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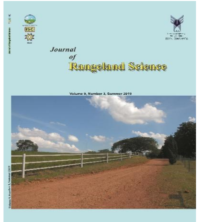

Research and Full Length Article:

The Role of Local Settlements in Combating Desertification of Isfahan's Desert Rangelands

Seyedeh Zohreh Mirdeilami [A*], Ezatolla Moradi [B] and Mohammad Pessarakli [C]
[A] Ph.D. in Rangeland Sciences, Socio-Management, Department of Rangeland Management, Gorgan University of Agricultural Sciences & Natural Resources, Gorgan 4913815739, Iran. *(Corresponding Author), Email: Zohremirdeilami@gmail.com
[B] Ph.D. in Rangeland Sciences, Ecology, Department of Rangeland Management, Gorgan University of Agricultural Sciences & Natural Resources. Manager of Natural Resources and Watershed Management Directorate of Semirom, Isfahan Province, Forest, Rangeland and Watershed Management Organization, 8174671156, Iran
[C] Professor, School of Plant Sciences, College of Agriculture and Life Sciences, The University of Arizona, Tucson, AZ 85721, USA

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Abstract. Undoubtedly, land degradation linked to desertification causes a decrease in qualitative and quantitative features of natural resources. This research aimed to assess land desertification by local residents and their role in controlling desertification in Isfahan province, Iran in 2016. The criteria were soil climate, vegetation, erosion, and demography. The indicators of soil texture, stone fragment, organic matter, soil depth, Electrical Conductivity (EC), soil drainage, soil slope, precipitation, evapotranspiration, aridity index, fire risk, erosion protection, drought resistance, plant cover percent, wind erosion, water erosion, land use, population density, grazing intensity, policy, and management. Some parameters include land use, DEM, NDVI, roads, springs, fire history data, stress intensity, tolerance, mean productivity, AUM index, lithology, morphology and relief, wind speed, soil characteristics, plant cover percent, wind erosion features, soil moisture, type and distribution of sand dunes, and land management. The assessment of desertification has been conducted by the Mediterranean Desertification and Land Use (MEDALUS) method in ArcGIS10 software. This research was based on the importance of socio-economic issues, establishing a realistic framework for qualitative indicators and indices adapted to Iran's situation. Those are population, poverty and economics, people rights and institutional regulations, and socio-cultural criteria achieved by an interview with local communities and experts. A single desertification status map was generated based on all the quality maps. Finally, the generated map was compared with local settlements density map. Results showed that 91.23% of the rangelands (with area 38203 km2) are classified as severe and moderate with low settlements density and 1.83% of the rangelands (with area 766 km2) are lower in severity with high settlement density. This result illustrated that local settlements and nomadic have a positive role in combating the desertification. They are able to eliminate the desertification to minimum and vice versa. The desertification status and local settlements density maps are essential in management efforts to combat the desertification via local settlement abilities.

Key words: Desertification assessment, MEDALUS, Local settlements, Quality

Introduction

Desertification is one of the major problems in the arid and semiarid lands (Millennium Ecosystem Assessment (MEA), 2005; Amiraslani and Dragovich, 2010). Thomas (1997) and Yang *et al*. (2005) had assessed the extent, nature, and rate of desertification at global, regional, and local levels. Desertification is considered as "land degradation in arid, semi-arid and dry sub-humid areas" (UNCCD, 1994). The Land Degradation Assessment in Drylands (LADA) program was launched by the FAO (Yang *et al*., 2005). This program studies the biophysical and socio-economic components of desertification using both local and scientific knowledge (FAO, 2002; Yang *et al*., 2005).

