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Assessment and mapping of desertification sensitivity in central part of Iran

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Abstract
Knowledge of behavior climatic indexes can be help to planning future programs Bahabad study area in the eastern part of the province of Yazd with a hot and dry climate, high potential evapotranspiration and low rainfall has a high potential for desertification. The aim of this research is evaluation of classification intensity by IMDPA model with emphasis to climate criteria. The indices included mean annual precipitation; UTI aridity index and length of drought period were applied for preparing of intensity map of desertification by using Arc Gis software .Scores of indices were recorded in different study units. At last, using the formula, CI= (a× b ×c) $^{1/3}$. Final Score of climate criteria (CI) was determined in the study area based on IMDPA. In this model, desertification potential classes are moderate, and high. The result showed that 68.42% of the study area is considered as medium, and 31.58% of the study area is on the high desertification intensity class.

Keywords: desertification intensity, climate criteria, IMDPA model, Bahabad

INTRODUCTION

Now days 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). 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). Many Methods have been developed for assessment and mapping of desertification hazards, (Mashayekhan and Honardoust, 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. 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) and an (2007) was surveyed the vegetation cover on desertification phenomena and they showed that vegetation

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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 s 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. 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 & 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, 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 climate indicator on desertification with method Iranian Model (IMDPA) in central part of Iran.

Materials and methods

Study area

The study area is located in the east of Yazd province far 200 kilometers from Yazd and 80 kilometers from Bafgh city, on the hill between the mountains with geographical position as 55° 36′ of eastern longitude and 31˚ 33′ to 32˚ 29′ northern latitude (fig 1). Bahabad has a semi arid climate with 154 mm annual precipitation; the evaluation is this area from sea level is 1390 meters. The maximum recorded temperature is 45 degrees and minimum to 20 degrees below zero.

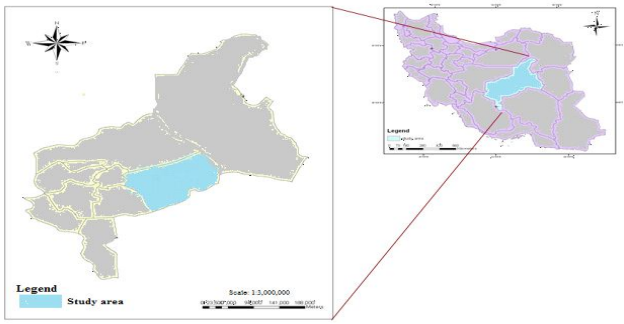

Fig1. The position of study area

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), MEDALUS (European Commission, 1999). and MICD (Ahmadi, 2005) were reviewed in this research and 9 criteria were chosen based on previous experiences for desertification intensity previous experiences for desertification intensity mapping (Ahmadi, 2004).In bases Iranian Model of Desertification Potential Assessment 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, Before starting the indices scoring, unit work map of the study area was provided using geology, land use and slope maps of the study area. 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 climate criteria. Climate criterion includes the following indices: Climate: mean annual precipitation, UTI aridity index, length of drought period, (Table2). As it was referred before the integration of information layers of each index to get final desertification map was done using GIS.

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

Table 2 Classes and the corresponding weight assigned for the calculation of the climate criteria

	Quantitative and qualitative for desertification grade			
Indexes	**0 - 1.5 Low**	**1.6 - 2.5 Medium**	**2.6 – 3.5 High**	**3.6 – 4 Very high**
annual precipitation index(mm)	≥ 280	150 - 280	150 – 75	75>
UTI aridity index	150 – 180	150 – 120	120 - 90	90 – 0
length of drought period index	3until4year	5 until 6 year	6 until 7 year	More than 7 year

