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International journal of Advanced Biological and Biomedical Research

Volume 2, Issue 3, 2014: 669-681

Assessment of Desertification Risk in agricultural land in south of Iran

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ABSTRACT: In many countries, studies to determine the severity of desertification and providing land plans to implement desertification. One of the models is modified MEDALUS or Iranian model (IMDPA), has been used in present research in order to investigate desertification situation in the Tashk region of Fars province. In this research, the modified IMDPA model used with emphasis on the water, soil and agricultural indexes, and indicators for each criterion has been considered in different value. The qualitative values of desertification indexes placed in four classes as, low, moderate sever and very sever. Among evaluated indexes, Irrigation system and drop level of groundwater have the most effects on desertification with numerical values 4 and 3.7 respectively. In the other indexes, crop yield and SAR of water have the lowest effects on regional desertification with numerical value 1 and 1.5 reactively. Analysis of result showed that the intensity of desertification obtained 2.54 on the entire of region based on 3 indexes and in the base of modified IMDPA model, the regional desertification intensity came to get medium.

Key words: Desertification hazard, Tashk, IMDPA model, GIS

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. (Safari Shad et al, 2013; Rohina et al, 2013). Land degradation in arid, semi arid and dry subhumid affected by climate changes and human activities (Mazloom et al, 2013, Bayat et al, 2013, Dashti Marviland Dabiri, 2013). ManyMethods have been developed for assessment and mapping of desertification hazards, (Mashayekhan and Honardoust, 2011). (Kharin et al., 2000) prepared the desertification map of West Asia by presenting several methods for desertification assessment. (Zhu et al., 2007, Sakcali et al., 2008) , 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 MEDALUS model in RiberiaSeca basin. (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

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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. (Ladsia, 2000), studied desertification in Barry, Italy, with MEDALUS model. In this research indices such as soil, climate, vegetation, land use, management quality and anthropogenic factors were evaluated. (Esfandiari and Hakimzadeh, 2010), studied desertification potential condition in Tashk region using IMDPA model to recognize the effective factors on land degradation. (Jafari et al., 2011), Studied desertification in Segzi Pediment by IMDPA The obtained map showed that 1.5%, 20% and 78.5% of the study area are considered as medium, high and very high desertification intensity classes, respectively. (Shakerian, et al., 2011) Evaluated desertification intensity in Jarghooyeh region, based on IMDPA model, their results showed that, this area classified in low class of desertification. According to the new definition of desert. In desertification evaluation using IMDPA Model in Taraz Nahid, Saveh, with quantitative intensity value DS=2.31 was calculated, that showed the moderate class for study region. (Toranjzar and Poormoradi, 2012). More parts of Iran encounter desertification problem, in order to challenging with desertification, it is necessary to do some scientific research and assessment in different parts of the country. The results may help to control and reduce the damages resulted from this phenomenon. The aim of this research would be the effects of active agricultural on soil degradation and water degradation with method Iranian Model (IMDPA) in south part of Iran**.**

2- MATERIALS AND METHODS

2-1- Study area

The study area is located in the Southern of Iran (53°41′11″–53°44′02″ E and 29°46′42″–29°48′57″ N), has a maximum elevation of 1600 meter and the main geomorphological units of this area are piedmont plain and fan and parent material is Alluvial. The average annual precipitation is 210 mm and according to climatic classification of Amberzheh, climate of this area is cold desert , the most part of study area is agricultural land .fig 1 exhibits the location of study area in Iran and in the Fars province.

