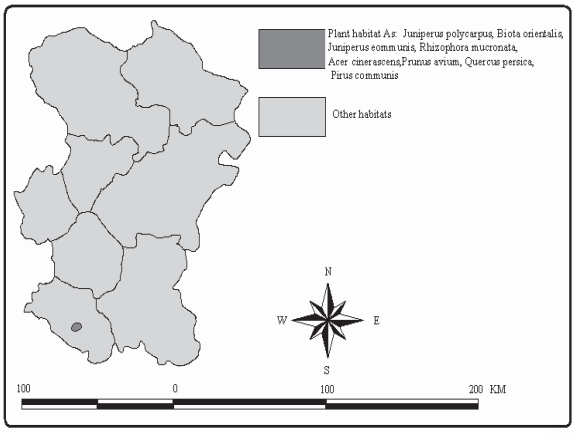

Fig. 10: Characteristics of Value of the protective species in the studied

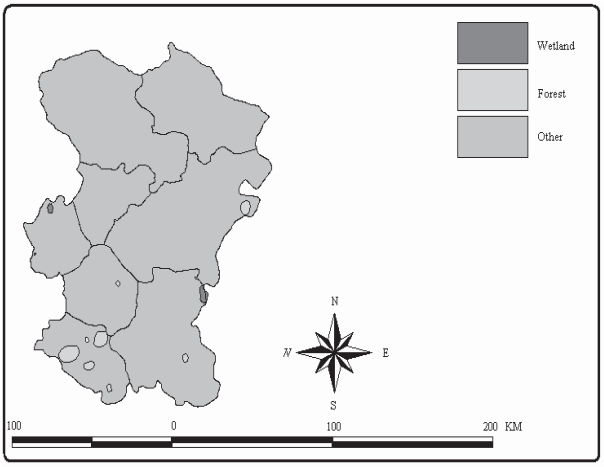

Fig. 11: Characteristics of the Sensitive plant habitats in the studied area

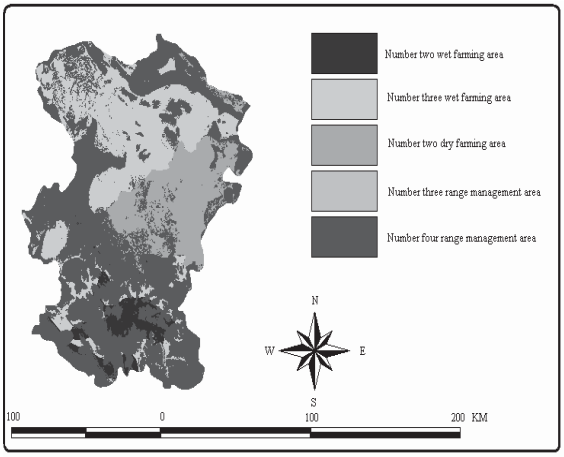

Fig. 12: Results of Evaluation

ACKNOWLEDGEMENT

This research was supported by Agricultural planning & Economic Research Institute (APERI) and Hamadan Management & Planning Organization (HMPO). Authors would like to thank Mr. Kazemi Director of APERI and Mr. Marghaie zadeh, the head of HMPO. Also special thanks to Kaviani (the Head of Jihad-e Agriculture education complex in Hamadan province), Majid hokmi, Manoochehr Asaee, Mansour Hosseini and Abbas Karami and other friends for their participation.

REFERENCES

Amarsaikhan, D., M. Ganzoring, G. Batbayar, D. Narangerel and S. Tumentsetseg. 2004. An Integrated Approach of Optical and SAR image for forest change study. Asian Journal of Geoinformatics. 4(3): 27-32.

Biagi, L., A.M. Brovelli and M. Negretti. 2002. Environmental thematic map predication and easy probabilitic classification. procceding of open source GIS - GRASS users conference,Trento Italy. Available from : ww.blackwell-synergy.com/links/doi/10.1111/j.1467-671.2004.00181.x/abs/

Burrough, P.A. 1996: Principles of geographic information systems for land resources assessment. 2nd ed.Oxford science publication, New York.

Ceballos-Silva, A. and J. Lopez-Blanco. 2003. Evaluating biophysical variables to identify suitable areas for oat in Central Mexico: a multi-criteria and GIS approach. Agriculture. Ecosystems & Environment. 95(1): 371-377.

FAO, 1981: A from work for land evaluation, FAO soils bulletin 32. Food and Agriculture Organization of the United Nations, Rome Italy, pp: 5-11

Karen, C.H. and C.R. Brain. 1998: GIS in site design. John Wiley & Sons Inc, New York.

Makhdoum, M.F., A.A. Darvishsefat, H. Jafarzaheh and A.F. Makhdoum. 2002: Environmental evaluation and planning by geographic information system. Tehran university publication ,Tehran .pp. :185-242

Mc_ Harg, I.L. 1971: Design with nature. Natural history press, garden city, New York. pp: 53-76

Mitra, D. and D. Ilangovan. 2004. Site selection for harbour facilities in the Gulf of Cambay, India using Geographic Information System. Asian Journal of Geoinformatics. 4(4):81-86

Nouri, J. and R. Sharifipour. 2004. Ecological Capability Evaluation of Rural Development by means of GIS. Iranian J. Environ. Health. Sce. Eng. 6(2):81-90

Obi Reddy, G.P., A.K. Mji, G.R. Chary, C.V. Srinivas, P.Tiwary and K.S. Gajbhiye. 2004. GIS and Remote Sensing Applications in Prioritization of River sub basins using morphometric and USLE parameters –A case study. Asian Journal of Geoinformatics. 4(4):35-50

Ozcan, H. ,M.Cetin, K. Diker. 2003. Monitoring and assessment of land use status by GIS. Environmental monitoring and assessment. 87(1): 33-45

Reyahi Khoram, M, M. Shariat and A. Azar. 2004. Prioritizing the methods of treated wastewater reuse by the fuzzy analytic hierarchy process, case study is Hamadan community wastewater. Proceeding of the International Conference on Water Security for future Generations. 26-31 July 2004, Changchun Jilin Province, PR China