Iran. J. Environ. Health. Sci. Eng., 2005, Vol. 2, No. 3, pp. 183-188

ECOLOGICAL CAPABILITY EVALUATION FOR AQUACULTURE ACTIVITIES BY GIS

***[1]M. Reyahi Khoram, [1]M. Shariat, [1]N. Moharamnejad, [2]A. Azar and [3]H. Mahjub**

[1]Department of Environmental Management, Graduate School of the Environment and Energy, Science and Research Campus, Islamic Azad University, Tehran, Iran

[2] Department of Management, Faculty of Humanities, Tarbiat Modarres University, Tehran, Iran

[3] Department of Biostatistics, School of Public Heath, Hamadan University of Medical Sciences, Hamadan, Iran

Received 14 November 2005; revised 20 Desember 2005; accepted 23 April 2005

ABSTRACT

Geographic Information System (GIS) is the best suitable system for land evaluation. In this research, at the first step, the Makhdoum's model is introduced, and then Hamadan Province, from aquaculture point of view and capabilities of the lands to fulfill aquaculture activities is evaluated. GIS was used for the mentioned purposes. The software used was Arc View (version 3.2 a), with the UTM projection. For evaluation, Mc Hark method of Maps overlaying was utilized. According to the results, the suitable surface area for aquaculture activities was introduced, which was equal to 13.1 percent of Hamadan Province. According to the evaluations, this province has limited potentials for aquaculture activities. Therefore, it is necessary to pay attention to these limitations in development plans.

Key words: GIS, environmental evaluation, aquaculture, Hamedan

INTRODUCTION

With a growing population, changing eating habits and severe limits on global wild caught fish stocks, aquaculture activities are a rapidly developing industry. So that, aquaculture would develop as a good source of animal protein for the growing population (Dao *et al.*,2004). Sustainable aquaculture development and planning requires comprehensive data on land use, water, economic and human resources available in a given area and synoptic integration and analysis of these resources. Geographic Information Systems (GIS) with remote sensing technique are gainfully used or such a comprehensive analysis which lead to identification of suitable aquaculture site. By using remote sensing technique and GIS, the advantage is not only in time and cost effectiveness, but also in achieving a more comprehensive and integrated treatment of aquaculture development criteria, which is difficult through conventional techniques alone. 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 the west of Iran, 320 km far from Tehran with 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-b).Using Makhdoum's model in this research, it is necessary to introduce it at first:

In fact, it is a linear, multi unknown quantity model to evaluate and recognize the potentials and capabilities of the land for aquaculture objectives. In this model, 16 parameters, related to different factors, or related to 16 informational layers are

Corresponding Author: Tel/Fax: +98811 822 5885
Email: *phdmrk@yahoo.com*

used and each informational layer is consisted of several classes. In this model, the capabilities of the lands in aquaculture are defined in selection 3, where each selection 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).

MATERIALS AND METHODS

This research was carried out in Hamadan Province, west of Iran, during 2004 to 2005, from aquaculture point of view and capabilities of the lands to fulfill aquaculture activities, using GIS (Iftikhar and Greenaway, 2002).In this research, 5 GIS layers of maps have been used to evaluate the ecological capability, by using the Makhdoum's model (Makhdoum *et al.,* 2002). The titles of used layers are presented in Table 1. The process of land evaluation is presented in three parts: A-Collecting information was fulfilled in two ways, first 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 field patrolling in all of the essential areas and analyzing as well as collocating comparison of natural conditions of the lands. B-Analyses: The characteristics and environmental parameters of each area were various, 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). In this research, the Makhdoum'smodel has been used to analyze the data . (Reyahi Khoram *et al*., 2004a). C- Evaluation: Which 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 (Mc Harg, 1971) has been used to evaluate the capability of the land. In addition, GIS has been used to evaluate the land as main tool. The software used was Arc View (version 3.2a) with the Universal Transverse Mercator (UTM) projection and scale was 1/250,000 (Karen and Culpepper, 1998). After preparation of the above mentioned layers, it was preferred to unite the projection system of all of the layers and the projection system was selected (UTM). 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 five 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 software. In addition, the amount of the cell sizes was selected as ten meters. This selection caused the operation to be very exact. Then for each parameter, Map query (MQ) was considered. Later, the extent of interfering overlapping of the cases was analyzed using multiple MQ's.

