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Comparison of the Land Qualitative Suitability with the Use of FAO Method and Ales Model for Major Crops in Sardasht of Behbahan Khuzestan Province, Iran

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Abstract: The aim of this research was comparison of the land qualitative suitability of results with the use of FAO method and Automated Land Evaluation System or ALES method for major crops in Sardasht of Behbahan in Iran. The study area covers 6000 hectares, located in south part of Khuzestan Province. Climatic data was derived based on nearest synoptic station (Behbahan) and was processed using Cropwat program. A profile was dug in each map unit and horizons of that profile were discripted. Three main crops include wheat, barley and rice was selected for evaluation. After data collection which include climatic and land characteristics of the study area, climatic requirements and soil requirements for selected crops were derived from tables developed by Sys *et al*. and by Givi in surveyed area. The climatic classes in FAO method obtain suitable (S_1) for wheat and barley, moderately (S_2) and marginally suitable (S_3) for rice. The results of qualitative land suitability classification showed that most areas in all methods fall under moderately suitable class (S_2) for wheat and barley and severe suitability class (S_3) for rice, although due to soil limitations they vary from S_2 to N. The result showed that ALES model and square roots can identify suitability class more precisely than stories and limitation method. Land suitability map were also prepared through ILWIS software.

Key words: ALES method · Parametric method · Wheat · Barley · Rice

INTRODUCTOIN

One of the ways to provide food for the human being is to increase production in area unit and to utilize the Land with respect to its potentiality in an appropriate way. Any utilization of the land over its capability will cause degradation and yield reduction in long - term duration. Therefore the need for optimum use of land has never been greater than that at present because of rapidly growing population.

Today, One of the methods land qualitative suitability of Crops is done using software ALES. This mode, by Rossiter in 1990 [1] and van Vamyk and Rossiter in 1995 are presented [2].

The Automated Land Evaluation System (ALES) is a computer program that allows land evaluators to build their own knowledge - based systems with which they can compute the physical and economical Land suitability in accordance with FAO's framework for land evaluation [3]. ALES is not by itself an expert system; it does not include by itself any knowledge about land and land use. ALES is merely a framework within which it is possible to build an evaluation model suited to the prevailing local conditions. In terminology of knowledge- based systems it is a shell, which provides a reasoning mechanism and constrains the evaluator to express inferences using this mechanism. The ALES program works with so called decision trees, being hierarchical multiway keys in which the leaves are results (e.g. severity levels of land qualities) and the interior nodes of the tree are decision criteria (e.g. land characteristic values). These trees are traversed by the program to compute an evaluation using actual land data for each map unit.

Two different method including FAO method and ALES model were used to determine land suitability classes. Land suitability map were also prepared through ILWIS software [4].

The aim of this study was Comparison of the Land qualitative suitability with the use of FAO method and ALES model for major crops in Sardasht of Behbahan.

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MATERIALS AND METHODS

The study area covers about 6000 hectares which is located about 40 Kilo meters south of Behbahan in Khuzesta province, southern Iran. After preparation of topography map of the area and determination of mentioned area on the topographic map, the activity of determination of soil unit has been done which in all 13 units determined and in each unit profile has been dug. And they have been described completely and samples have been collected from each profile. And after passing through 2 (mm) meter sifting, they have been prepared for physical and chemical analysis. The test done consisted of determination of textures with the use of hydrometric method. Determinations of Electrical conduction in saturated concentration (ECe), Determination of soil acidity (pH), Exchange sodium percentage (ESP) of and measurement of Calcium carbonate. Soils were classified according to Keys to soil taxonomy 2006 [5]. After data collection including climatic and land characteristics of the study area, climatic requirements and soil requirements for selected crops were derived from tables developed by Sys *et al*. [6-8] and by Givi [9]. Three different methods including limitation method, parametric (stories and Square root method) according to FAO system and ALES model were used to determine land suitability classes.

