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Evaluation of the Effects of Vegetation Characteristics on Desertification (Case Study: Northern Hableh Roud, Iran)

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Abstract

One of the characteristics in Iranian Model of Desertification Potential Assessment (IMDPA) is vegetation. Since vegetation is very important factor in the degradation of land, so some indices were determined for this item in order to evaluate desertification potential of arid, semi arid and arid sub humid areas of Iran. The indices included vegetation condition, exploit and revegetation. To calibrate the vegetation item in the IMDPA model, above mentioned indices were assessed in Northern Hableh Rood region as semi arid and arid sub humid region. To do this, in the first stage unit work map of the study area was prepared based on slope, land use and geological maps. Scores of indices were recorded in different study units. At last, using the following formula, $VI = \sqrt[3]{VC_I * VU_I * VR_I}$, final score of vegetation character (VI) was determined in the study area based on IMDPA. After scoring vegetation character, desertification intensity map for vegetation character including four low, medium, intensive and very intensive classes was prepared. The map showed that 62.2%, 37.2% and 0.6% of the study area are considered as low, medium and high desertification intensity class, respectively. There wasn't very high class based on vegetation character.

Keywords: IMDPA; Soil; Desertification; Hableh Rood; Iran

1. Introduction

Desertification is generally understood to refer to land degradation in arid, semiarid and dry semi-humid climatic zones (UNEP, 1992). It involves five principal processes: vegetation degradation, water erosion, wind erosion, salinization and waterlogging, and soil crusting and compaction (Dregne, 1998). Vegetation degradation includes the loss of coverage and biomass, as well as compositional changes, such as replacement of native by exotic species (Mouat and Hutchinson, 1995).

Success in combating desertification will require the linkage between desertification and climate, soil, water, land cover and socio-economic factors.

In desertification process, because of changes in soil condition (salinity, sodicity, OM content, accumulation of poisons) and increase of water and wind erosion, vegetation is changed.

Therefore, with evaluation of vegetation it is possible to determine desertification intensity. For this work, we need indices of vegetation. These indices must be:

1- Quantiable
2- Sensitive to partial changes
3- Usable in national scale
4- Suitable with sample size
5- Simple and low cost for measuring, information collection and evaluation.
6- Able to evaluate the current status of desertification

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7- Able to separate environmental factors and human –induced desertification.
8- Suitable with ecological factors
9- Limit in number

Many studies have been done to introduce land degradation assessment methods i.e. FAO-UNEP, Turkmenistan model, GLASOD, MEDALUS, LADA, etc.

Ladsia (2000) studied desertification of Barry in Italy with MEDALUS model. In this research indices such as soil, climate, vegetation, land use, management quality and anthropogenic factors were evaluated.

Rubio and Bochet (2000) suggested that some indices such as canopy cover, biomass, distribution pattern, root system, structure, morphology, biological type, germination rate will be more benefit for evaluation of desertification based on vegetation criteria.

Each of these models has been designed considering an special region's ecological, biological, socio-economic and conditions.

Hence, to have a model with national application and adaptable is necessary to design a model adaptable with different environmental condition of Iran. Considering different effective indications in desertification, this paper focuses on vegetation indicator of Iranian Model of desertification potential assessment (IMDPA).

2. Materials and Methods

In order to evaluate vegetation role in desertification, a part of north Hableh Rood basin in Tehran-Semnan provinces was chosen as study area. The climate of mentioned basin, with an area of 295250 ha, changes from semi-arid in Southern parts to dry sub humid in Northern parts. The mean annual precipitation of study area estimated about 350 mm. Rangelands cover about 230529.3 ha of the study area, including 9-60 percent of vegetation in different types. The average of vegetation percentage is estimated about 28.3.

2.4AU/ha and 138076A.U. are grazing capacity for one and four month grazing periods, respectively. The condition of rangelands differs from good to very poor in different types. Good, average, poor and very poor condition include 0.30%, 41.8%, 57.3% and 0.6% of rangelands area, respectively.

