Int. J. Forest, Soil and Erosion, 2018 8 (4)
ISSN 2251-6387

Research Paper

Assessing desertification intensity in Alborz province using IMDPA model

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Abstract: Desertification phenomenon has been described as one of the most obvious forms of natural resources degradation in the world. During last decades, extensive international efforts have been done for combating desertification. This phenomenon occurs because of natural factors or anthropogenic factors. Awareness of desertification criteria and indicators, investigation of a regional model and determining the most important factors affecting desertification are essential for combating desertification. So in this study, desertification intensity of Alborz province was assessed using IMDPA model. The results showed that 3308.1377 Km^2 of total area of Alborz province (5127.7362 Km^2), was in class I or low intensity of desertification, 1640.0254 Km^2 was in class II or medium intensity of desertification, 179. 5731 Km^2 was in class O or ineffective class and class III or intensive and also class IV or very intensive didn't exist in the region so that in some parts of south and north of Alborz province desertification has been increasing and classes with high intensity has been increased while classes with low intensity of desertification has been decreased.

Keywords: desertification, Alborz province, natural resources degradation, IMDPA

Introduction

Iran is a vast country that has specific climate because of its special location and topography. The annual average of rainfall is about 860 mm in the world while in Iran, it is about 250 mm (Negaresh, 2011; Razaghi, 2008). According to United Nations desertification and combating desertification conference, in future, desertification menace more than 785 million people of arid area population that is equal to 17.7% of total population of the world and 60 to 100 million people of them are affected directly because of decline in land fertility and other desertification processes (Babaev,1999). Desertification means land degradation in arid, semi-arid and dry sub-humid regions. Desertification occurs as a result of climate change or anthropogenic factors (Danfeng, 2006, Reynolds, 2009). The first step for combating desertification is prevention of desert development. It should be dependent on recognition of factors that can lead to changes in an area and consequently desertification. Desertification is the most obvious form of natural resources degradation in the world and in recent decades many international efforts have been done for combating this phenomenon. Awareness of desertification criteria and indicators, investigation of a regional model and determining the most important factors affecting desertification are essential for combating desertification. Desertification criteria and indicators should be determined and assessed for identifying desertification status and severity and also protection of vulnerable regions so that desertification plans can be successfully done and desertification can be prevented through proper use of land and considering criteria and indicators effective on desertification (Zehtabian et al, 2007). Many studies have been done for assessing desertification in different parts of the world and different models have been presented. So it's essential that their criteria and indicators be assessed again and corrected regarding to different areas condition. For this aim, comprehensive plan for quantifying criteria and indicators affecting desertification in natural ecosystems of Iran was prepared (Yektafar et al, 2015). This model have 9 criteria including water, soil, vegetation cover, geomorphology, erosion, agriculture, socio-economic, climate and urban (technology) development which are as desertification criteria and their indicators are used for quantifying them (Ahmadi, 2004). Many studies have been done about application of this model for assessing desertification in different parts of Iran like:

Zolfaghari et al (2011) assessed desertification intensity of Sistan plain using IMDPA model. Their results showed that this model was relatively precise because of considering proper indicators, its simplicity, its specific method for weighting indicators, using GIS for combination of maps and also geometric mean for calculation of indicators scores and preparing desertification intensity map. So it can be used in similar region. Zolfaghari and Khosravi (2016) assessed desertification severity of Saravan using IMDPA model. They have used 4 criteria including climate, vegetation cover, wind erosion and soil in their research. Their results showed that 45.25% of the region was in medium and 54.39% of the region was in sever class of desertification. 0.37% of the region was residential areas that wasn't in any class. Also according to their results climate and soil criteria had the most and the least effect on desertification of Saravan respectively. Abdi (2008) assessed desertification intensity of Abozeidabad using IMDPA model based on water and soil criteria and concluded that soil EC and after that water EC with average weight of 3.67 and 2.80 had the most effect on desertification respectively and groundwater depletion, SAR and Cl concentration with average weight of 1 had the least effect on desertification. According to his results, desertification class was medium for the whole region. Esfandiari et al (2009) assessed desertification intensity of Tashk region using IMDPA model and groundwater criterion. They have used 4 indicators including EC, SAR, irrigation system and annual groundwater level depletion in their study. Their results showed that irrigation system index was too important in desertification of region and according to desertification map, 1% of the region was in low class, 28% was in intensive class and 71% of the region was in medium class. Zehtabian et al (2013) assessed desertification intensity of Garmsar plain using IMDPA model and parameters related to agriculture and groundwater. Their results showed that agricultural factors with