In parametric method, using grades assigned to each of the characteristics of land, land and climate index was calculated in two ways:

The Storie method [10]

$$I = A \times B/100 \times C/100 \times \ldots \quad \text{(Eq. 1)}$$

The Square root method [11]

$$I = R\min \sqrt{A/100 \times B/100 \times C/100}\ I = R\min \quad \text{(Eq. 2)}$$

Where:

I = Index (%)
R min = Minimum rating (%)
A, *B*, *C* etc. = remaining ratings (%)

Application of these methods implies that requirement tables have to be produced for each land utilization type. We compared the land characteristics with the plant requirements tables introduced by Sys *et al*., (1993). For determination, the limits of land classes we used pattern introduced by Sys *et al*., (1991). The land suitability classes are defined as follows:

- Lands having indexes >75 are in S1 (very suitable) class.
- Lands having indexes 50-75 are in S2 (moderate suitable) class.
- Lands having indexes 25-50 are in S3 (marginal suitable) class.
- Lands having indexes < 25 are in N (non-suitable) class.

ALES can be done in several modes for different purposes. Who started ALES when the model completed, were entered ALES in the evaluation mode with the DOS command evaluate.

RESULT

Regarding to results obtained from description of the profiles and physical and chemical analysis of the samples soils were classified in Two orders Inceptisols and Entisols (Table 1). The results from analysis of climatice data showed that the growth cycle in this area was from 10^{th} of November to 11^{th} April and length of growth period was about 153 days. In the study area, the growth cycle of wheat and barley With the growth of the region does not match and therefore this crops will receive less water at the end of its growth and the product will be less which needs irrigation to complete this process. The comparison of suitability classes for wheat, barley and rice crops with limitation method, parametric and AELS model is shown separately in the Tables [4-6]. The results of qualitative land suitability classification showed that in different method, most areas fall under moderately suitable class (S_2) for wheat and barley and marginally suitable class (S_3) for rice.

DISCUSSION

With comparison results land evaluation of map units for rice production using all three methods of limitation, parametric and ALES can be noticed that ALES Model and square rood method for most map units was same and ALES model was showed for some of the soil units better Class suitability. The results from land suitability classification showed that most of units for wheat and barley will be put in the suitable class (S_2). The results

Table1: Results of Soil Classification

Soil Series		U.S.D.A. Keys to Soil Taxonomy 2010			
No.	Name	Family	Subgroup	Order	F.A.O/Unesco 1989
1	Abuzar	Fine, carbonatic, Hyperthermic	Typic Calciustepts	Inceptisols	Calcic Cambisols
2	Qaleh kaebi	Fine Loamy, Carbonatic, Hyperthermic	Typic Ustifluvnts	Entisols	Eutric Fluvisols
3	Arabha	Coaese Loamy, Carbonatic, Hyperthermic	Typic- Ustorthents	Entisols	Calcaric Regosols
4	Sardasht	Coaese Loamy, Carbonatic, Hyperthermic	Typic Haplustepts	Inceptisols	Calcic Cambisols
5	Deh Bisheh	Fine, carbonatic, Hyperthermic	Typic Haplustepts	Inceptisols	Calcic Cambisols

