Advances in Bioresearch
Adv. Biores., Vol 6 (3) May 2015: 41-45
©2015 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV 7.20 [Poland]

Advances in Bioresearch

ORIGINAL ARTICLE

Ecological Land Suitability for Dry Farming using AHP and GIS

Leila Saadabadi[1], Naser Ahmadi-Sani[2,] Lida Razaghnia
1. Faculty of Agriculture and Natural Resources, Mahabad Branch, Islamic Azad University, Iran
2. Faculty of Agriculture and Natural Resources, Mahabad Branch, Islamic Azad University, Iran, 3. MSc of Watershed Management, Faculty of Agriculture and Natural Resources, Mahabad Branch, Islamic Azad University, Iran

ABSTRACT
Achieving a balance between ecological resources and resource consumption is required for land use planning. Suitability of ecological resources for different uses will help to find efficient strategies for sustainable development. The aim of this study was to evaluate the ecological land suitability for dry farming using Analytical Hierarchy Process and Geo Information System. The criteria and sub-criteria of the ecological potential for dry farming land use were determined and weighted within analytical hierarchy process. Data were collected from various sources and mapped in GIS environment. Overlaying weighted standardized sub-criteria maps resulted in a suitability map for dry farming. The map showed that no land unit of study area has a high suitability for dry farming, and some places are completely unsuitable for this land use. Most areas have medium suitability for dry farming.
Key words*: land suitability, dry farming, AHP, GIS.*

Received 22/02/2015 Accepted 29/04/2015 ©2015 Society of Education, India

How to cite this article:
Leila S, , Naser A-S, Lida R, Ecological Land Suitability for Dry Farming using AHP and GIS, Adv. Biores., Vol 6 [3] May 2015 :41-45**.** DOI: 10.15515/abr.0976-4585.6.3.4145

INTRODUCTION

In today's world, the most important challenge is food security and its provision as vital human need [8]. Food security is considered as an inevitable necessity in the most Communities like Iran. Agriculture section plays the basic role in food security. On the other hand, natural resources and the global environment are potentially limited to meet human needs, so human, in order to achieve balance between the land processes, need to planning and rational management. Lack of attention to potential and over-exploitation cause the existing resources destroyed and would bring along irreparable damage. To deal with this situation, a comprehensive plan of land use logical selected uses according to the environment capability is needed. In this regard, one of the useful issues is evaluation of land ecological potential [11]. Ecological capability assessment is determining or predicting the potential of lands [10]. Ecological capability evaluation is so important to proper planning and multipurpose use, based on potential identification and productivity [11].

According to reviews, several studies have been done on evaluation of ecological capability using multi-criteria decision method. In recent decades, to complicated decisions, the researchers have concentrated on multi-criteria decision models. Multi-criteria decision is selecting the superior option, with considering a number of criteria The Criteria might be quantitative or qualitative, positive or negative [1]. These models are able to reducing cost, time and increasing accuracy in decisions.

On the other hand, due to effective performance of GIS in analysis, data management as well as high speed and accuracy in generating database, maps and tables, are suitable to evaluating the ecological capability [12]. Geographic Information System provides valuable information for spatial planning through determination of proximity and juxtaposition of data [5]. In addition to modifying the required maps, this system is utilized in management and interpretation of ecological data in various stages of planning process [7]. In the previous studies [2, 9, 13, 15], the ability and usefulness of GIS, have been demonstrated in site selection and combining of different ecological criteria. So, ecological capability assessment of study area for dry farming using new technologies such as GIS is critical.

The Study area

The study area is part of "Nazlou Chai River" basin, located in northwest of Urmia with area of 42630 ha. The climate of the area is mountainous and temperate. The average of annual precipitation is about 400 mm. maximum and minimum of annual temperature in area are about (38°c) and (-3°c) respectively (Fig. 1).

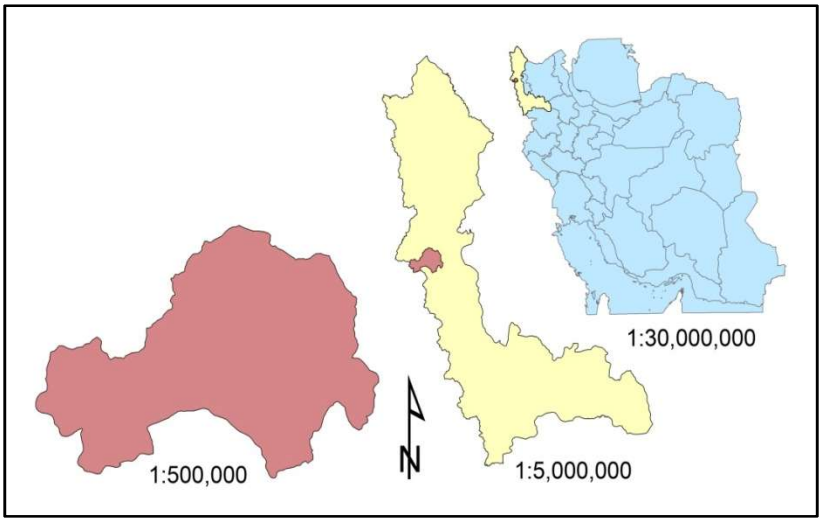

Fig. 1- The study area location in West Azerbaijan Province of Iran

MATERIALS AND METHODS

Identification of sources

The key parameters affecting the dry farming were identified through checking the references and backgrounds, as well as collecting the expert opinions within the designed questionnaire based on the analytic hierarchy process.