Table 1: The summary of Makhdoums model used in this study

Class									
1	2	3	4	5	6	7	8	9	10
>10000	10000-6000	6000-3000	<3000	-	-	-	-	-	-
NO.E	<0.25	0.25-0.7	>0.7	Rill erosion	Gully erosion	Aluvial erosion	-	-	-
Mongrove	creek	Wetland	Savana	bank	dene	Foreste	Others	-	-
0-2	2.1-5	5.1-8	8.1-12	12.1-15	15.1-20	20.1-25	25.1- 40	40.1-65	>65
*	**	Others	-	-	-	-	-	-	-

* *plant species such as Taxus baccata , Buxus hyrcanus , Acer hyrcanum , Cupressus sempervirens , var.horizontalis , Sorbus torminalis*
** *Juniperus polycarpus , Biota orientalis, juiperus, Rhizophora mucronata, Quercus cinerascens, Prunus aviom, Quercus persica , piruscommunis*

RESULTS

Based on the literature review, water capacity layer of the studied area was obtained (Reyahi Khoram *et al*., 2004a). The studied region has a few surface water resources, and therefore a great part of the water necessary for the province is supplied from groundwater resources. In addition, because of the extra usage of groundwater the water table in all of the plains of the studied region has been dropped. In the studied area, there are only three classes for this layer (Fig. 1). Soil erosion by water: According to the gathered data, only 5 information layers out of 7, are concerned with the erosion in the province, where there is no gully erosion or alluvial (Fig. 2). The sensitive plant areas: Based on the field study, Hamadan is too far from the sea and that the province does not have mangrove, creek, savanna areas, and dene. The forests of the province cover 35,000 hectares, while there are few wetlands, some of which become dry in summer. In this research, the importance of the protection of the natural resources and the environment value of the forests and wetlands were considered, and it was preferred to show this subject in evaluating the land largely, although the forests and wetlands of the province are too limited (Fig. 3). Over-all slope: by using topographic map of the studied area, overall slope, layer was obtained. Also, the information showed that 31.6 percent of the provinces lands had a slope more than 12 percent (Fig. 4). The value