Results and discussions

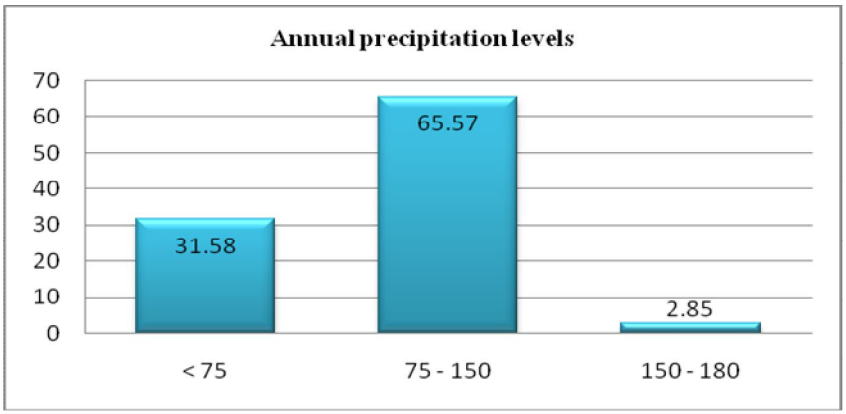

Fig2. Frequency percent of annual precipitation

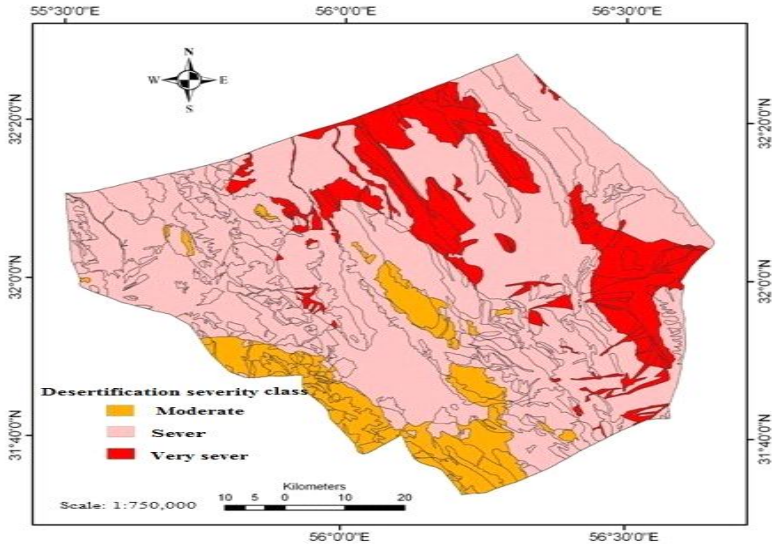

Fig3. Desertification intensity map for the annual precipitation index

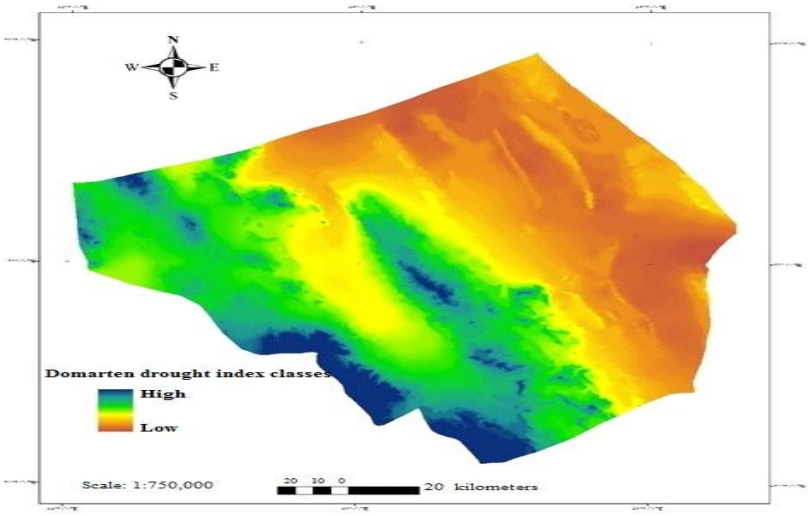

Fig4. Desertification intensity map of Domarten drought index

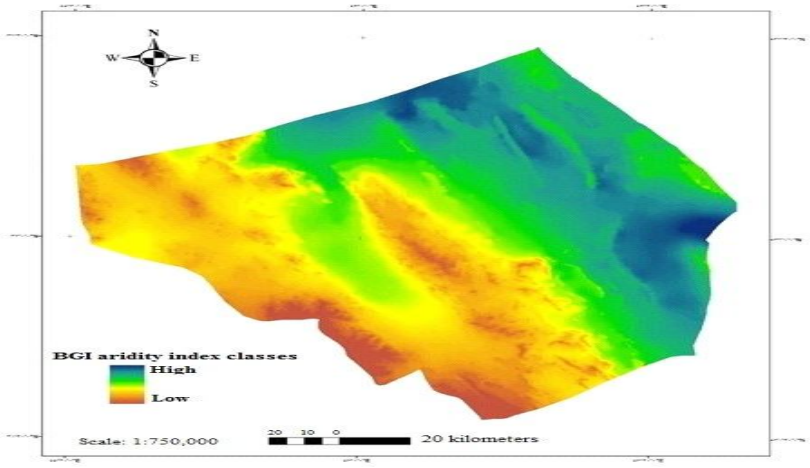

Fig5. Desertification intensity map of BGI aridity index

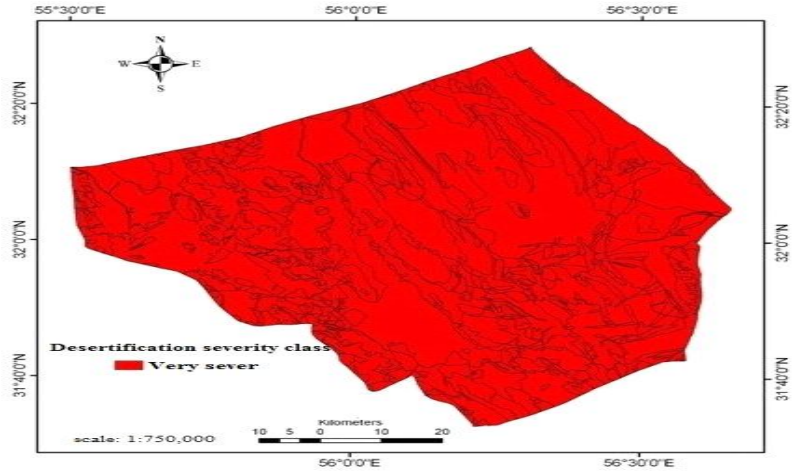

Fig6. Desertification intensity map of UTI aridity index

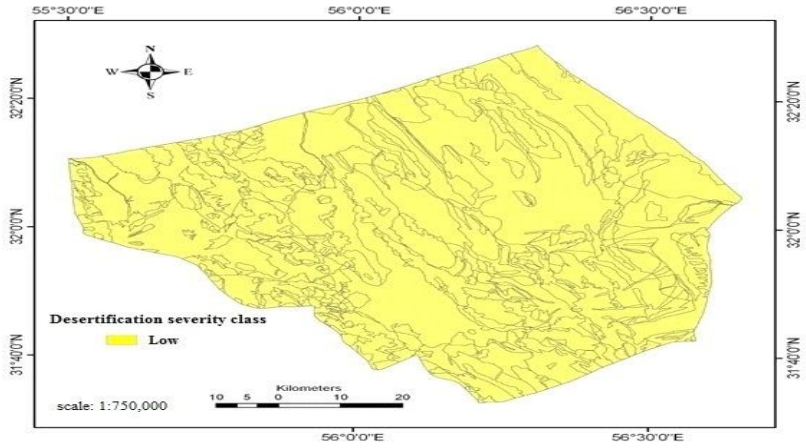

Fig7. Desertification intensity map of length of drought period index

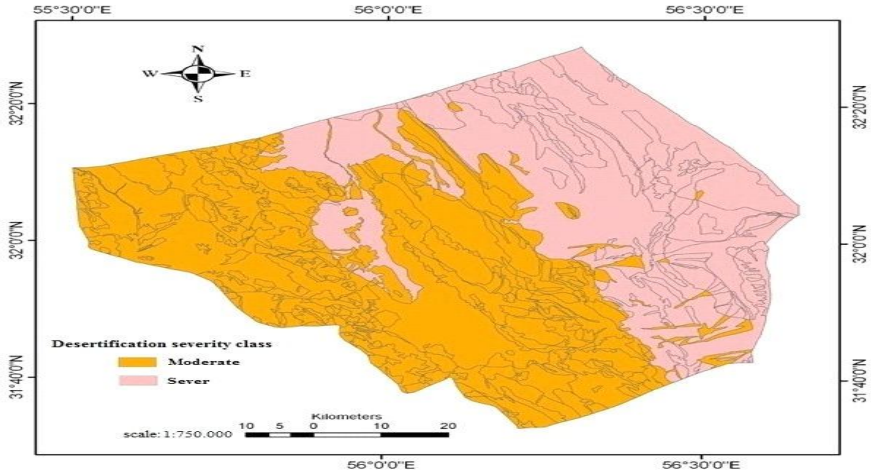

Fig8. Final map of desertification status with severity classes in study area

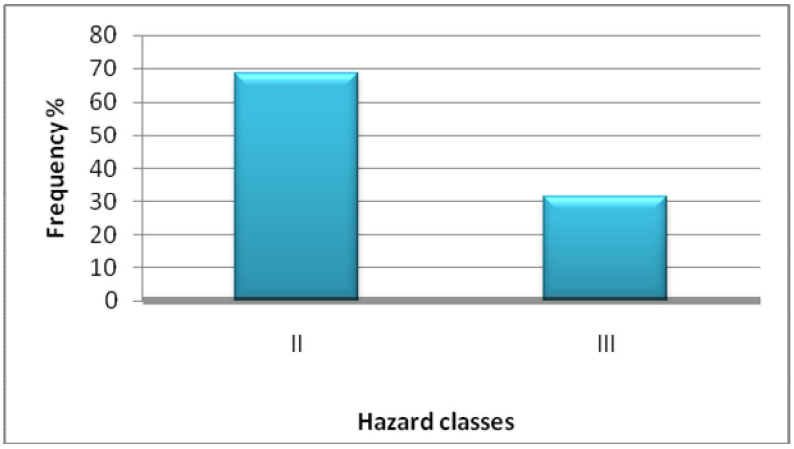

Fig9. Comparison graph of hazard classes frequency in Bahabad region

Frequency of Percent annual precipitation classes showed 65.57% from region is at high class of desertification and 31.58% at the very high class of desertification, only near 2.58% almost is at medium class of desertification (Fig2). The map of annual precipitation prepared by Gis (Fig3) As mentioned earlier, between precipitation and elevation from sea level in the region, there is a significant relationship Bahabad. This indicates that the Highlands region