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Evaluation of desertification intensity with using of "Iranian Model for Desertification Potential Assessment" in the Marghzar of Shahrekord's plain

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ABSTRACT

Desertification could be traced back to one or many factors. Thus, to cope with such a phenomenon, there exists a need for a profound understanding of the processes and the causes. The study area of the current paper is the extent of Shahrekord's Marghzar as an important case amongst the important ones of the province. In order to evaluate the roots of desertification in the area, the Iranian model of desertification potential assessment (IMDPA) was used. Three criteria included are water resources status, soil and vegetation. These criteria were scored against the defined set of scores provided in the tables. According to the fact that in the model, each criterion is summed up by applying geometric average of the indices, the final map of the corresponding criterion was prepared by superimposing all the maps of the indices. Next, the criteria were combined by applying geometric average and the final map was created. Based on the criteria, the severity of desertification in the region according to the IMDPA model is 1.61 which falls into the medium class. Results indicate that the vegetation utilization and water table drawdown indices, as the two most influential indices, are averaged around 4 and 3.23, respectively. The vegetation index acts as the most critical case defining the lion share of the desertification severity of the area. Of the total area, 3.1% is classified as low and 96.9% as medium severity classes. From the major causes of desertification in the region, one could point out to over utilization of the rangelands and intense livestock grazing which have imposed a downgrading force over the vegetation cover. Of the rest, over withdrawal from the underground reservoirs and the multiplicity of wells could be mentioned. These latter causes have the Marghzar dried and water tables drawn.

Key words: Desertification, IMDPA, Marghzar, Shahrekord's plain

INTRODUCTION

In today's world, desertification is an important environment problem. This problem is seen not only in arid and semi arid region but also seen in some parts of sub humid region (Abbasi, 1996; Safari Shad *et al*, 2013; Rohina *et al*, 2013). In united nation organization development and environment conference in Rioudojanirou in 1992 year desertification defined as: Land degradation in arid, semi arid and dry sub-humid affected by climate changes and human activities (Khosravi *et al*, 2013, Mazloom *et al*, 2013,

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Dashti Marvili and Dabiri, 2013; Ekhtesasi and Sepehr, 2011). In this time, using of desertification models is the best method for assessment of effective factors on land degradation and desertification severity from experts viewing. Despite of models abundance, one model is the best that has adapted considering to environmental and human conditions. To assess desertification, various research done in outside and inside of Iran. Zhu *et al* (2007), Sakcali *et al* (2008) and an (2007) was surveyed the effect of vegetation cover on desertification phenomena and they showed that vegetation cover condition after soil condition has maximum effect on desertification and desertification intensity increased with decrease of vegetation cover. Lavado *et al* (2008) in evaluation of land sensitivity to degradation by using ESAs model in southwestern of Spain showed that prepared desertification map is adapted with real condition and is the better than in comparison to other models. Tavares (2012) evaluated and prepared sensitivity to desertification map with using Mealus model in RiberiaSeca basin. The result of this study showed that more than 50% of studied watershed basin has an obvious consequent of a changed region to desert. Ahmadi *et al* (2006) surveyed desertification condition of Fakhr Abad Region in Mehriz City with using changed Medalus method and obtained result explained that half of this region located in low class of desertification and about 41% of it located in medium desertification class. Zehtabian *et al* (2008) was evaluated soil and water criteria base on Medalus methodology in Ain-e- Khosh's Dehloran and presented desertification map at the end of research. Desertification intensity class is critical for the entire region based on desertification map. Nikoo (2011) studied desertification potential condition in Damghan region using IMDPA model to recognize the effective factors on land degradation. The aim of this study was including: desertification intensity and now condition evaluating, desertification map preparing, criteria and indices Analyzing and preferring and recognition effective factor on desertification in Marghzar region of Shahrekord's plain.

MATERIAL AND METHODS

Study area

This research performed in Marghzar that is located in south Shahrekord town in Chaharmahal& bakhtiari province. Studied area is located in 50˚ 13′ 89″ to 51˚ 09′ 67″ E and 32˚10′ 29″to 32˚34′ 67″ N and The studied area was about 579.97ha (Natural resources and watershed management bureau of Chaharmahal&Bakhtiari, 2011). To identify climate for studied area, we used from data and information of Shahrekord station (base station). Therefore studied area climate determined as cold and semi arid.