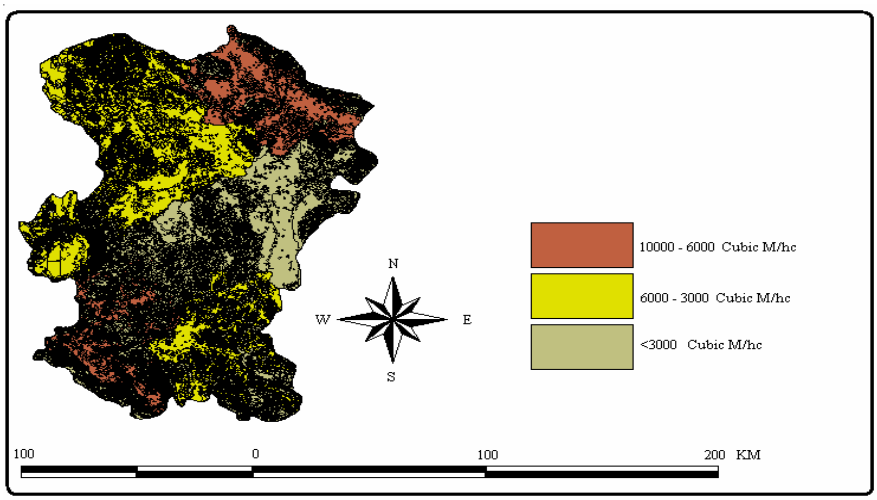

Fig. 1: Characteristics of the amount of water capacity in Hamadan

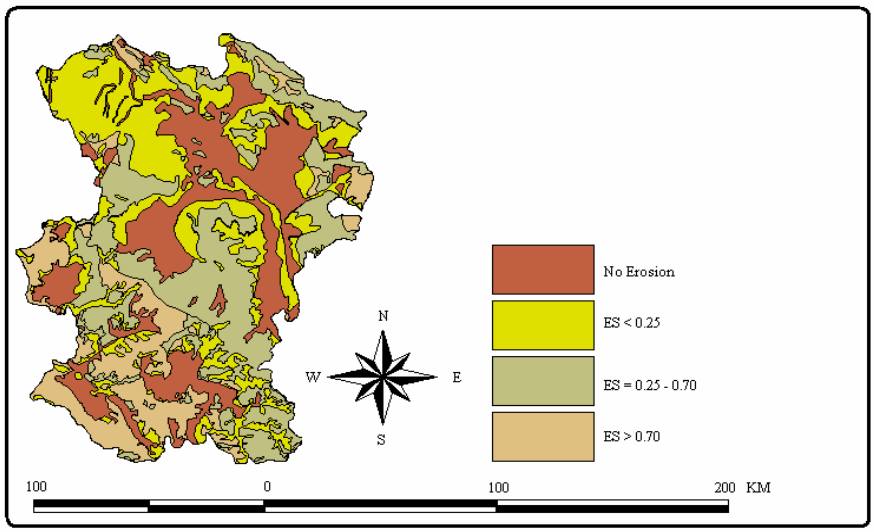

Fig. 2: Characteristics of soil erosion in Hamadan

of the protective species: Based on the field study, the tree species of the first layer in the province are not present, and the tree species of the second layer in the province are found in Nahavand woodlands to a limited degree (Fig. 5). In the studied area, considering some limitations such as water capacity and erosion, there is low capability for aquaculture activity. Finally according to the collected data in the total surface area of region, suitable surface area for aquaculture activities is equal to 220,000 hectares (13.1 percent of the province) (Fig. 6).

DISCUSSION

Currently, aquaculture plays a small role in the studied area, but according to obtained results, this province has potential for aquaculture activities. Aquaculture activities contribute a small part to the gross domestic product (GDP) of the studied area, although aquaculture activities create job opportunity for rural poor. The results of this study may be compared with another study done in Saleh Bay, West Nusa Tenggara that suitable area for marine cage culture was found 677 hectare or 8 % of the total studied region (Radiarta *et al.*,