receives a significant part of rainfall occurs. It seems that in mountainous areas get more incoming precipitation. Also, if the biological function has been needto perform; the probability of success will be more in mountainous areas. According to the (fig 4) the Coefficient Domarten drought index all station less than 10, Therefore Bahabad was classified as dry region. The map of Desertification intensity BGI aridity index prepared by Gis with using of equation: K. (fig5). According to figure number 6, in relation to other determinate index (UTI), the total study area located in very sever class of desertification. The result of deciles index indicated the amount of the years that low

continuously that this factor caused the sensitive layer of desertification in related to drought period index located in low class, (fig7). Although the intensity drought is low in region Bahabad but in attention to fragile situation in desert ecosystems, and severe droughts can be enter the irreparable harm to the desert therefore management can be more successful. Finally three maps combined together and geometrical mean of them calculated and final producted map desertification intensity of region Bahabad. That 68/42 % of the area of desertification middle class and 31/58 % of the area is on the desertification high class.

Summary and conclusion

There are vast natural areas in Iran, which have susceptible and fragile ecosystem and desert condition. There are about 50 million hectares desert lands in Iran and 120 million hectares are also desert-pore regions. it is necessary to determine relevant criteria and indices for desired land uses as well as for desertification control. To achieve this mentioned objective and based on review of international and national desertification models in literature, climate criteria and 3 indices were selected which quantitative and weighted values of these factor determine climate change intensity in central of Iran. IMDPA model, a comprehensive desertification model, due to comprehensiveness and use of geometric mean in estimation of climate criteria final map of desertification severity and ArcGIS software were used. In the IMDPA model, a weight ranging from 1 to 4 was assigned to each layer based on its influence on desertification, Value 1 and value 4 indicate the best and the worse conditions, respectively. At last three maps combined together and geometrical mean of them calculated and final producted map desertification intensity of region Bahabad. That 68.42 % of the area of desertification middle class and 31.58 % of the area is on the desertification high class.

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