Methodology

In order to evaluate the roots of desertification in this study, the Iranian model of desertification potential assessment (IMDPA) was used that this model provided considering to Iran condition and calibrated in different climate region. IMDPA was used to evaluate now desertification condition and to provide its desertification map. The aim of this study was to identify the most important desertification factors, indicators and criteria in Marghzar area. Considering to dominant condition and done primitive studies in studied area, water criteria selected with electro-conductivity (EC), sodium absorption ratio (SAR) and water table drawdown indices, soil criterion selected with soil texture, soil depth, gravel content and EC indices and plant cover criterion was selected with vegetation condition, vegetation utilization and vegetation reproduction indices based on IMDPA model. Each index based on rate effect on desertification being score from 1 (best value) to 4 (worst value). Mentioned criteria were scored against the defined set of scores provided in the tables 1, 2 and 3. Then produced number values for indices in unit works changed to thematic maps by ARC GIS software. According to the fact that in the model, each criterion is summed up by applying geometric average of the indices, the final map was prepared. In this stage, isolate and combination of criteria applied with their geometric average and final desertification map was prepared by superimposing all the maps of the criterions. This map is defined according to

desertification classes in table 4 and can showed desertification intensity in 4 classes (Low, medium, severe and very severe).

Table1. Indices of soil criterion to assess the current situation (actual desertification potential)

Indicator	Actual desertification condition			
	1 (Low)	2 (Medium)	3 (severe)	4 (Very severe)
3. soil texture	Clay and clay loamy	Fine loam	Coarse loam	Sandy and sandy loamy
4. depth gravel content	15<	15-35	35-75	75>

Table 2. Suggested indices for assess the plant cover criteria

Indices	Actual desertification condition			
	1 (Low)	2 (Medium)	3 (severe)	4 (Very severe)
1. vegetation condition	Offensive species are low than 5% of plant composition and annual species is low than 25%	Offensive species are 5-20% of plant composition and annual species are 25-50%	Offensive species are 20-50% of plant composition and majority of plant combination is annual plants	Offensive species are more than 50% of plant composition and area vegetation cover is including annual plants
	Perennial canopy cover more than 30%	Perennial canopy cover 15-30%	Perennial canopy cover 5-15%	Perennial canopy cover low than 5%
2. Vegetation utilization	Uproot sign can not see	Shrub or tree cutting is more than annual biomass	Shrub or tree cutting is high and obvious	Shrub or tree cutting is very severe in now or last time
	Grazing is equilibrium or is low than capacity and it occurred in appropriate season	Livestock surplus to 25% more than grazing capacity	Livestock surplus to 25-50% more than grazing capacity	Livestock surplus is more than 50% of grazing capacity
3. Vegetation reproduction	Reproduction done naturally	Reproduction done with low cost	Reproduction done with high cost	Reproduction is very hard or impossible and without ecological or economical advantage
	Not need to reclamation activity	reclamation activity was effective	reclamation activity was effective partly	reclamation activity was not effective

Table 3. Suggested indices for assess the water and irrigation criteria effective on desertification

Indices	Actual desertification condition			
	1 (Low)	2 (Medium)	3 (severe)	4 (Very severe)
EC($\mu mho/cm$)	<750	750-2250	2250-5000	>5000
SAR rate	<18	18-26	26-32	≥ 32
Groundwater downfall (Cm/year)	< 20	20-30	30-50	> 50

Table 4. Desertification potential assessment

Desertification class	Qualitative description for desertification grade	Quantitative grade for desertification class
1	Low	0-1/5
2	Medium	1/6-2/5
3	severe	2/6-3/5
4	Very severe	3/6-4

RESULTS

Scoring the vegetation criterion

The results for the evaluation of vegetation criterion are detailed in table five. The studied indices are vegetation condition, vegetation utilization and reproduction that were scored in each work unit.