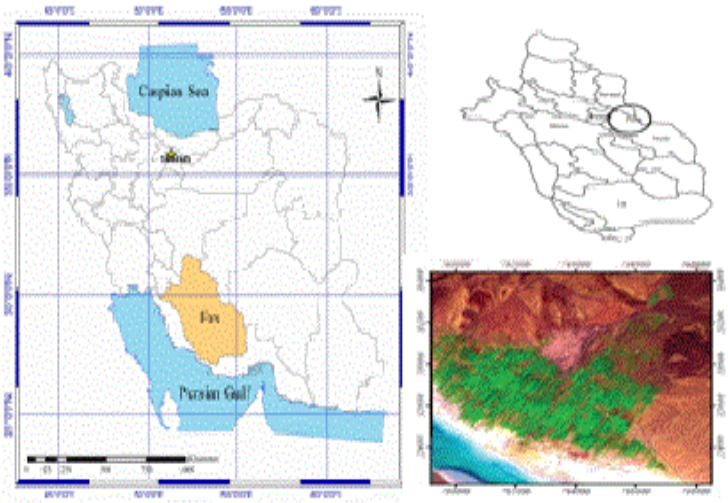

Fig 1. Location of the study area in Fars province and Ira

2-2-IMDPA Model

IMDPA model, a comprehensive desertification model, was presented by the faculty of natural resources, university of Tehran, as the result of a project entitled determination methodology of desertification criteria and indices in arid and semi arid region of Iran. In this project, some international models of desertification such as FAO-UNEP (FAO/UNEP, 1984), GLASOD, LADA, AOOSD, MEDALUS(European Commission, 1999) as well as national model MICD (Ahmadi, 2005) were reviewed in this research and 9 criteria were chosen based on previous experiences for desertification intensity mapping (Ahmadi, 2004). A score ranging from 1 to 4 is assigned to each index based on weight of each factor. Finally the value of each criterion was obtained as geometric average of scores of single indices according to the formula:

Index−X =[(Layer−1).(layer−2)...(Layer−n)]1/n
Where:
Index-X: A given criteria
Layer: Index of each criterion
N: number of indices for each criterion
Finally the desertification intensity will be a result of geometric average of 9 criteria as follows:
Desertification intensity = (Water × Soil × Water erosion × Wind erosion ×Climate × Vegetation cover × Agriculture × Technological development × Management)$^{1/9}$.

The geometric average of relevant indices determines values related to other criteria, which ultimately will result in desertification intensity, and class in each geomorphologic work unites of different land use (Agricultural). At the end, the risk of desertification (final map) is classified in 4 subtypes according to the Table1. The risk of desertification in study area was evaluated on the basis of the soil criteria, water criteria and agricultural criteria. When the scores are assigned, the indices are grouped. The value of quality index for each elementary unit within an index is obtained as geometric average of scores for single indices. Consequently 11 maps representing the condition of each index were produced to study the role and effect of each index in desertification. Then agricultural and water and soil maps were generated as geometric average of the mentioned indices showing the desertification condition in 4 classes. Consequently 3 maps representing the condition of each criterion was produced to study the role and effect of each index in desertification. To study these criteria, data collected from analyses of soil and water samples and interpolating amongst data points were be used. Table 2 and 3 show indices used to evaluate recent desertification condition and chosen to study water and soil criteria in study area., and Table 4 shows indices used to evaluate recent desertification to study agricultural in Task region.

Table1. Classification of desertification intensity

Desertification class	Quantitative grade for desertification class	Qualitative description for desertification grade
I	0 - 1.5	Low
II	1.6 - 2.5	Medium
III	2.6 - 3.5	High
IV	3.6 - 4	Very high

3- Results

For evaluating the proposed method in this study, with respect to all information mentioned in methodology and assessment method, this method for up to 5900 ha of Tashk region was used and obtained data were analyzed. In general,
various steps of studying and evaluation effective indices to determine soil, water degradation intensity by agriculture and to analyze obtained data are presented in the Figures2-12.

Table2. Suggested indices to assess ground water degradation in Iran

	Class	**Low**	**Medium**	**High**	**Very high**
Index	**Value**	**0 – 1.5**	**1.6 – 2,5**	**2.6 – 3.5**	**3.6 - 4**
Groundwater table decrease(cm/year)		<20	20 - 30	30 – 50	>50
Irrigation system		Modern high pressure system is based on computer programming	Pressure Classic	Modernized traditional (siphon, Gsylnd, valvular perforation)	Traditional optimal design (plot size,leakage, discharge, leak along the width, spacing, shape plot leaks)
EC (µmhos/cm)		<250	250 – 750	750 - 2250	2250 - 5000
SAR		<10	10 – 26	26 - 32	>32

Table3. Suggested indices to assess soil degradation in Iran

	Class	Low	Medium	High	Very high
Index	**Value**	**0 – 1.5**	**1.6 – 2,5**	**2.6 – 3.5**	**3.6 - 4**
depth		> 80	50 - 80	20 – 50	< 20
EC (µmhos/cm)		< 5	5 - 8	8 – 16	> 16
texture		Sandy Clay, Silty Clay	Loam, Sandy Clay Loam, Silty Clay Loam, Silty Loam,	Loam Sandy, Sandy Loam	Sandy, Clay<60%
Gravel percentage		< 15	15 - 25	25 – 75	> 75

