

Study of the Effect of Management Criterion on Desertification Control (Case Study: Kashan)

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Abstract

Desertification is more related to social and anthropogenic issues than natural causes and it becomes more important over the time. Human effects on desertification could be classified as direct and indirect factors. This study has focused on the effect of management factor, as a dominant case, on desertification of Kashan region based on IMDPA (IMDPA: Iranian Model of Desertification for Potential Assessment) model. The geometric average weight was used in order to find out the numerical value of management factor and then; desertification status map of the area was prepared using GIS. The results showed that about 59.96 percent of the region, based on management criterion, is classified in the medium class of desertification which mostly covers central, northern, southeastern and western parts of the region. Meanwhile, irrigation systems, rangeland ploughing and the index of evaluation implemented activity having the numeral value of 3.52, 3.43 and 2.23 are the most important affecting factors on desertification, respectively. Increasing unwise human activities due to lack of sufficient knowledge on new irrigation and cultivation technologies has been resulted on accelerated degradation and consequent desertification. Then, combination of new extension and traditional knowledge, policy making and planning may lead to desertification control in the region.

Keywords: Management; IMDPA model; Desertification; GIS; Kashan

1. Introduction

Physical issues such as soil salinity, alkalinities erosion as well as anthropogenic activities including over grazing, unwise irrigation and deforestation have been considered as the responsible factors of desertification in recent years (Darkoh, 1987). Soil and vegetation cover is a social and human-related phenomena which is, sometimes, more important than natural factors (Saadi, 2003). Anthropogenic factors have considerable effects on desertification. In a case study, it was revealed that, lack of proper management of

rangelands is the most important factor among 39 variables of soil and water degradation (Saadi, 2003). The results of factor analysis shows that in sufficient rules, regulations and sustainable strategy of natural resources management, weakness of agricultural and natural resources extension, lack of proper rural management, industrial pollution, land use change, poverty and lack of integrated management are the most important affecting factors. Wang (2006) concluded that human related factors such as number of livestock, population and bare lands are the most important factors on desertification. Another research by Ma (2007) resulted that population increase, over grazing and lack of proper management of water resources has the dominant effects on land degradation and

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desertification.

One of the proposed methods to classify the desertification status is IMDPA model which enable the user to assign a numeral value for each sub factor of management for preparation of desertification map.

Vesali (2008) argues that pump age time of wells and crop yield have the highest and lowest effects on desertification in Kashan and Aran Bidgol regions, Iran. Abdi (2008) also concluded that desertification status of Abozeid Abad is in the metric level base on soil and waters factors of IMDPA model.

For better management and reducing desertification impacts, it is needed to implement proper strategies considering natural and human aspects (Mehrabi et al., 2010). Environment planning and policy making can play a major role in successful participatory management of natural resources (Lemos & Agrawal, 2006). Rate of people participation is one of the effective factors in IMDPA model. In this research, all management and anthropogenic factors which affect on desertification based on IMDPA model were classified and rated.

2. Material and Methods

2.1. Study area

Kashan plain is located in 51° 05' to 51° 54' E and 33° 54' to 34° 23' N and has an arid climate with annual average precipitation of 133.5 mm. This region is in Isfahan province and south of Tehran with mean annual temperature of 18.8°C.

2.2. Methodology

In this research and based on IMDPA

methodology, rangelands and shrub lands were considered for policy making while agricultural lands were chosen to examine the effectiveness of management criterion (Tables 1 and 2).

A range of 1 to 4 was assigned to each layer indicating its positive effect as 1 while lowest impact as 4 (Table 3).

Finally, weighted values of each index and sub index were mapped in GIS based on geometric average as follow:

$$Index-X = [(layer - 1) \cdot (Layer - 2) \dots (Layer - n)]^{1/n}$$

Where

Index-X: criteria

Layer: indices of each criterion

N: number of indices of each criterion

According to the mentioned formulas, the following indices were calculated:

- Range land and shrub land index = (over grazing × shrubs cutting × range ploughing × yield reduction)
- Agriculture index: (Land use change × wise farming × unwise application of machinery and pesticides × irrigation × change of well to qanat)
- Policy and management = (Required actions × combating desertification methods × implemented activities × people participation)
- Management quality = (type and intensity of land use × policy and management)

3. Results

Based on the average weights of each land use (Table 4), it is clear that rangeland ploughing (3.43) and improper irrigation measures (3.52) have the highest scores in range and shrub land and agricultural land uses (Tables 4-5). Figures 1 and 2 show the landuse intensity in both landuses.