Table 5. Desertification status in the vegetation criterion and the studied indices of each work unit

Work Unit	desertification status in each index						Desertification severity of the vegetation criterion	Delineation of the desertification status of the vegetation criterion
	Vegetation condition		Vegetation utilization		Vegetation reproduction			
	quantitative	qualitative	quantitative	qualitative	quantitative	qualitative		
1	3	severe	4	Very severe	3	severe	3/3	severe
2	2	Medium	4	Very severe	2	Medium	2/5	Medium
3	2	Medium	4	Very severe	2	Medium	2/5	Medium
4	3	severe	4	Very severe	3	severe	3/3	severe
5	2	Medium	4	Very severe	2	Medium	2/5	Medium
6	2	Medium	4	Very severe	2	Medium	2/5	Medium
7	3	severe	4	Very severe	3	severe	3/3	severe
8	3	severe	4	Very severe	3	severe	3/3	severe
9	2	Medium	4	Very severe	2	Medium	2/5	Medium
10	2	Medium	4	Very severe	2	Medium	2/5	Medium

Results of scoring the vegetation criterion for the rangelands state that from the three indices of vegetation criterion, the vegetation utilization with the average of 4 has the most thrusting effect upon the rangeland's desertification in the area.

Scoring of water component criterion

Results of evaluating the water component of the model are presented in table six. The included indices are the electro-conductivity (EC), sodium absorption ratio (SAR) and water table drawdown being scored in each work unit.

Table 6. The quantitative and qualitative status of desertification severity for the water component of the model and the corresponding indices

Desertification severity of the water criterion	Delineation of the desertification status of the water criterion	desertification status in each index						desertification status in each index
		EC	EC	EC	EC	EC	EC	
		quantitative	quantitative	quantitative	quantitative	quantitative	quantitative	
Medium	1/58	Very severe	4	Low	1	Low	1	1
Low	1/25	Medium	2	Low	1	Low	1	2
Low	1/25	Medium	2	Low	1	Low	1	3
Low	1	Low	1	Low	1	Low	1	4
Low	1	Low	1	Low	1	Low	1	5
Low	1	Low	1	Low	1	Low	1	6
Medium	1/58	Very severe	4	Low	1	Low	1	7
Medium	2	Very severe	4	Low	1	Medium	2	8
Medium	1/58	Very severe	4	Low	1	Low	1	9
Low	1	Low	1	Low	1	Low	1	10

Results obtained for the evaluation of water component's indices show that among the three indices, the water table drawdown obtaining the value of 3.23 has the most severe impact on the rangelands within the desertification model.

Scoring soil component

Detailed results of the evaluation of the soil component could be found in table seven. The indices consist of soil texture, soil depth, soil's gravel content and the EC being scored in each work unit.

Table 7. Desertification status for the soil component of the model and the corresponding indices in each work unit

Delineation of the desertification status of the soil criterion	Desertification severity of the soil criterion	desertification status in each index								Work Units
		Soil Texture		Soil Texture		Soil Texture		Soil Texture		
		qualitative	quantitative	qualitative	quantitative	qualitative	quantitative	qualitative	quantitative	
Low	1/18	Low	1	Low	1	Low	1	Medium	2	1
Low	1/18	Low	1	Low	1	Low	1	Medium	2	2
Low	1/18	Low	1	Low	1	Low	1	Medium	2	3
Low	1/18	Low	1	Low	1	Low	1	Medium	2	4
Low	1/18	Low	1	Low	1	Low	1	Medium	2	5
Low	1/18	Low	1	Low	1	Low	1	Medium	2	6
Low	1/18	Low	1	Low	1	Low	1	Medium	2	7
Low	1/18	Low	1	Low	1	Low	1	Medium	2	8
Low	1/18	Low	1	Low	1	Low	1	Medium	2	9
Low	1/18	Low	1	Low	1	Low	1	Medium	2	10

Given what is obtained, for the soil criterion in the rangelands and among the four defined indices, the soil texture by the value of 2 acts as the most influential one in determining the desertification severity in the whole region.