Iran has four ecological zones in which the majority of the deserts are located in Iran-o-Turanian zone (Heshmati, 2007). Iran is located in south western Asia where 53.7% of Iran's deserts are rangeland and nearly 100 million ha (70%) of the land are subject to desertification followed by water erosion, wind erosion, salinization, and physical degradation. Regarding the topographical conditions and species diversity, the region falls into plains and mountainous sub-regions (Heshmati and Squires, 2013). Lands of world are endangered to desertification due to various factors mainly including climatic changes and human activities (Verstraete, 1986; FRWO, 1994; Arnalds and Archer, 1999; National Action Program (NAP), 2004a; Sepehr *et al*., 2007). It has been reported that more than 10–20% of the areas affected by desertification are due to the human activities to meet their basic needs in drylands and the growing human population (Millennium Ecosystem Assessment (MEA), 2005). The growing human population and following increased needs for food and natural resources have exerted environmental stress (Arnalds and Archer, 1999; Akhtar-Schuster *et al*., 2016).

Rangelands as ecosystems are landforms with climate, soils or topographic limitations that are not suited for intensive agriculture or forestry. All rangelands are used by livestock grazing regarded as the traditional primary use worldwide (Stoddardt *et al*., 1975; Holechek *et al*., 1989). According to the Saidi and Gintzburger (2013), the degradation gradient clearly declines away from the settlements. In addition, fuel wood collection by local residents and rain-fed arable cropping resulted in desertification of its fragile arid rangelands (Saidi and Gintzburger, 2013). The unsustainable use and drought factors caused that the rangeland plains became severely degraded across Iran. Many rangeland settlements had already left their lands in looking for jobs. The migration and displacement will continue if desertification is not stopped. Glantz and Orlovsky (1983) stated "With all factors cited in the existing definitions, desertification would encompass most kinds of environmental changes related to productivity". Continuing challenges lead to potential future problems, including rapidly depleting groundwater supplies and a predicted reduction in the plant growth period accompanying climate changes (Amiraslani and Dragovich, 2011; Heshmati and Squires, 2013). Many causes of desertification begin soon after the settlement (Thorarinsson, 1981), including animal grazing and wood harvesting, and soil erosion by wind, water and cryogenic processes (Arnalds, 1990; Arnalds *et al*., 1995), disturbed vegetation due to improper utilization (Magnusson, 1994), and sand encroachment on the vegetated land, especially in the highlands (Arnalds *et al*., 2001). Mehrabi *et al*. (2008) summarized population, poverty and economics, rights and institution and socio-cultural criteria as qualitative indicators and indices that are adapted to the situations of Iran. Some researchers concluded that the main effective factors in desertification processes include land use change and erosion risk (Mashayekhan and Honardous, 2011), and anthropic activities as the primary disturbances (Becerril-Piña *et al*., 2015). Toranjzar and Poormoridi (2013) considered the desertification of Taraz Nahid, Saveh by IMDPA model via five factors including climate, soil, vegetation, irrigation, and socioeconomic. The final desertification map shows the balanced (moderate) and intense (severe) classes of desertification process in the region. They recommended using the Desertification Trend Risk Index (DTRI) as a low-cost and easily applied tool to assess and monitor the desertification.

Some techniques applied to the assessment of the degradation sensitivity include GIS and aerial photography in western Asia deserts (Harasheh and Tateishi, 2000), southern Italy by Mediterranean Desertification and Land Use (MEDALUS) (Ladisa *et al*., 2002) and in arid lands, Italy and China by TM aerial photos (Yang *et al*., 2005; Santini *et al*., 2010). Tongway and Hindley (2000) assessed and monitored the desertification in rangelands with soil indicators based on the Trigger-Transfer-Reserve-Pulse framework of landscape function. Khosroshahi *et al*. (2013) stated that the desert soil of Iran has EC more than 8 ds/m, pH more than 8.5, SAR greater than 12. Genetic and biological soil horizons have no significant distinction. Tavares *et al*. (2015) used MEDALUS model to produce a map of areas sensitive to desertification based on some quality indicators (including climate, soil, vegetation, land management, erosion, and social factors).