Table4. Suggested indices to assess active agricultural in Iran

	Class	Low	Medium	High	Very high
Index	**Value**	**0 – 1.5**	**1.6 – 2,5**	**2.6 – 3.5**	**3.6 - 4**
Cropping pattern		Irrigated and rain gardens.	Suitable for irrigated and rainfed agriculture	Fallow lands	Rainfed Agriculture inappropriate
Product performance		Plain land for permanent cultivation	Plain farming land with temporary	Elevated land with permanent cultivation	Cultivated land with a high temporal
Advanced agricultural		Using the traditional farm inputs	The traditional use of external chemical inputs farm	Moderate use of external inputs and machinery, chemicals, semi-mechanized	All mechanized heavy use of appropriate machinery and chemicals

3.1. Analysis of indices

3.1.1. Indices of Water Resources Criterion

In order to determine the level of desertification of the region using the groundwater criterion, firstly regarding the information in table2 and field surveys, the indices considered in the unit map of the region have been graded.

Figures 1 to 4 are presented maps of water resources indices.

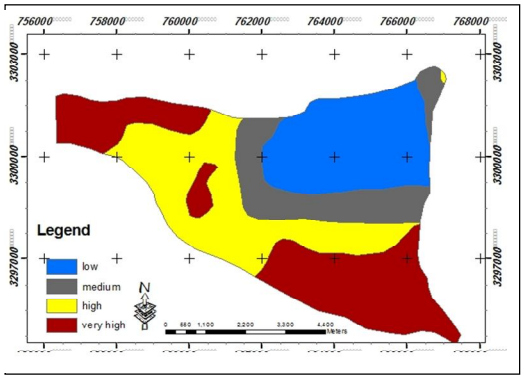

Fig 2. Map of Electrical Conductivity Index(EC)

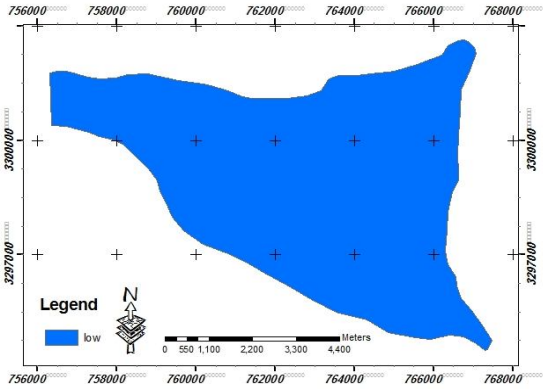

Fig 3. Map of Sodium Absorption Ratio Index(SAR)

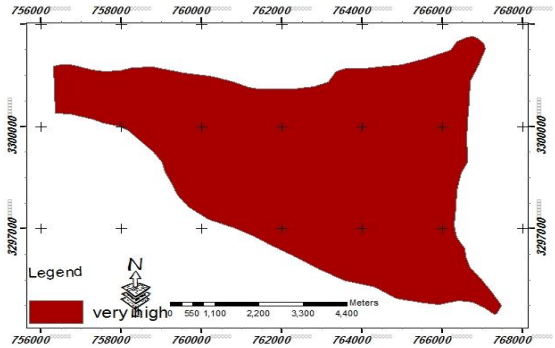

Fig.4. Map of Irrigation System Index

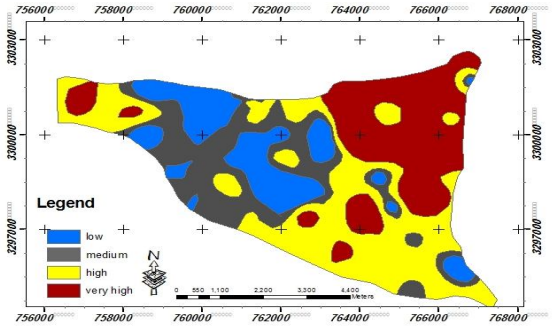

Fig.5. Map of Groundwater Table Decrease Index

After studying mean value of factors involved in water resources deterioration, it's indicated that Irrigation system index with a geometric average of 4 which shows very high class is the most effective factor in increasing groundwater degradation intensity of studied region. In general, we can introduce the following table for all indices influencing water resources deterioration

Table 5. Geometric average of the quantitative values of water resources degradation criterion

Order	Index	Value	Class
1	Groundwater table decrease	3.7	Very high
2	Irrigation system	4	Very high
3	EC (µmhos/cm)	2	Moderate
4	SAR	1	Low

3.1.2. Indices of Soil Criterion

In order to determine the level of desertification of the region using the groundwater criterion, firstly regarding the information in table3 and field surveys, the indices considered in the unit map of the region have been graded.