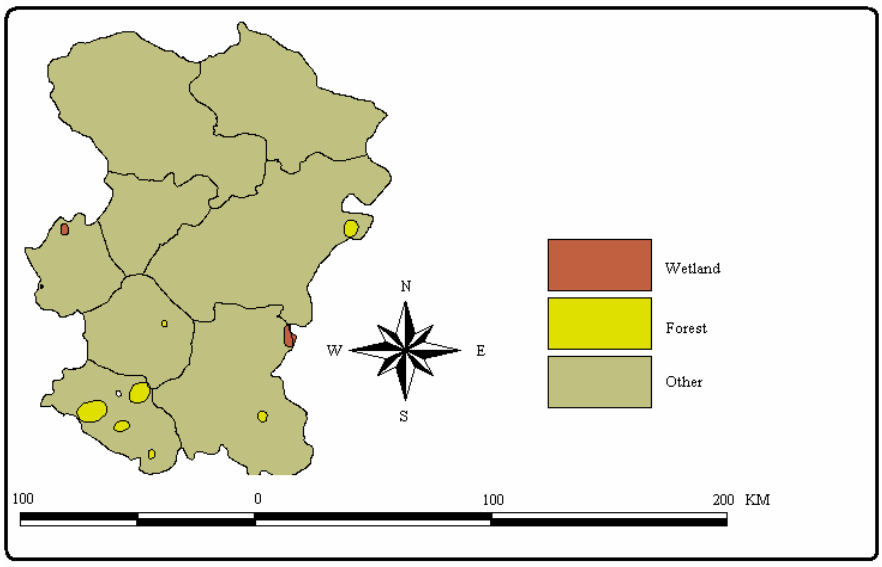

Fig. 3: Characteristics of the sensitive plant areas in Hamadan

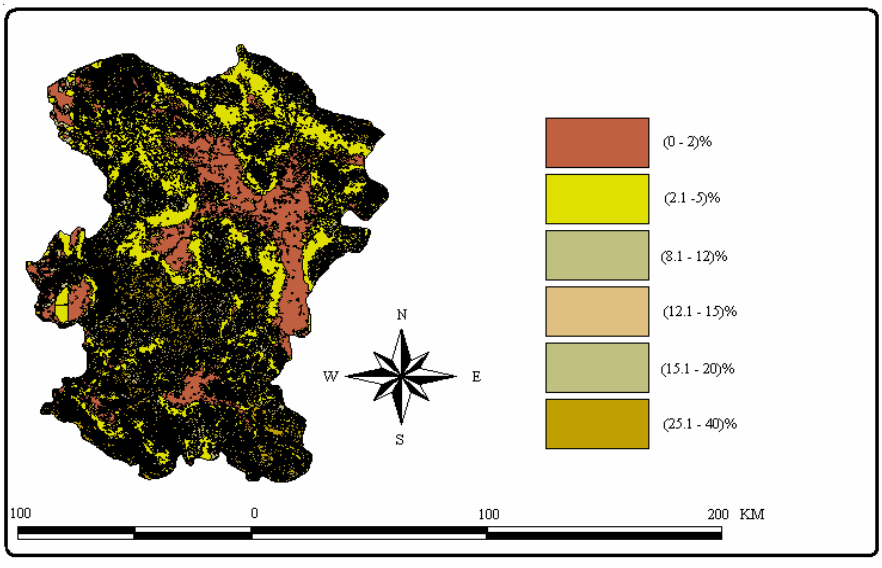

Fig. 4: Characteristics of overall slope in Hamadan

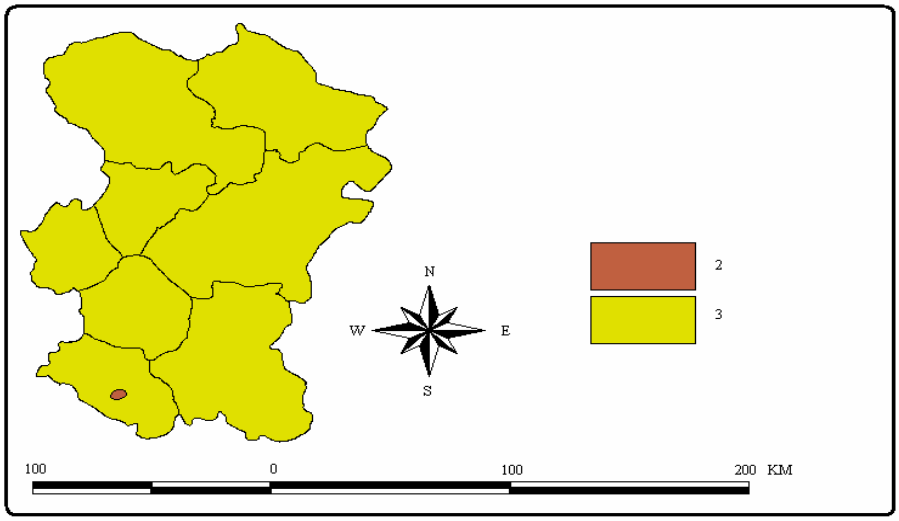

Fig. 5: Characteristics of the value of the Protective species in Hamadan

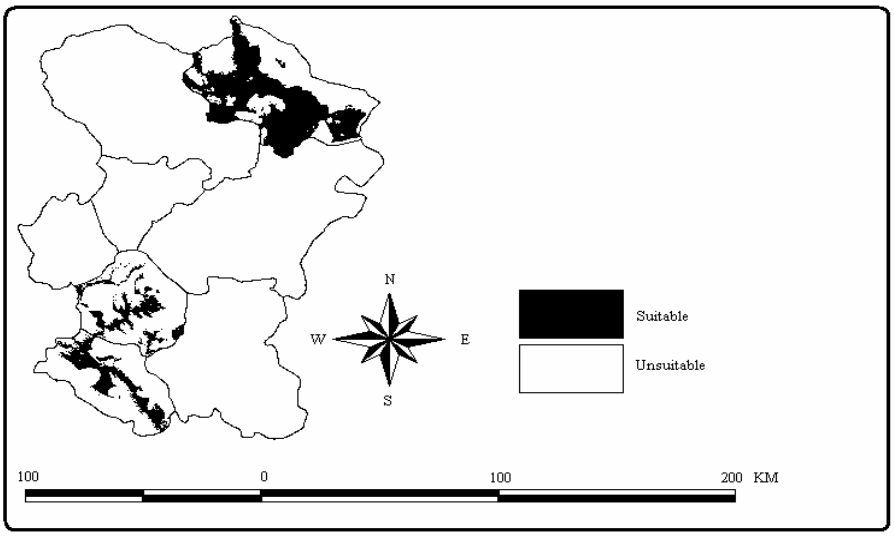

Fig. 6: Results of evaluation in Hamadan province

2005). Area could be utilized only 68 hectares (10%) or 27.080 cages with dimensions of 2.5 x 2.5 x 3.5 meter. Also Dao, *et al.*, (2004) reported that, about 4.7% (2,725 hectare) of the total land area of 57,618 hectare in Daitu Thainguyen in Vietnam are suitable for watershed pond aquaculture, compared to the existing 404 ha watershed ponds. Moreover, these findings show that it executing aquaculture faces many limitations in, and it is necessary to pay attention to these limitations. Suitable areas for aquaculture activity are located near rivers, roads and lower elevated areas in the north and south of province (Fig. 6). In the present study, more emphasis has been given to the evaluation of capability of Hamadan province related to aquaculture activities but for better planning and design, detailed study required for construction, operation, maintenance, utility and environmental impact assessment. The authors believe that this model would be applicable for other provinces in Iran, as well.

ACKNOWLEDGEMENTS

This research was supported by Hamadan Management and Planning Organization (HMPO). Authors would like to thank Mr. Marghaiezadeh, the Head of HMPO.Authors

would like to thank Mr. Marghaie zadeh, the Head of HMPO. Also, we would like to thank the experts and specialists for their cooperation in this research.

REFERENCES

Amarsaikham, D., Ganzoring, M., Batbayar, G., Narangerel, D. and Tumentsetseg, S., (2004). An Integrated Approach of Optical and SAR image for forest change study. Asian J. Geoinf., **4** (3), 27-32.