Ecological resource mapping

In order to the mapping of landform sub-criteria, digital elevation model of area was prepared using topographic map with 1:50000 scale. The slope, aspect, and elevation were prepared using DEM and categorized regarding to the study objectives and literature review.

Using land units' map of NazlooChai resulted from integration of geomorphologic, Geological and Physiographic maps scaled 1:50000 and with literature review as well as, obtaining views of experts, soil properties each unit soil identified. Then in GIS, properties of each unit was generalized to the polygons in the layer. In next step, each of the produced maps was classified based on the study goal, area conditions and literature review.

Precipitation map was created using data of weather stations. For this purpose, an equation between precipitation and elevation using 10-years rainfall average of adjacent stations and their elevation was generated. Then, placing the area's DEM in the equation, the precipitation map was prepared for the entire area. To mapping the area's temperature, similar method was used as well.

The weight determination of criteria and sub-criteria

The weight of criteria and sub-criteria were specified by expert's opinion in academic and administrative departments within AHP.

Standardization of Maps

To standardizing the indices, interval bipolar method was used. The value of each class of sub-criteria maps (indices) was determined based on expert's opinion and literature reviewing and then was inputted to the descriptive table of the maps. To standardize the restriction maps, Boolean logic was used and values 0 and 1 were extended to the mapping classes that meaning suitability and non suitability respectively.

Mapping the ecological suitability

One of most common and simplest techniques in multi-criteria evaluation (MCE) is combined weighted linear combination (WLC). Thus, in present study, this method was used. In order to **s**uitability evaluation, the weight of each sub-criterion obtained from AHP (Table 1) was multiplied by corresponding standardized data layer that resulted the maps of weighted standardized. Then with

multiplying the resulting map in the constraint map, the map of ecological suitability for dry farming was obtained.

RESULT AND DISCUSSION

Map of soil's sub-criteria

The soil's sub-criteria were the texture, fertility, erosion, depth, pH, percentage of organic carbon, percentage of lime and drainage. The main of the area contains loam and sandy - loam soil. Most of the area soil was half deep, with low and very low fertility, resistant to erosion, and well or medium drainage. The PH range of area soil was between "7-8.2". For example, the map of soil texture classes has been presented in Fig. (2).

Map of landform's sub-criteria

The least importance was belonged to the criterion of landform and its sub-criteria importance respectively containing slope, elevation and aspect. Fig. (3) Indicates the map of slope classes as example.

Map of climate's sub-criteria

Climate was identified as the most important basic criterion and rainfall was determined as the most sub-criterions. Temperature and comparative humidity were respectively second and third in importance. The whole area was located in one class of temperature and precipitation for dry farming, and in terms of moisture too, the whole area's conditions were uniform.

Map of constraints

In this study, regarding to area's conditions, only slope over 15% was issued as the limitation and according to this, the restriction map of slope was prepared.

Map of the Ecological suitability

According to suitability map, about 32712.5 ha, equivalent to 77% of area, have the mean suitability where is contained as major part of the area, extended in the East, north and central and diverse zones in the western half of the study area. These areas of lands have little slope, semi deep soil and resistant to erosion. Approximately, 9647.5 ha, equivalent to 33% of the area, has been located in the poor suitability class that extended mostly in the western half of the area and there are small areas in the North and East. No suitability areas have been mainly distributed in the rocky and mountain area with slope above 15%. Fig. (4) and Table 2 show the suitability classes.

Comparing the results of this study with the results of previous lands evaluation studies performed using FAO method, despite of different goals and methods of these two studies, major parts of area have been determined as mean suitability for dry farming, similarly.

Table 1- The weight of criteria and sub-criteria for dry farming use

Criteria	**weight**	**Sub-criteria**	**weight**
Climate	0.669	Rainfall	0.298
		Temperature	0.121
		Moisture	0.088
Soil	0.208	Texture	0.093
		Fertility	0.087
		Erosion	0.067
		Depth	0.053
		PH	0.034
		Lime	0.02
		Drainage	0.015
		Organic Carbon	0.028
Landform	0.123	Slope	0.055
		Aspect	0.015
		Elevation	0.027

Table 2- The area of suitability classes

Suitability classes	Area (ha)	Area (%)
Mean suitability	32712.5	77
Poor suitability	9647.5	33