According to the results of some reports on participatory approaches, the National Action Program (NAP) provided impetus towards a transformation of previous procedures, a policy impact that is continuing to generate changes (Mashayekhan and Honardous, 2011; Amiraslani and Dragovich, 2010). Desertification in some provinces of Iran was recognized between the 1930s and 1960s (Whyte, 1977, Amiraslani and Dragovich, 2011). Iran has ecological diversity in fauna and flora that resulted in a variety of geographic and climatic conditions. The deserts types of Iran are Clay Deserts, Wet Clay Deserts, Clay and Saltmarsh that some of them have strong sunshine, very low relative humidity, little rainfall, and excessive vaporization (Forghani, 2008). Iran is located on the Earth's arid belt with its specific synoptic conditions. So, Iran is exposed to the occurrence of drought, an issue emphatically mentioned by the UNCCD, particularly in the vast central plateau and east and south of Iran with the short rotation cycle (National Action Program (NAP), 2004b; Azimi *et al*., 2013). The deserts of Iran are some of the most arid areas and maybe the hottest areas of their kind in the world. Expanding Iran's deserts will lead to unsustainable livelihoods for citizens, especially for the people living on rangelands. Therefore, urgent remedial actions are needed. According to Squires (2010), Iran is one of the countries that attempt to control the scourge of desertification by nations, both rich and poor.

Overall, desertification leads to social, economic and cultural threats as poverty. Poverty then drives populations to over-utilization of natural resources, accelerating land degradation. Poverty and desertification have a cause and effect relation. Lifestyles of nearly one billion of the world's population are affected by desertification. Desertification is a complex phenomenon and a challenging issue that limits our ability to categorize, survey, monitor and reclaim the condition of the land. International recognition of the seriousness of desertification was formalized in 1977 Action Plan under the general guidance of the United Nations Environmental Program (Glenn *et al*., 1998; Amiraslani and Dragovich, 2010); and later, the Rio Earth Summit in 1992 paved the way for three important conventions including the UNCCD (Amiraslani and Dragovich, 2010). In this research, it assesses land desertification in Isfahan province, Iran and the roles of the local residents in controlling the desertification processes.

Materials and Methods

Case study

Isfahan province is a vast area (77888 km^2) located in Iran-o-Turanian Zone, the central Iranian plateau region of Iran (55°14′43″–50°05′57″E and 34°25′46″–30°38′35″N) (Mojiri and Jalalian, 2011). The study region included an approximately 107027 km^2 with range management and restoration projects e.g., cultivate shrub, direct farm, fertilization, repair of springs, etc. (Ghilishli *et al*., 2016). Isfahan province with elevation of 200-3950 m above sea level has two geomorphologic main units: a mountain unit and a plain unit with 27 facieses (Fig. 1). The mean annual rainfall is 150–300 mm with a high inter-annual variability. The hottest and coldest months are July and January with mean monthly maximum and minimum temperatures of 46°C and 4°C, respectively (Aslinezhad, 2013). The wind is dry and generally cold and strong (typical land uses are rangelands and dry farming) (Sepehr *et al*., 2007).