Table 2: Data obtained from metrology station of Behbahan

Months year		January	February	March	April	May	June	July	August	September	October	November	December
Days Number		31	29	31	30	30	30	31	31	30	31	30	31
Degree heat (C)	Average maximum	17.7	20.1	23.8	31.6	38.9	43.6	28.3	44.9	41	35.2	25.9	20.2
	Average minimum	6.9	7.4	10.3	16	21.7	25.2	50.6	27.3	22.4	17.6	11.6	8.3
	Absolute maximum	26.2	30.2	34	41.6	46.8	48.6	23	49.8	46.6	42.6	34	30.6
	Absolute Minimum	-2.8	-0.4	3	6.8	13.2	19.6	36.6	21.8	16	11	0	0.2
	Average	12.3	13.8	17.1	23.8	30.3	34.4	39.6	36.1	31.7	26.4	18.8	14.3
	Day	15.2	17	20.1	27	33.8	27.7	32.4	39.6	35.7	30.6	22.6	17.7
	Night	10	11.1	14.1	20.1	26.2	29.7	0	31.9	27.4	22.5	15.8	11.9
Rainfall (mm)	Total	85.8	36/3	61.2	24.8	2.7	1.4	23	0.07	0.04	3.8	45.1	78.6
Relative Humidity (%)	Average	71	64	56	45	30	22	11.2	25	26	33	52	65
Sunshine hours (hrs/day)		4	7	7.3	8.3	10.4	11.9	13.9	11	10.4	9.2	7.3	5.8
Length day (h)		10.4	11.1	12	12.9	12.8	14.1	2.11	13.2	12.4	11.5	10.6	10.1
Wind speed (m/sec) (2 meter)		0.77	1.13	1.34	1.64	2	2.26	27.8	1.75	1.64	1.18	0.98	0.62
Potential evapotranspiration (mm)		45.3	67.9	105.7	161.6	239	276.3	138.9	244.6	193.8	130.2	71.7	42.3
Half the potential evapotranspiration (mm)		22.6	33.9	52.8	80.7	119.5	138.1	120	122.3	96.9	65.1	35.8	21.1

Table 3: Data of Land Characteristic and soil of soil separated units

ESP (%)	EC dS/m	pH	Lime (%)	Depth (cm)	Subsoil gravel	Texture	Reduction (cm)	Map units
13.8	2.25	7.3	52.5	140	15	SiCl	50	1.1
1.95	2.20	7.8	48.8	130	--	SiL	-	2.1
14.8	65.70	7.6	46.8	140	-	SiCl		2.2
5.8	76.20	7.5	48.9	150	-	L	80	2.3
36.6	8.27	7.7	49.1	150	-	SiL	-	2.4
25.6	32.12	7.9	46.8	150	-	L	45	2.5
5.5	1.50	7.7	59.0	150	-	L	--	3.1
4.63	2.02	7.5	46.0	150	-	CL	115	4.1
8.2	22.30	7.4	52.5	150	-	SiCl	50	4.2
5.6	2.70	7.7	48.1	150	-	SiCl	75	4.3
12.16	5.40	7.6	49.5	150	-	SiC	85	5.1
15	16.00	6.6	52.1	150	-	SiC	76	5.2
40	18.00	7.6	52.0	150	-	SiC	-	5.3