Figures 1 to 4 are presented maps of Soil indices.

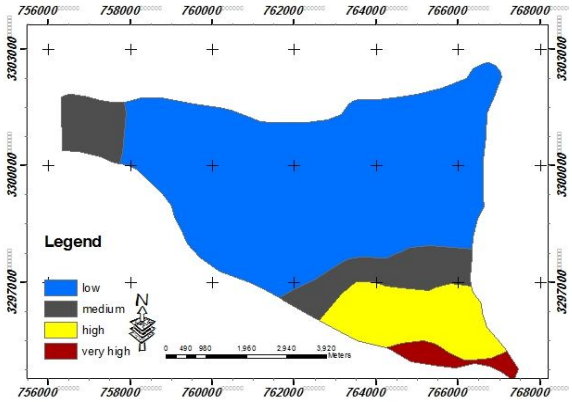

Fig.6. Map of soil Texture Index

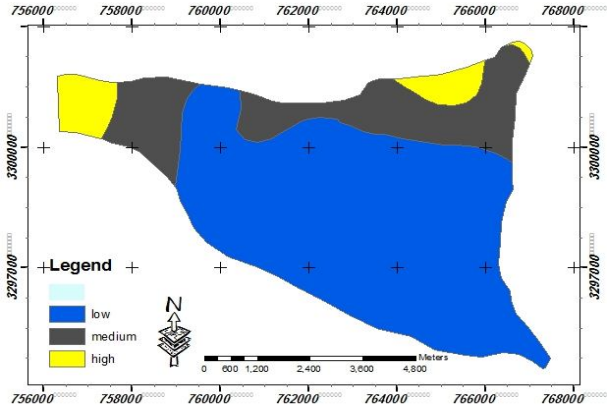

Fig.7. Map of soil Depth Index

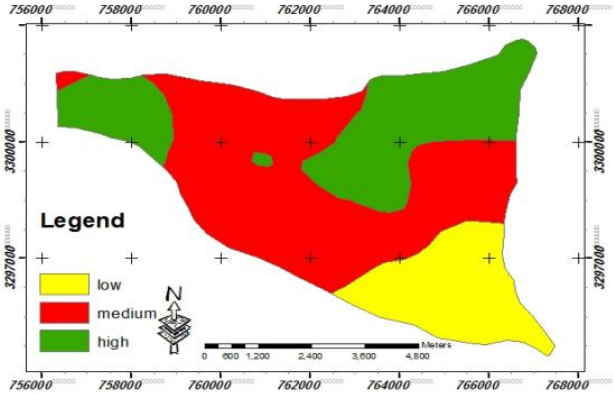

Fig. 8 Map of EC soil Index

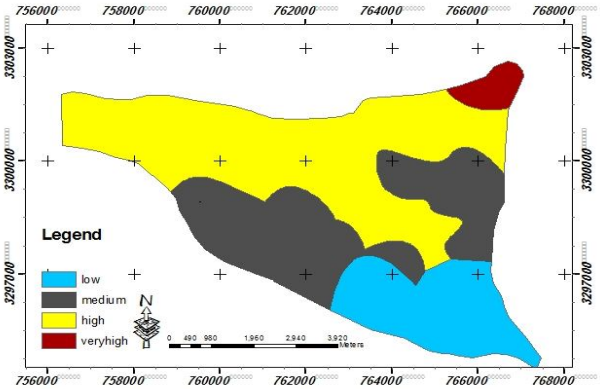

Fig. 9. Map of soil Gravel Index

Analyzing the mean value of four effective indices on soil degradation presents that soil texture index is the most effective factor in increasing soil degradation intensity by the geometric the most effective factor in soil degradation intensity of studied region. In general, we can introduce the following table for all indices influencing soil deterioration.

Table-6 Geometric average of the quantitative values soil indices

Order	Index	Value	Class
1	depth	1.5	Low
2	EC (µmhos/cm)	2.1	Moderate
3	texture	2.9	High
4	Gravel percentage	2.3	Moderate

3.1.3. Indices of Agricultural Criterion

In order to determine the level of desertification of the region using the groundwater criterion, firstly regarding the information in table4 and field surveys, the indices considered in the unit map of the region have been graded.

Figures 1 to 4 are presented maps of agricultural indices.