Among different effective indices of vegetation indicator in desertification, three indices including vegetation condition, utilization of vegetation and reproduction were chosen.

Table 1 shows the indices and their scoring. As shown in table 1, there are four classes to represent desertification severity based on vegetation indices effects. Score 0-1.5 is representative of class low of desertification, that is, if any index lies between 0-1.5, therefore its influence on desertification is low. 1.6-2.5, 2.6-3.5, and 3.6-4 are the sores to show moderate, severe and strongly severe classes of vegetation induced desertification. In this method, it is possible to provide a desertification potential map considering each index score using GIS. The final score of desertification potential caused by vegetation is calculated using the following geometric mean method:

$$VI = \sqrt[3]{VC_I * VU_I * VR_I}$$

Where VI is final score of vegetation indicator, VC_I is vegetation condition index score, VU_I is vegetation utilization index score, and UR_I is vegetation reproduction index score.

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. Totally 37 homogenous unit works were recognized in which scoring of three vegetation indices were performed within these unit works.

As it was referred before the integration of information layers of each index to get final desertification map was done using GIS technology.

3. Results and Discussion

The map of current desertification status caused by vegetation, prepared according to final score of vegetation indicator (Fig 1).

Table 2 shows the surface areas of each desertification classes caused by vegetation. Table 2 indicates that 143402.65, 85660.3 and 1466.55 of the study area are considered as low, moderate and high (severe) desertification intensity classes, respectively. There wasn't very high class based on vegetation character.

The final map of desertification revealed that 62.2%, 37.2% and 0.6% of the study area are considered as low, moderate and high desertification intensity class, respectively. The majority of low desertification class area is located in those parts with dry – sub humid climate while medium and severe classes of desertification are mainly related to areas with

semi-arid climate. Among three vegetation indices, vegetation condition index plays the main role in desertification of the study area. Since utilization of vegetation is approximately equal to grazing capacity, on the other hand due to relatively high precipitation plants reproduction has good condition, therefore these two indices are not very effective in view point of desertification.

Table 1. Proposed indices for vegetation cover assessmen

	Desertification intensity			
Index	3.6-4 (Strongly severe)	2.6-3.5 (Severe)	1.6-2.5 (Moderate)	0-1.5 (Low)
Vegetation condition	Invader species are>50% of vegetation cover and annual plants are dominant	Invader species are20-50% of vegetation cover and annual plants are dominant	Invader species are5-20% of vegetation cover and annual plants 25-50%	Invader species are<5% of vegetation cover and annual plants >25%
	Surface litter is <30%	Surface litter is 30-70%	Surface litter is70-90%	Surface litter is >90%
	foliage cover of perennials is <5%	Foliage cover of perennials is 5-15%	Foliage cover of perennials is 15-30%	Foliage cover of perennials is >85%
	Forage production is 25% of annual production	Forage production is 25-65% of annual production	Forage production is 65-85% of annual production	Forage production is >85% of annual production
	No regeneration of decreasers group	Rarely regeneration of degreasers group	Regeneration of degreasers group are low	Regeneration of degreasers group are Suitable
Utilization of vegetation cover	Heavy cutting of brush, shrub and trees	cutting of brush, shrub and trees are apparent	cutting of brush, shrub and trees are more than annual biomass	cutting of brush and uproot of shrub are not seen
	Heavy stocking rate	Grazing is more than capacity	Stocking rate is a little more than annual production	Stocking rate is equal to the rang capacity
	Imbalance between vegetation type and grazer animal	Weak imbalance of grazer animal	Proportion of grazer animals is not very good	Proportion of grazer animals and vegetation type are suitable
Reproduction	Regeneration of plants are impossible(ecological problem)	Regeneration of plants involve high expense	Reproduction of plants are access able with low expense	Reproduction of plants are done naturally
	Range improvement projects have not successed till now	Range improvement projects be success to some extent	Range improvement projects be success and effective	Region does need not to reclamation projects
	Invaders species are dominant and increaser ones are not seen	Invaders and increaser species are dominant and decreasers ones are not seen	Decreasers and increaser species are dominant and invaders ones are seen seldom	Decreasers and increaser species are 70 and 30% respectively and invaders ones are not seen
	No reproduction	Vegetative reproduction	Sexual and Vegetative reproduction	Sexual and vegetative reproduction but first is dominant