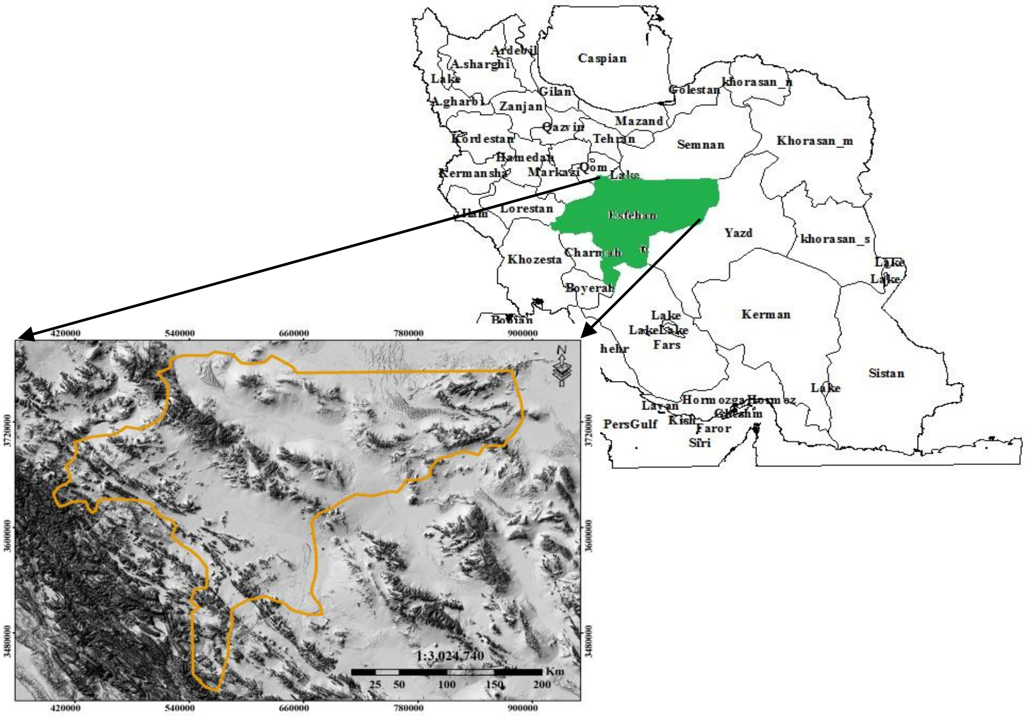

Fig. 1. The location of the study area

This region has nearly 6.3 million ha of arid and semi-arid rangelands including 1652 traditional sections (Fig. 2). According to National Action Program (NAP) (2004b), nearly 34000 local residents utilize these rangelands.

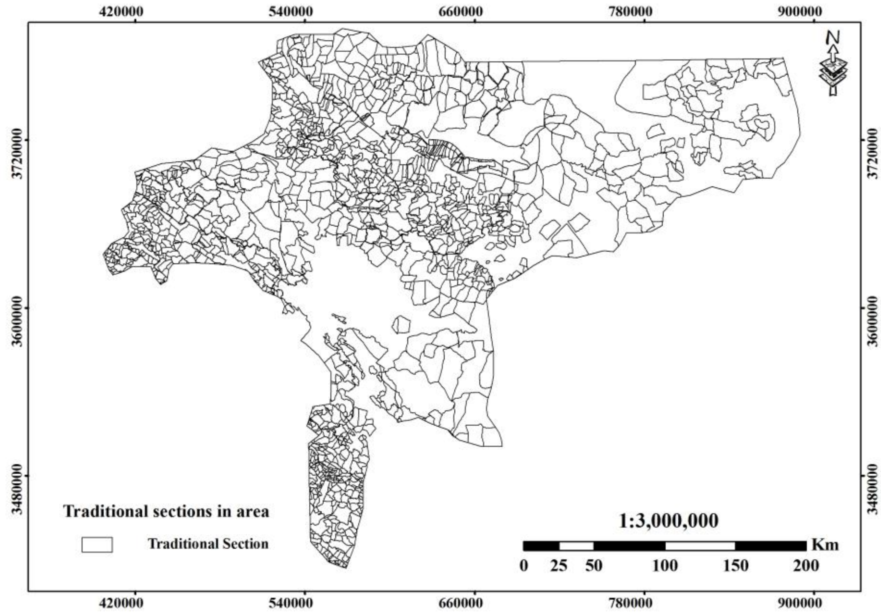

Fig. 2. The traditional sections in the rangelands of Isfahan province

Methodology

The aim of this study was to provide more reliable data on the rate and risk related to desertification activities. Desertification intensity was assessed using the MEDALUS method (Sepehr *et al*., 2007) in cooperation with World Meteorological Organization (WMO) and United Nations Environment Program (UNEP), Food and Agricultural Organization (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO), and the International Society of Soil Science (ISSS) at the international level.