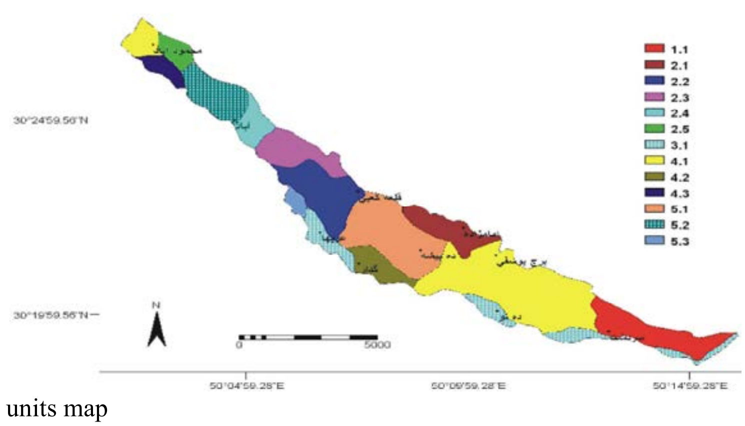

Fig. 1: soil separated units map

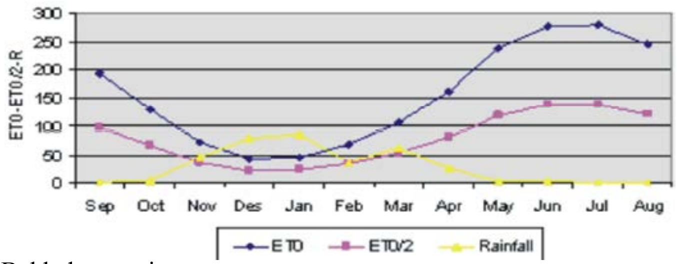

Fig. 2: growth course of Behbahan station

Table 4: Land suitability Classes for Wheat, Barley and Rice with ALES model

Rice	Barely	Wheat	Map units
S2	S2s	S2s	1.1
S3	S2s	S2s	2.1
S3	S2s	S2s	2.2
S3	S2s	S2s	2.3
N	S2s	S2s	2.4
N	Ns	Ns	2.5
S3	S2	S2	3.1
S2	S2s	S2s	4.1
S2	S2s	S2s	4.2
S2	S2s	S2s	4.3
S3	S2s	S2s	5.1
N	S3s	S3s	5.2
N	Ns	Ns	5.3

Table 5: Land suitability classes for Barley with limitation, stories and square root method with ALES model

ALES	Square root	Stories	Limitation	Soil units
S2s	S2s	S3s	S2s	1.1
S2s	S2s	S2s	S2s	2.1
S2s	S2s	S2s	S2s	2.2
S2s	S2s	S2s	S2s	2.3
S2s	S3s	S3sn	S3sn	2.4
Ns	Nsn	Nsn	N1sn	2.5
S2	S2s	S2s	S2s	3.1
S2s	S2s	S2s	S2s	4.1
S2s	S2s	S2s	S2s	4.2
S2s	S2s	S2s	S2s	4.3
S2s	S2s	S2s	S2s	5.1
S3s	S3sn	S3sn	S3sn	5.2
Ns	Nsn	Nsn	S3sfn	5.3

obtained from researches showed that the parametric method has better precision than limitation method [12]. According to the carried out analysis with parametric method (square root and stories) it infers that the square root in relation to stories method was near to the reality and it is better to use this method for determination of land class suitability.

Soil units 3.2, 2.2 and 2.3 for rice production with the use of stories method is located in unsuitable class, while square root has a critical class suitability.

Table 6: Land suitability classes for Rice with limitation, stories and square root method with ALES model

ALES	Square root	Stories	Limitation	Soil units
S2	S3	S3s	S2s	1.1
S3	S3	S3	S2c	2.1
S3	S3	N	N1n	2.2
S3	S3	N	S2s	2.3
N	N	N	N1n	2.4
N	N	N	N2n	2.5
S3	S3	N	S2s	3.1
S2	S3	S3	S2w	4.1
S2	S3	S3	S2s	4.2
S2	S3	S3	S2c	4.3
S3	S3	N	S3n	5.1
N	N	N	N2n	5.2
N	N	N	N2n	5.3

Table 7: Suitability classes and their corresponding land indices

Suitable classes	Index
S1 (Very suitable)	75-100
S2 (moderately suitable)	50-75
S3 (severe suitability)	25-50
N (non suitable)	0-25

Comparison of land suitability classes of different map units for wheat and barley showed most of the soil units are moderately suitable (S_2) because of lime, salinity and alkalinity limitations.

With regard to land suitability classification for rice. it can be noticed that most of the soil units in the study area are not suitable for rice cultivation or they are critical suitable (S_3) Therefore cultivation of rice is not suggested in the area and land in the area has the least suitability for cultivation of rice. With the exception of unit 2.5 because of salinity limitation, cultivation of wheat and barley for different units is suggested.

With comparison of the obtained results from methods of land's suitable classes determination with the use of square root methods and AELS model for wheat and barley, we can notice that all units have the same class suitability. Quantitative and qualitative evaluation of land suitability for crops in Bardsir area in Kerman state which has been conducted by Zainolldini and Banaei showed that among the different methods used, the ALES software and square root gives better results than the other methods in the area of Bardsir.

CONCLUSION

The results of Land qualitative suitability classification showed that in different method, most units in the study area fall under suitable class (S_1) for wheat and barley and moderately suitable class (S_2) and severe suitability (S_3) for rice. From the comparison of results of land evaluation in this area and other areas which have been conducted by other people can be understand that the method of using ALES model and square root is suggested in comparison to the other methods include storie and limitation method.

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