Table 2. Extent of different desertification classes in Hable Rood basin

Area		Desertification intensity
percentage	hectare	
62.2	143402.65	Low
37.2	85660.13	Moderate
0.6	1466.55	Severe
-	-	Strongly severe

Vegetation condition index is scored based on canopy cover percentage species composition. Difference classes of canopy cover percentage for determination of desertification intensity is used as follows:

Canopy cover (%)	class of desertification
>30	low
15-30	moderate
6-15	High
<6	very high

Overgrazing is one of the main vegetative factors that has remarkable effect on desertification. Overgrazing and the resulting spatially extensive reduction of vegetation cover fundamentally alter the hydrological properties and the related transport processes. Severe overgrazing results in the development of bare, possibly interconnected patches within rangelands. A reduction of the vegetation cover is accompanied by a decrease in surface roughness. Trampling by livestock leads to the compaction of the soil resulting in decreased infiltration capac

ities (Hastings and Turner, 1965). Both the decrease of roughness and of the infiltration capacities result in a substantial increase of overland-flow velocities and in run off production (Whitford, 2002; Rietkerk et al., 1997).

Other studies indicate that livestock overgrazing and increasing aridity are the major causes for desertification (McPherson, 1995; Wondzell and Ludwig, 1995), though there complex interactions of factors may be responsible for desertification (Humphrey, 1958; Reynolds et al., 1999).

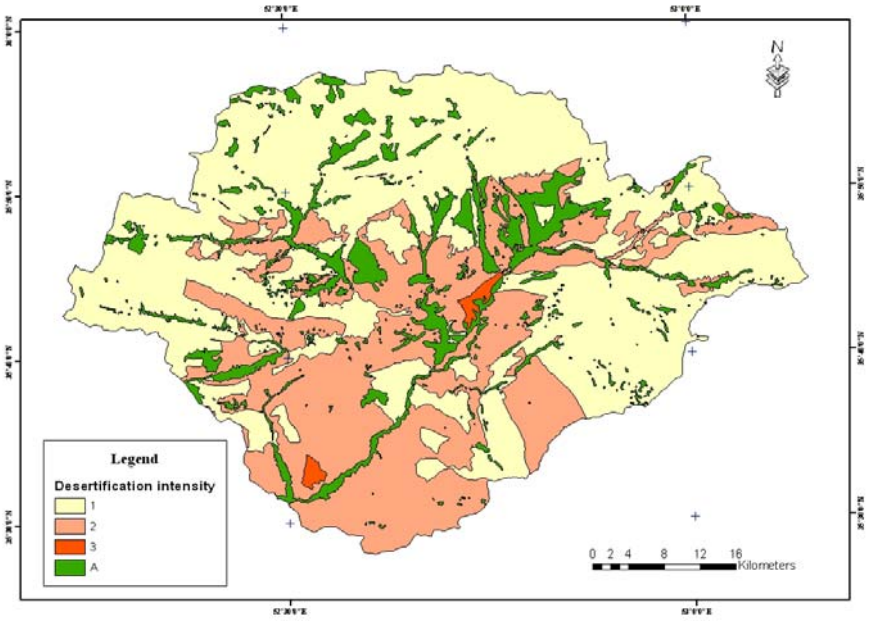

Fig. 1. Map of current desertification status caused by vegetation

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