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Quantitative assessment of desertification with emphasis on geo-climatology

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ABSTRACT

Desertification is considered as an important problem facing arid and semi-arid regions, as Iran. These processes are resulted either from human activities or adverse natural conditions. However, the combination of both is often applicable. The aim of this study is the identification of areas sensitive to desertification in the southeastern coast of Iran. In this study we used from IMDPA model for quantitative of this problem and we used from GIS for mapping of desertification. Three main benchmarks of desertification, including: soil, wind erosion and climate were considered. The results show that the weight of soil is 1.7 that it is the most effective benchmark in region. On the other hand with analysis of indicators we know that the most important is annual precipitation. After obtain each weigh of benchmarks we understand that the weight of desertification intensity (DS) in region is 1.61 and located in very high class. We know more that 1321.74 (Ha) is in medium class and 2639.30(Ha) of area is in very high class. After soli benchmark, wind erosion with 1.64 value and climate with 1.51 value are effective in desertification.

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Introduction

Desertification is generally understood to refer to land degradation in arid, semi-arid, and dry semi-humid climatic zones (UNEP 1992). Today, the UN definition of desertification is that it is 'human induced land degradation in dry and sub-humid regions' (UNCCD: United Nations Convention to Combat Desertification). Another view is that desertification occurs everywhere but that it is actually most prevalent in cold regions where the low temperatures and short growing season create fragile ecosystems that lack resilience obvious starting point when considering the causes of desertification is the increase in the human population from about 1 million in the Stone Age to1 billion in 1850 and 6 billion in the 1990s (Imenson,2012).

Desertification process as a great problem effects most of the countries in the world especially developing countries. This process has high rate in arid and semi-arid countries as Iran. There are vast natural areas in Iran, which have susceptible and fragile ecosystem and desert condition. According to the new definition of desert, except a narrow strip in north of Iran, other parts of the country encounter desertification problem. Because of climatic geomorphologic conditions of Iran, desertification has been widely recognized as one of the most serious environmental problems in Iran.

It is widely recognized that desertification is a serious threat to arid and semiarid environments which cover 40% of the global land surface and are populated by approximately 1 billion humans. Given the potential relevance of this problem, it is surprising that there is no consensus on the proper way to assess the desertification status of a piece of land. During the last 70 years, conflicting definitions have produced both different assessment methodologies and divergent estimates (veron et al., 2006). Desertification is regarded as one of the most serious social–economic–environmental issues in arid, semi-arid and dry sub-humid areas (Sepehr and zucca, 2010). The first step in desertification process is to recognize phenomena, whether separately or in interaction with each other, that cause decreased potentials and change the region. In order to challenging with desertification, it is necessary to do some scientific research and assessment in different parts of the world. The results may help to control and reduce the damages resulted from this phenomenon. In many regions of the world especially in arid and semi-arid ones, studies have been done to assess the land degradation rate, degradation status and mapping.

To evaluate desertification, various assessments and studies have been done in the country and abroad that has resulted in offering many regional models. The most important offered models are UNEP-FAO (FAO/UNEP, 1984; Grumblat, 1991; Harahsheh, 1998;), TAXONOMY (Babaev et al., 1993: Kharin, et al. 1985) ESAs¹ (Basso, F. et al. 1999; Giordano, et al. 2002; Ladisa, 2002), MEDALUS (European Commission, 1999; Kosmas, et al. 1999; Zehtabian, Gh., et al. 2005), ICD² (Ekhtesasi, M., M. Mohajer, 1995), MICD³ (Ahmadi, et al. 2005), IMDPA⁴ (Ahmadi, 2004; Zehtabian, et al. 2009)

In this research we obtain intensity of desertification in karhi region in Iran that is an important region in southeastern of Iran for agriculture and fishing.

Materials and methods Case study

The study of area is located between 60° 3 10 until 60° 9 7 eastern longitude and 25° 30 57 until 25° 35 52 northern latitude and this region is an area of approximately 4770 ha that located within 700 kilometers southwest of Zahedan on the border the gulf of Oman. Slope of plains in region is very low and is about zero to 5%. Streams originating in the mountains and after during long distance throw the gulf of Oman. The major rivers

¹ Environment Sensitive Areas to Desertification

² Iranian Classification Desertification

³ Modified Iranian Classification Desertification

⁴ Iranian Model of Desertification Potential Assessment

are located within the area that surrounded on two sides the region are Sargan and kahir rivers. The main occupation of this area is Farming and fishing. According to right conditions of soil and groundwater, this area is one of the poles of agricultural in the Sistan and Balochestan province in Iran. Coastal dunes with a height of 5 meters along the coast have formed and the majority of these hills have been active and moving. In the study area in summer there is monsoon rainfall and so in the winter systematically regime that influenced by the origin of the Red Sea and the Mediterranean. Most of the rainfall in autumn and winter, and the long-term average rainfall are 94.98 mm and the average temperature estimate to 26.6 ° C. The average relative humidity was 65%, the mean wind speed is 6 knots, the prevailing southwest wind and 40% is the percentage of calm winds. Geologically the study area is part of the Makoran region and also follows from the nature of the zone. And in the long term the average potential evapotranspiration estimated to 2180.3 in the region.





Methodology

We used from IMDPA model to evaluate the extent of desertification during the period. Based on its effect on desertification with regard to region condition, field survey, and expert opinion, a weigh between 1 to 4 was gave to each index; so that value 1 and 4 are the best and worst, respectively(Tab1). Based on the performed weighing a map was prepared for each index. Then, to determine desertification intensity for each criterion, geometric average of indices of the same criterion and relation (1) were used, and finally based on performed weighing a map was prepared for each criterion.