geometric mean equal to 2.27 were the most effective factors of Garmsar desertification. Also their results showed that 83.2 Km^2 of the whole region was in medium class and 236.8 Km^2 was in low class of desertification intensity. Vesali (2008) investigated biophysical indicators of desertification intensity affected by human activities in Kashan and Aran va Bidgol regions using IMDPA model. Raeisi (2008) studied effective factors on desertification intensity in Kahir region using IMDPA model. He concluded that soil degradation criterion was the most important factor for desertification. Niko (2011) assessed desertification potential for identifying effective factors on land degradation in Damghan region. Kamali et al (2010) investigated desertification intensity based on water, soil and vegetation cover criteria using IMDPA model in Faryab region. Rafie (2011) assessed desertification of Yazd-Ardakan plain based on water and climate criteria using IMDPA model.

According to the researches and also native nature of IMDPA model, it seems that this model should be evaluated in different parts of the country with different climatic condition. Regarding to this issue, IMDPA model was used for assessing desertification intensity of Alborz province in this study.

Materials and methods

The study area

Alborz province is located in 50º 10´ to 51º 30´ Eastern longitude and 35º 28´ to 36º 30´ Northern latitude. Karaj is the center of this province and geographically it's limited to Mazandaran province from north, to Ghazvin province from west, to Tehran from east and to Markazi province from south. This province is located at the south of central Alborz highlands and its altitude variation is too, so its weather is affected by altitude. Alborz province is affected by northern, northwest, western and especially southwest systems in cold season. Its rainfall is affected by these systems which starts at October and November and will continue until mid-May. According to the last census in 2010, population of this province is 5.2 million people which includes about 5% of the whole Iran population. Figure (1) shows the location of Alborz province.

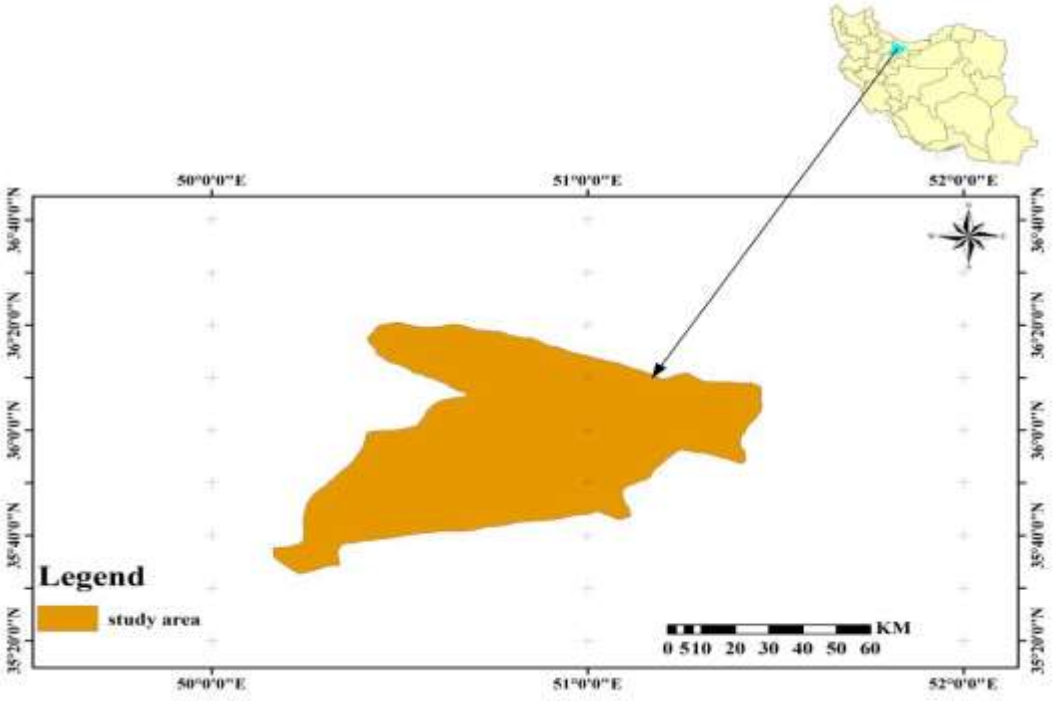

Figure 1: location of Alborz province in Iran

Methodology

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 semiarid region of Iran. This model have 9 criteria which are as desertification criteria and their indicators are used for quantifying them. At first 130 indicators were selected for all 9 criteria but in one hand it wasn't possible to prepare information of all of them for the whole of country and on the other hand it was costly and time consuming. So for each criterion, up to 4 key indicators were identified. Indicators related to each criterion are as follow:

- Climate: drought, aridity index, rainfall amount.
- Geomorphology: land use, rock sensitivity and physiography.
- Soil: EC, texture, depth, gravel percentage.
- Vegetation cover: coverage status, coverage utilization and vegetation cover rehabilitation.
- Water: negative balance of water, groundwater depletion, EC and SAR.

- Erosion: water erosion (vegetation cover density, land use and water erosion density and type) and wind erosion (days with dust storm index, vegetation cover, non-living cover density and erosion facies appearance).
- Socio-economic: socio-cultural factors, organization and participation, awareness, experience and native knowledge.
- Agriculture: cultivation patterns, crop performance and application of inputs and machinery.
- Urban or technology development: mine and road density, converting forests and rangelands to urban and industrial areas, improper agriculture, converting garden lands to residential-industrial regions and amount of green space per person.

In this study each index received a weight (1 to 4) according to expert opinion and each criterion was obtained based on its indicators geometric mean according to the formula below:

$$Index - X = \left[(Layer - 1).(layer - 2)...(Layer - n)\right]^{1/n} \quad (1)$$

Index X: each criterion
Layer: indicators related to each criterion
N: number of indicators related to each criterion
Weighted averages of indicators related to each criterion were determine and finally desertification intensity was gain based on geometric mean of all criteria according to the formula below:

$$Desertification\ intensity = \Sigma^{1/9}\sqrt{water \times soil \times vegetation \ldots. \times socio - economic} \quad (2)$$

Then, final map of desertification intensity was determined using different layers and obtained maps related to each criterion and combination of layers and maps. So, map of each criterion status was obtained from its own indicators. These maps can be used for the study of each index quality and its effect on desertification. Table (1) shows intensity classification of desertification status.

Table 1: Intensity classification of desertification status

order	Numerical value	class
1	1-1.5	Low
2	1.6-2.5	Medium
3	2.6-3.5	High
4	3.6-4	Very high

Results

Four criteria map of natural, socio-economic, human activities criteria which leads to wind and water erosion were combined in GIS software for preparing desertification intensity map of Alborz province in order to study desertification condition of Alborz province which is one goal of Desertification Atlas preparation.
Table (2) shows the result of these four criteria combination and figure 2 shows the percentage of each class area.

Table 2: Classes of Alborz province desertification intensity

Desertification intensity	Class of desertification	Are (Km^2)
Low	I	3308.1377
Medium	II	1640.0254
Intensive	III	-
Very intensive	IV	-
No effect	O	179.5731