Table 1. Indices used for evaluation of policy and management

Assessm ent index	Class	Low	Medium	High	Very high
	Score	1-1.50	1.51-2.50	2.51-3.50	3.51-4.00
Required action		More than 75% protected	50-75% protected	25-50% protected	Less than %25 protected
Combating desertification methods		Proper management is sufficient	Low biologic measure is possible	Combating desertification with mechanical and biologic measures	Combating desertification is impossible ecologic-economic
Implemented activity		No action	Action is effective until now	Action is relatively efficient	Unsuccessful activity
People participation		Good connection between people and experts	Lack of people attention to extension	Projects without people participation	Conflict between local people and technical staff

Table 2. Indices of land use type and intensity

Very high 3.51-4.00 I→V	High 2.51-3.50 II,III→IV	Medium 1.51-2.50 III→II	Low 1-1.50 I→II	Class Score Land use change	Assessment index	Secondary factors	Primary factors
Lack of agricultural measure, no fallow and intense plough	Improper agriculture and fallow	Relatively proper agriculture, perennial crops	proper agriculture perennial crops and orchards	Proper agricultural activity	Crop yield		
Low efficient machinery and pesticide	Improper machinery and pesticide	Modern machinery and pesticide	Modern machinery NO pesticide and insecticide	Improper use of pesticide and machinery			
Improper irrigation >12	Relative proper irrigation 6-9	Relative proper irrigation 3-6	Proper irrigation 1-3	Irrigation system Change of well to qanat			
Stock rate/ grazing capacity >3 CV>50%	Stock rate/ grazing capacity = 2-3 %25<CV<%50	Stock rate/ grazing capacity = 1-2 %10<CV<%25	Stock rate /grazing capacity=1 CV<%10	Over grazing Shrubs cutting			
Bare lands and plough ranges (>75%)	Bare lands and plough ranges (50-75%)	Bare lands and plough ranges (20-50%)	Bare lands less than 20%	Range plough and bare lands	Range and Shrub lands		
Very high <25	High 25-65	Medium 65-85	Low 85-100	Yield reduction compared to potential condition			
Improper development without consulting regional capacity	Improper development	Relatively proper based on local condition	Proper	Urbanization and rural development	Urban areas		

Table 3. Frequency distribution of current condition of desertification classes

Range	Symbol	Qualitative classification
0.0001-1	1	Neglectiable
1.1-1.5	2	Low
1.6-2.5	3	Medium
2.6-3.5	4	High
3.6-4	5	Very high

Table 4. Average weights of range and shrub land areas

Row	Assessment index	Average value	Class of desertification
1	Over grazing	1.63	Low
2	Shrub cutting	1.57	Medium
3	Rangeland ploughing	3.43	High
4	Yield reduction compared to potential condition	2.25	Medium

Table 5. Average weights of agricultural lands

Row	Assessment index	Average value	Class of desertification
1	Land use change	1.33	Low
2	Proper farming	1.75	Medium
3	Improper machinery and pesticides	2.46	Medium
4	Irrigation systems	3.52	Very high
5	Change of well to qanat	3.23	High

Meanwhile, numerical values of management and implemented policy of the region resulted 1.92 which indicates medium

condition of the region based on this criteria (Table 6).

Table 6. Average values of policy making and implemented management criteria in the region

Row	Assessment index	Average value	Class of desertification
1	Required action	1.93	Medium
2	Desertification measures	1.90	Medium
3	Implemented actions	2.23	Medium
4	Attention to people participation	1.51	Medium

According to the prepared maps of indices, final map of desertification intensity based on

management criteria was prepared for the region (Figure 3).