Index-X= $[(Layer-1).(Layer-2)...(Layer-n)]^{1/n}$

Where, Index-X is the related criterion; Layer is the indices of each criterion; and n is number of indices in each criterion.

We mapping region about climate, soil and wind erosion benchmark (Tab1) then eventually analysis intensity of desertification in region (Tab2).

Eventually we used from this relation for mapping and make the intensity of desertification in study area. We make aspect, slope and land use map of region (Fig3) with GIS in this study.

 $DM=(CQI \times SQI \times WiEI)^{1/3}$

In this relation DM= Intensity of desertification, CQI= Climate benchmark, SQI= Soil benchmark and WiEI= Wind erosion benchmark.

Nateghi et al. (2008) assessment of desertification intensity with using IMDPA model in Segzi plain showed that the region had the high and very high degree of desertification intensities, and water criterion played the highest role in this trend. Jaafari-zadeh et al. (2010) studied the desertification intensity in Molasani region, Ahvaz province, using IMDPA model. The results showed that vegetation criterion with value 3.52 occurred in very high class. The criteria of agriculture, socio-economical issues, climate, erosion, urban development technology with values 2.42, 2.21, 2.05, 1.55, and 1.86, respectively, occurred in medium desertification class. geology and geomorphology criteria had the low class with value 1.24.

Zolfaghari et al. (2011) examined the desertification intensity of System plain using IMDPA model and the results showed that 51.09% and 45.09% of the region occurred in medium and high desertification classes, respectively. Criteria of vegetation with value 1.51 and wind erosion with value 1.67 had the lowest and highest influence in desertification, respectively.

Azare et al. (2013) in Analysis of desertification criteria in Garmsar plain region showed that among study criteria, agriculture criteria is a major problem in the region with a geometric average of 2.27 which shows medium class of desertification. Among the whole study area, 83.2 km² was found to be in low and about 236.8 km² in medium class of desertification. It is distinguished that the intensity of desertification for the total area is 2.1 which is classified under medium class of degradation

Results

A series of surveys on the weighted average values of some climatic benchmark show that in this area annual precipitation indicator is the most effective factor in increasing desertification in the region. The value of each indicator given in the tab2 and mapping of desertification with this benchmark show in fig3.

The analysis of soil benchmark is given in tab2 series of surveys on the weighted average values of some soil benchmark show that Infiltration rate is the most effective indicator in the area. And in fig3 we show extent of desertification in this region with soil benchmark.

After assessment of wind erosion benchmark in this region we know that the most indicator of it is in high class. We know from analysis that Remoteness and closeness to deposits of sand and vegetation density plays a major role in desertification region. The result of analysis are given in tab2 and shows the intensity of desertification in fig3 with wind erosion benchmark.





Fig 3. Mapping of desertification intensity in region

Evaluation	Desertification class	Low	Medium	High	Very high
indicator	score	1.00-1.22	1.23-1.32	1.33-1.41	1.42-2
mate hmark	Annual precipitation	600 - 280	280 - 150	150 - 75	75 >
	Aridity index	0.45-0.65	0.2-0.45	0.05-0.2	< 0.05
Cli benc	Drought index(Class code)	5.6	4	2:3	1
soil nchmark	Soil texture	SC - SiC	L – SCL – SiCL- SiL	LS - SL	S-C>%60
	EC	> 8	16-6	32 - 16	>32
	SAR	>13	30-13	70 - 30	70<
be	Infiltration rate	>12	12-6	0.49-5.9	< 0.49
Wind erosion benchmark	Density of non-live coverage	MC>80	40 <mc<80< td=""><td>20<mc<40< td=""><td>MC<20</td></mc<40<></td></mc<80<>	20 <mc<40< td=""><td>MC<20</td></mc<40<>	MC<20
	Vegetation density	PC>40	20 <pc<40< td=""><td>10<pc<20< td=""><td>PC<10</td></pc<20<></td></pc<40<>	10 <pc<20< td=""><td>PC<10</td></pc<20<>	PC<10
	The number of days with dust storm	<10	30-10	60-30	60>

Tab Ldetails of benchmarks in I	MDPA model	
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Tab 2. Qualitative and quantitative value of desertification in the region

Desertification class	The numerical	indicator		
madium		Soil toyture	~	
medium	1.80	Soll texture	ark	
medium	1.72	EC	lic mu	
medium	1.53	SAR	scincl	
high	1.73	Infiltration rate	be	
Very high	1.9	Annual precipitation	rk	
medium	1.3	Aridity index	nate	
high	1.4	Drought index	Clim bench	
Very high	1.89	Density of non-live	ſ	
		coverage and Vegetation	sion urk	
Very high	1.87	The distance from the	sros uma	
		sand deposits	id e nch	
medium	1.25	The number of days with	Vir be	
		dust storm	1	

Discussions and conclusions

After analysis of Cross-sectional studies in many region of Iran we understanding that desertification made effects human and environmental causes and this opinion is different from one area to another. Because there are many indicator for assess of desertification in the area led that we evaluation with accuracy intensity of desertification in this study. We know that indicators of soil benchmark is the most important in desertification and the most effective indicators in region is annual precipitation that the quantitative value of it is 1.9 and is very important to control for this problem environmental. After obtain of each weigh of benchmarks we understand that the weight of desertification intensity in region is 1.61 and located in very high class. We know more than 1321.74 Ha is in medium class and 2639.30 of area is in very high class. After soli benchmark, wind erosion with value 1.64 and climate with value 1.51 is effective in desertification.

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