Biagi, L., Brovelli, A. M. and Negretti, M., (2002). Environmental thematic map predication and easy probabilitic classification. procceding of open source GIS - Grass Users Conference,Trento, Italy., Available from :aww.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.

Dao, H.G., Yang, Y. and James, S. D., (2004). Application of GIS for land evaluation of watershed aquaculture development in Thainguyen, Vietnam. Available from: http://www.afitaandwcca2004.net/html/paper/102-Application.pdf

Iftikhar, A. and Greenaway, F., (2002). GIS application for land planning and managementin Montserrat, West Indies. Available from: www.ing.unitn.it/~grass/conferences/GRASS2002/proceedings/proceedings/pdfs/Ahmed_Iftikhar.pdf

Karen, C. Hanna and Brain, C. R., (1998). GIS in site design. John Wiley and Sons Inc, New York ,

Makhdoum, M. F., Darvishsefat, A. A., Jafarzaheh, H. and Makhdoum, A. F., (2002). Environmental evaluation and planning by geographic information system . Tehran University Publications ,Tehran, 185-242.

McHarg, I. L., (1971). Design with nature. Natural History Press, Garden City New York, 53-76.

Mitra, D. and Ilangovan, D., (2004). Site selection for harbour facilities in the Gulf of Cambay, India using geographic information system. Asian Journal of Geoinformatics, **4** (4), 81-86.

Obi Reddy, G. P., Mji, A. K., Chary, G. R., Srinivas, C. V., Tiwary, P. and Gajbhiye, K. S., (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.

Radiarta, I. N., Saputra, A., Priono, B. and Praseno, O., (2005). Identification of suitability area for marine cage culture using remote sensing data and geographic information system in saleh bay, west nusa tenggara. Proceeding of the World Aquaculture Conference, Bali, Indonesia, 9-13 May.

Reyahi Khoram, M., Shariat, M. and Azar, A., (2004a). GIS application for evaluation and planning of Hamadan province for agricultural activity. Proceeding of the FOSS/GRASS Users Conference, Bangkok, Thailand, 12-14 September 2004.

Reyahi Khoram, M., Shariat, M. and Azar, A., (2004b). 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.