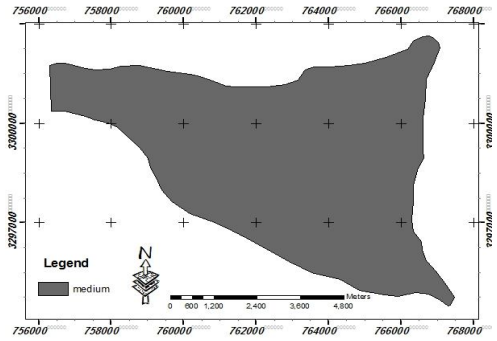

Fig 10. Map of Cropping pattern

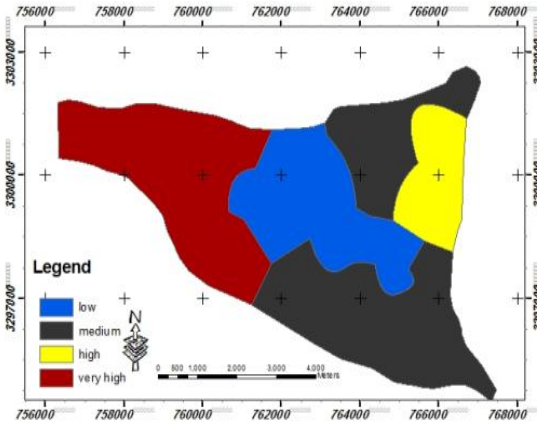

Fig 11. Map of Product performance

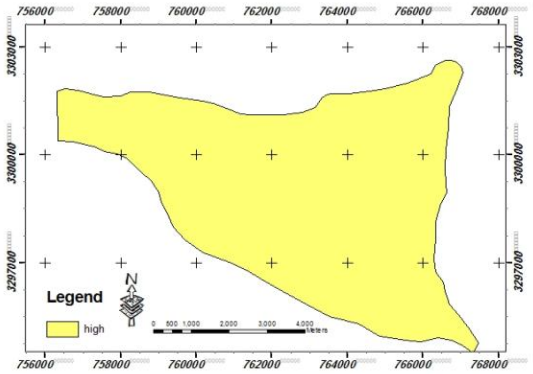

Fig 12. Map of Advanced agricultural

Due to the advanced agricultural maps can be downloaded: Indicators of cropping patterns because of two season irrigated agricultural lands in the Moderate class will be. Desertification indicators yield was also low rating, And the fourth sub-class, high performance, average performance, poor performance, and the performance was very poor, the advanced agricultural index is the most effective factor in increasing effect agricultural by the geometric. General 26% of the total area of desertification is quiet in class. Therefore is essential for proper management and land use practices.

Table. 7 Geometric average of the quantitative values Agricultural activities indices

Order	Index	Value	Class
1	Cropping pattern	2.3	Moderate
2	Product performance	1.5	Low
3	Advanced agricultural	3.1	High

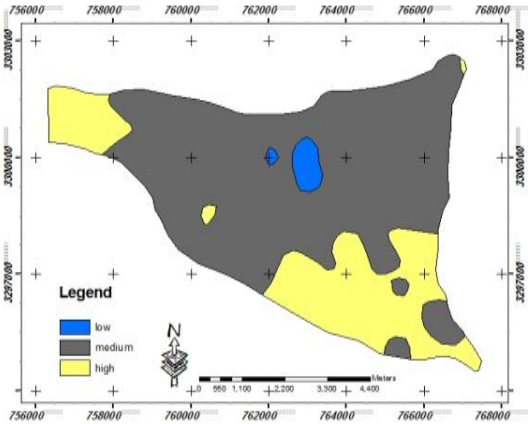

Fig 13. Map of Desertification Condition Based on Water Resources Criterion

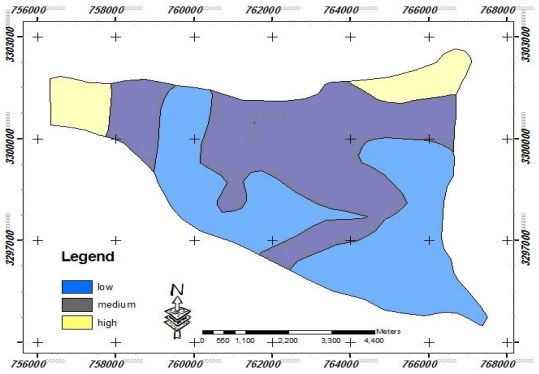

Fig 14. Map of Desertification Condition Based on Soil Criterion

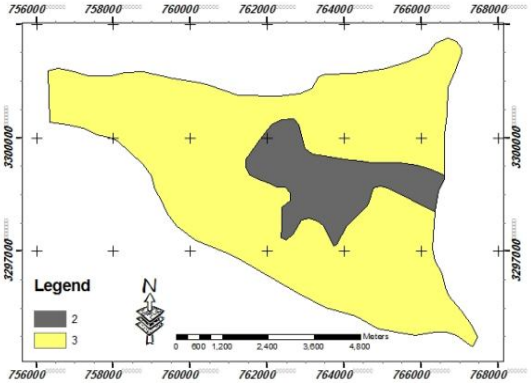

Fig 15. Map of Desertification Condition Based on agricultural activity Criterion