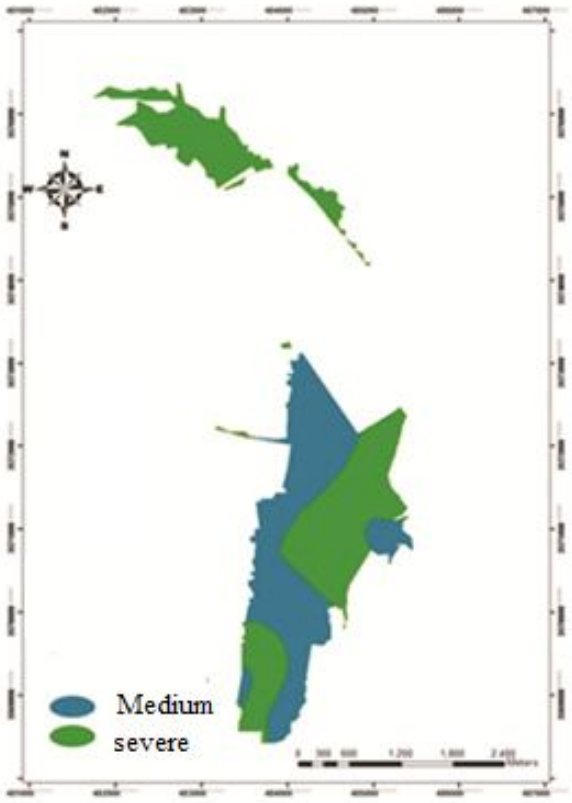

Fig. 1 Desertification severity map for the vegetation criterion

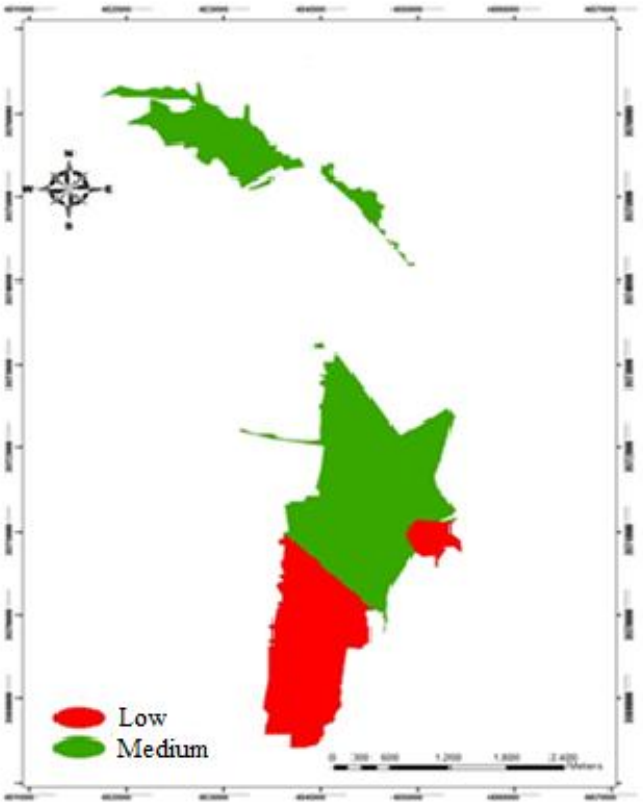

Fig. 2 Desertification severity map for the water criterion

Fig. 3 Desertification severity map for the soil criterion

Final evaluation of desertification potential in the work units

Table eight elaborates the end results of the evaluated criteria in the work units.

Table 8. Evaluation of the desertification groups and its potential in the work units

Desertification Work Units	Climate and Water Group	Vegetation Group	Geologic Group	Desertification Potential	Desertification Severity
1	1/58	3/3	1/18	1/83	Medium
2	1/25	2/5	1/18	1/54	Medium
3	1/25	2/5	1/18	1/54	Medium
4	1	3/3	1/18	1/57	Medium
5	1	2/5	1/18	1/43	Low
6	1	2/5	1/18	1/43	Low
7	1/58	3/3	1/18	1/83	Medium
8	2	3/3	1/18	1/98	Medium
9	1/58	2/5	1/18	1/67	Medium
10	1	2/5	1/18	1/43	Low

Supposing the three criteria, the total value for the IMDPA model calculated around 1.61 which agrees with the medium class's range. The following analysis showed that the vegetation criterion by the average of 2.67 conforms to severe class and could be served as the dominant factor defining the total number of the desertification severity. Among the indices, the two indices of vegetation utilization and water table drawdown accordingly with the quantities of 4 and 3.23 impose the greatest impact. With respect to the obtained results, of the total area, an extent around 3.1% falls into the low severity class while 96.9 corresponds to the medium severity. Owing mainly to the occurrence of the work units onto the Shahrekord Plain the medium class of the desertification severity could be broken down into two individual classes (that is 1.5-1.75 and 1.75-2) and the final map may be produced based on the new rule. In the final map, 50.6% of the total area is devoted to the medium class I (that is 1.5-1.75) and 46.4% to the medium class II (that is 1.75-2).