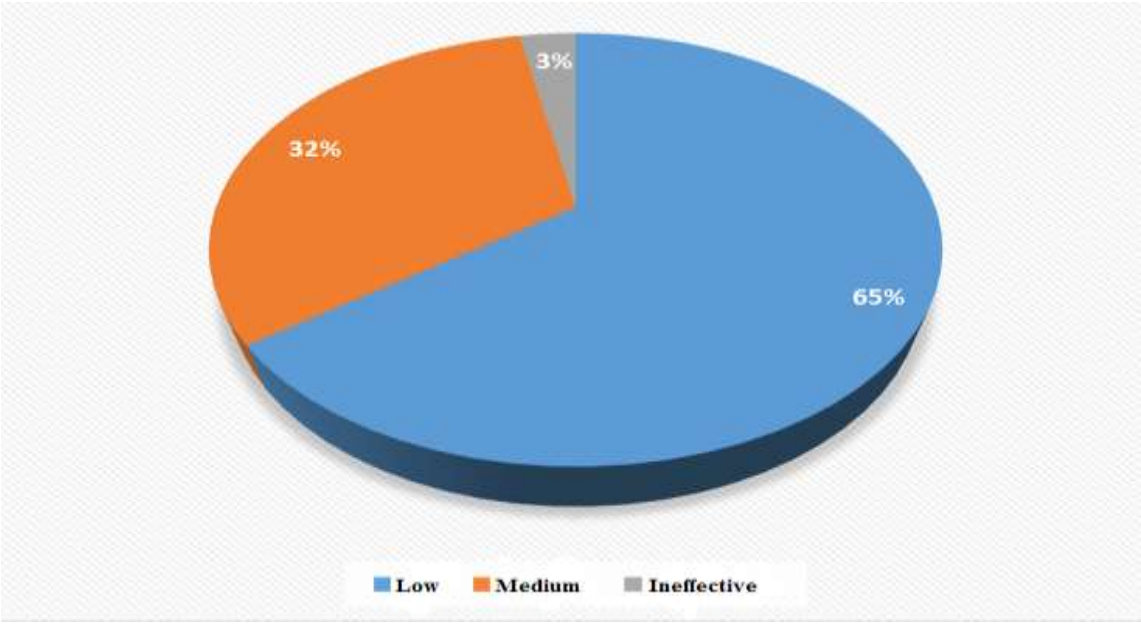

Figure 2: Classes of desertification intensity in Alborz province

Finally zoning map of desertification potential of Alborz province was prepared for all criteria (figure 3).

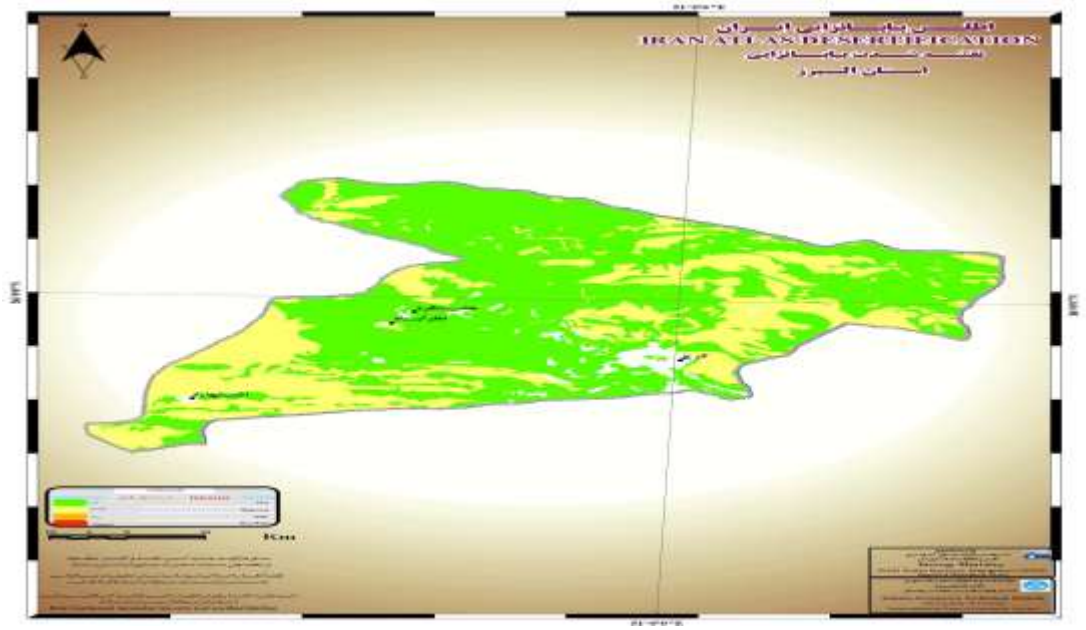

Figure 3: Desertification intensity of Alborz province

Conclusion

In this study IMDPA model was used in order to quantify criteria and indicators affecting desertification and preparing desertification intensity map of Alborz province. According to this model, 9 criteria were selected as desertification criteria that for quantifying them, their indicators were used. Four criteria map of natural, socio-economic, human activities criteria which leads to wind and water

erosion were combined in GIS software for preparing desertification intensity map of Alborz province. According to the results of this study, 3308.1377 Km^2 of total area of Alborz province (5127.7362 Km^2), was in class I or low intensity of desertification, 1640.0254 Km^2 was in class II or medium intensity of desertification, 179. 5731 Km^2 was in class O or ineffective and class III or intensive and also class IV or very intensive didn't exist in the region so that in some parts of south and north of Alborz province desertification has been increasing and classes with high intensity has been increased while classes with low intensity of desertification has been decreased. Our results were corresponded to Zolfaghari and Khosravi (2016) that assessed desertification intensity of Saravan region using IMDPA model, Niko (2011) that assessed desertification potential of Damghan region and Kamali et al (2010) that investigated desertification intensity of Faryab region using IMDPA model.

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