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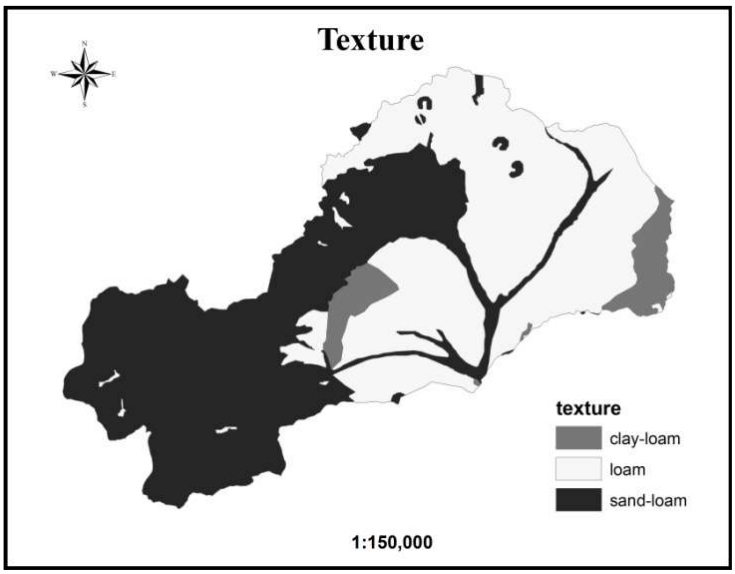

Fig. 2- The soil texture map

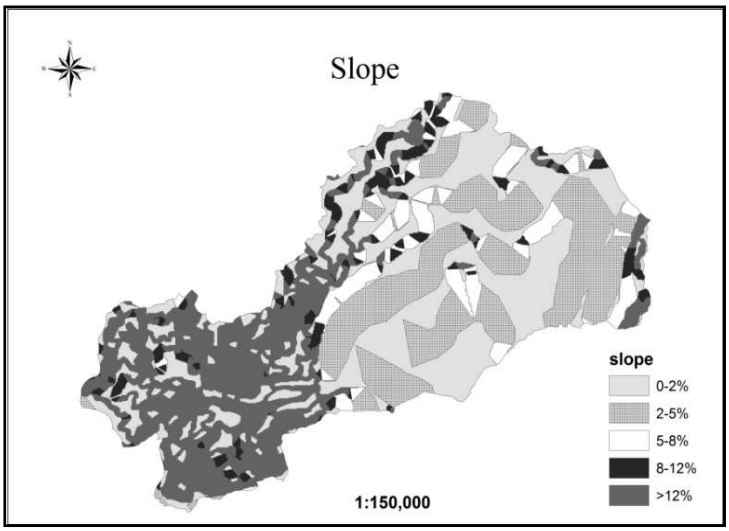

Fig. 3- The slope map

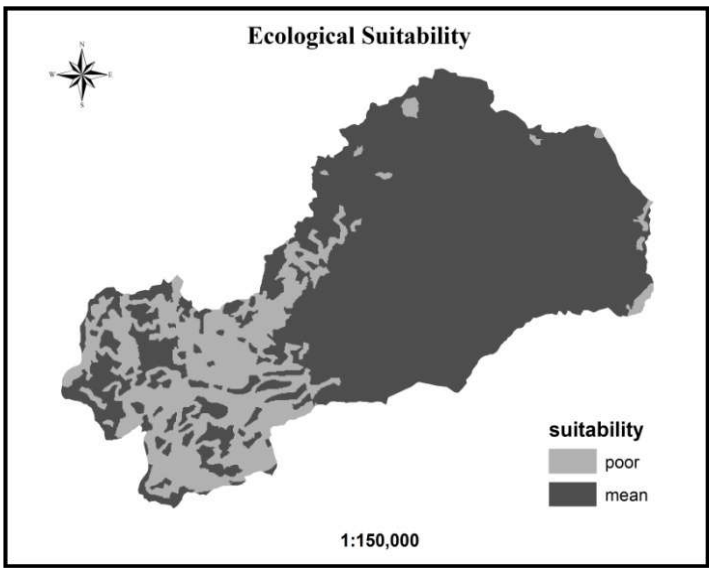

Fig. 4- The ecological suitability map

CONCLUSION

According to the resulting suitability map, any unit from area had not high suitability (very good) for dry farming. In addition, some zones of area were unable to dry farming and the most of area had medium suitability. There are no units with low suitability, too. The results also showed that factors such as slope, temperature, rock areas, and low depth of soil have caused the limited ecological capability of area for dry farming. The major limiting factor for dry farming in the study area is slope. As expressed in previous studies [3, 9, 14] using the multi-criteria decision making method based on GIS is simple and flexible, and many criteria can be used to solve a problem. Although it should be noted, with increasing the number of criteria, the decision makers may face with problems in assigning the weights of the criteria. The obtained results and several studies results [4, 6] indicated that AHP is a technique which can be widely used in multi-criteria decision making on various issues in basins. The WLC Method, In addition to combining all the criteria or layers together, considers the importance of each criteria based on their weight.

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