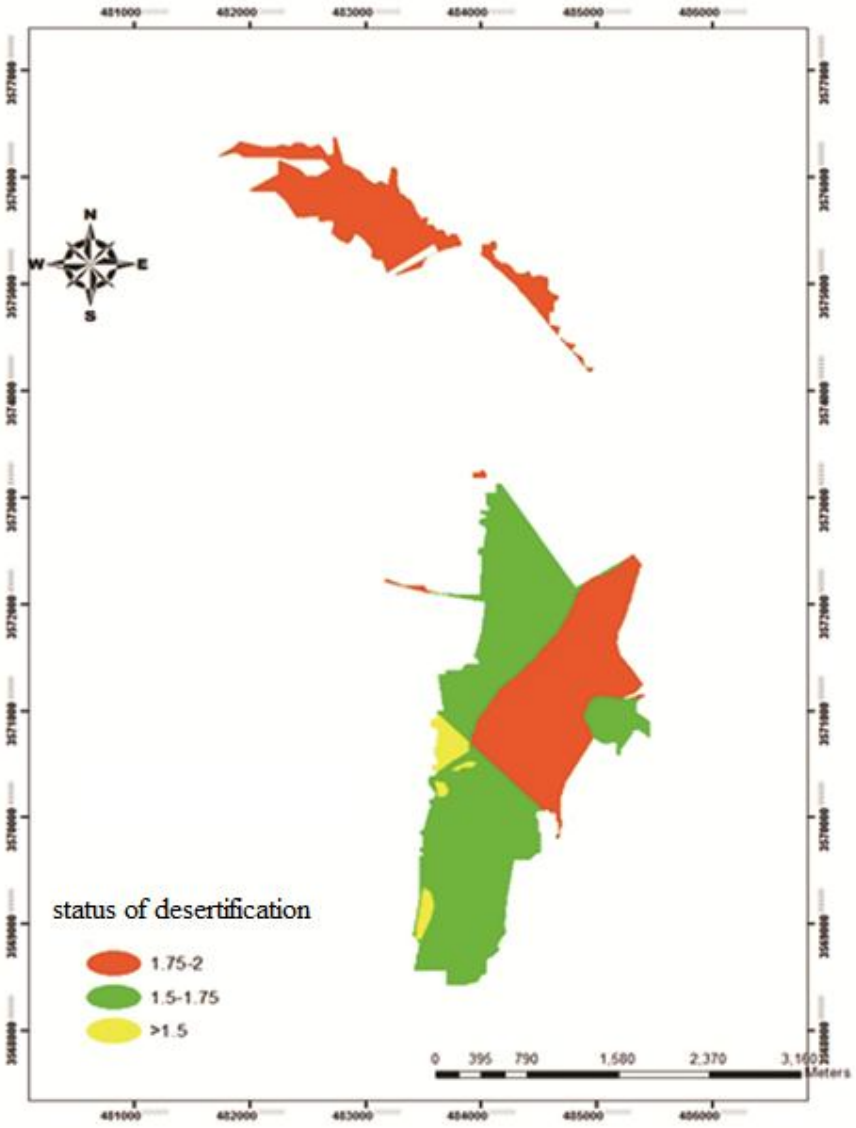

Fig. 4 Final map of the severity and status of desertification in the area

Conclusion

The IMDPA model was chosed based on some principles as given:

- The capabilities of the model to evaluate desertification severity in arid, semi-arid and sub-humid arid areas or even wet climatic situations
- The prioritization of the criteria and indices at work in the desertification process and the potential to plan and make decisions regionally and nationally to cope with it or to manage it
- The possibility of using GIS to calculate the total scores of each index and the final score and introducing the final map of desertification
- The lower range of incorporating personal misunderstanding of the situation in the model
- The compatibility with the Iranian ecological, environmental and socio-economic conditions

The values obtained from the mode show the lower share of the *low-severity class* compared with the medium-severity class. Results show that among all criteria, the vegetation case acts as the mode influential and the soil component allocates itself a lower quantity. By implying high severity of livestock grazing in the meadows, the vegetation utilization index is believed to be one of the important indices. The water table drawdown ranks the second which stems from the over withdrawal of ground water reservoirs and the multiplicity of well in the region. In order to shift the situation in the area for better, few suggestions could be made such as lessening the utilization rate of the ground water reservoirs and grazing intensity. Subsequently, managerial actions like seeding; exposing the rangelands and so forth could be of great help.

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