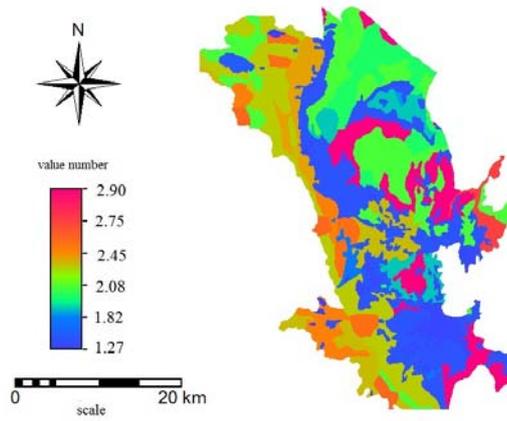


Fig. 1. Numerical value of range and shrub land type

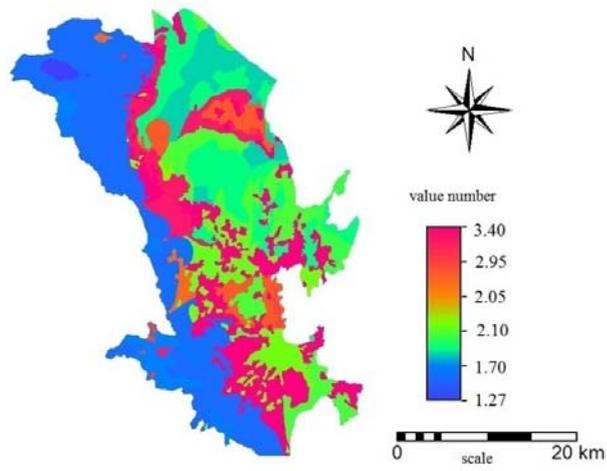


Fig. 2. Numerical value of agricultural lands

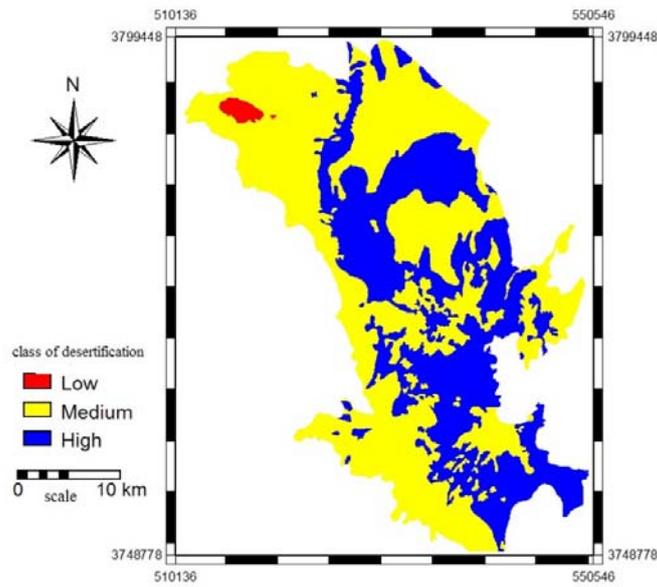


Fig. 3. Map of desertification intensity based on management criteria

According to figure 3, Kashan region is classified in three classing including 0.75 percent of the region in low class while 59.95% located in central, northern, southeastern and western party in middle class. It was revealed that 39.29% of the region has higher class of desertification mostly located in eastern and southeastern parts.

4. Discussion and Conclusion

Some factors in the region are responsible for unstable agriculture of the region including rangeland ploughing, improper irrigation, implemented activities and overuse of pesticides, these results confirms the same results done by Wang (2006), Vesali (2008), Ma (2007). Because of fine size particles of soil and water resources deficiency, flooding irrigation (especially in big sizes) is not recommended for this region because of high losses of water due to infiltration and evaporation which results in increasing trend of ground water depletion.

Also in Aran and Bidgol areas, there are some bare lands with long term fallow which increase susceptibility of the land to erosion and land degradation. Higher intensity of pesticide application (up to 20 times) is shown in the farm lands which are resulted in higher numerical value of this index (2.23).

Proper land use planning, policy making and management strategies is required to this region in order to attract local people attention to participating in combating desertification projects (Carlsson & Berkes, 2005; Pretty and Ward, 2001; Ghorbani, 2011). On the other hand, lack of sufficient knowledge on application of modern irrigation techniques require extension measures considering indigenous knowledge of local people in planning and management of desertification.

farmlands is one of the problems of the region, then it is required to implement legal measures in order to prevent land use change which is important for controlling accelerated desertification (Saadi, 2003; Wang, 2006).

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Since land use change from rangelands to