Analysis of studied criteria in Tashk region showed that water resources criterion with a geometric average of 2.92 shows high class while agricultural criterion with a weighted average of 2.3 stands in second order of desertification factors, and soil criterion with a weighted average of 2.2 shows moderate class.

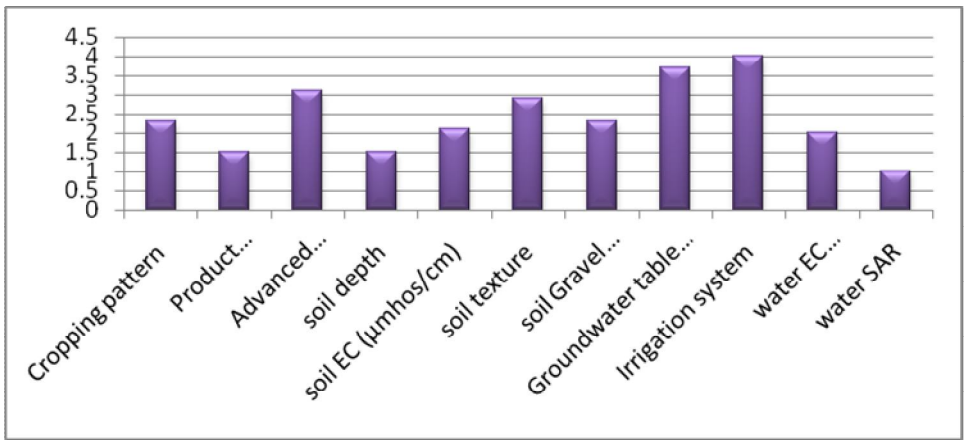

Fig. 16 Chart numerical value of various indicators

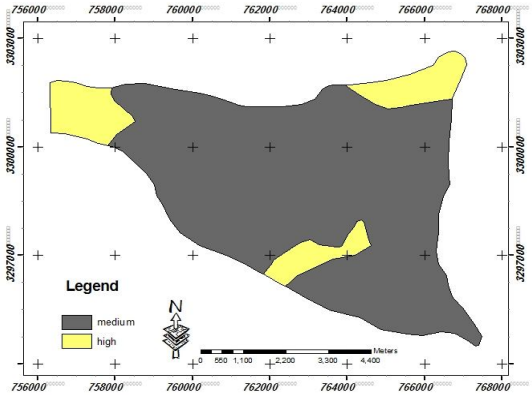

Fig 17. final map of desertification intensity soil and water degradation by agricultural

Discussion and conclusion

As a process of desertification in arid and semiarid ecosystem, desertification is widespread in the arid region of world. Although the government has gone into many projects to combat desertification in recent year, it seems that they are not adequate due to country extensive arid region. The problem needs more attention in addition to effective cooperation in the national as well as the international scene over the long term. We used a regional model by modifying IMDPA model whereby desertification parameters were collected in the study area, using GIS. The 3 composite criteria, each consisting of several indices, were analyzed. Based on the results, the soil criterion (average weight = 2.2) has average role in desertification process (Figure14). The water resources criterion (average weight = 2.92) has sever rate on desertification (Figure13). The agricultural criterion (average weight = 2.3) has moderate rate on desertification (Figure15). Analysis of soil and water and agricultural activity criteria indicates the rate of desertification in Tashk region is moderate with average weight 2.47. According to the classification of the Iranian model is medium class for total region (Figure17). Based on Figure 16: indicators irrigation system, groundwater table decrease, advanced agricultural had the greatest impact on desertification. And indicators Product performance, Soil depth and water SAR had the Minimum impact on desertification. It can be concluded that the assessment of desertification sensitivity is rather important to plane sustainable development in highly potential desert areas as Tashk region. Assessment information is essential to improve the employment of natural resources. The only quantitative aspect of desertification sensitivity demonstrates a clearer image of the risk state, thus, reliable priority actions can be planned.

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