In MEDALUS method, environmental factors (climate, soil, vegetation cover, hydrology and morphology) were used to evaluate degradation levels (Sepehr *et al*., 2007). The main factors including climate (precipitation, evapotranspiration and aridity index) (Dutta and Chaudhuri, 2015) were evaluated by the interpolation of data climatology stations during 25 years. Soil texture, electrical conductivity (EC), organic matter (OM), soil depth, slope gradient, stone fragments, and soil drainage were assessed by soil sampling random in land units (279 land units with 1200 samples). Vegetation (fire risk, erosion protection, drought resistance, land cover percentage) was considered by LFA method. Demographic pressure (population density, land use, grazing intensity) and erosion (water and wind erosion) were selected (Sepehr and Hassanli, 2005). Fire risk was assessed by such parameters as land use, DEM, NDVI, roads, springs, and fire history data received by office, and satellite images and recorded by GPS in the field. The fire risk zonation was prepared by weighted AHP in ArcGIS software (Myers *et al.,* 2004). The drought resistance was evaluated by Stress Intensity, Tolerance, Mean Productivity, and Drought resistance parameters (Rosielle & Hambelen, 1981; Fernandes, 1992; Fisher and Maurer, 1978) for dominant plant species in each indicator region. Grazing intensity was calculated by the Animal Unit Month (AUM) index that is the number of animal units per grazing area (ha) per month.

For calculating the drought index, the standardized annual precipitation (P-PM/SDP) was used where PM is the average of annual precipitation and SDP is the standard deviation of the long-term rainfall data. Wind erosion status was investigated using the Iran Research Institute of Forest and Rangelands method (Ekhtesasi and Ahmadi, 1995). In this method, wind erosion processes were evaluated by nine parameters (including lithology, morphology and relief, wind speed, soil characteristics, type and plant cover percent, wind erosion features, soil moisture, type and distribution of sand dunes, land use, and land management). The water erosion was evaluated by the Modified Pacific Southwest Inter-Agency Committee (MPSIAC) method in Iran (Zakeri *et al*., 2015).

The other parameters were provided by the Isfahan Natural Resources and Watershed Management Office (INRWMO), Iran's Mapping Organization (topographic maps (1: 25,000), aerial photographs (1: 55,000), and Land sat satellite images (ETM+ 2002 with color composite of 4-3-2 for evaluation of plant cover and 5-4-3 for evaluation of geology) (Sepehr *et al*., 2007). Morphology was prepared as study unit maps by overlying hypsometric and geological maps.

These criteria and indices were ordered from 1 to 2. The values "1" and "2" indicate the areas of least and most sensitivity, respectively. Values between 1 and 2 reflect relative vulnerability to erosion. Weighting indices were assigned to each category of the considered parameters based on Basso *et al*. (2000) (adapted from the MEDALUS project methodology, (Kosmas *et al*., 1999). It used 27 features in this study based on the criteria and indices.

In this study, there are two main steps: in the first step, climate, soil, plant cover, management, and erosion indices were determined from the sub-indicator layers (Eq. 1) (Sepehr *et al*., 2007).

In the second step, the quality layers were combined to give a single desertification sensitivity layer (Eq. 2) (Sepehr *et al*., 2007). After preparing the index map for each index, a Desertification Sensitivity Index (DSI) of the area was created according to the following equation (Kosmas *et al*., 1999).

Equation (1) $$Criteria_x = (Index_1 * Index_2 * Index_3 * ... * Index_n)^{1/n}$$

Equation (2) $$DSI = (Criteria_1 * Criteria_2 * Criteria_3 * Criteria_4 * Criteria_5 * Criteria_6)^{1/6}$$

Where:
X= the quality criteria,
n = the number of indices (layers) used to calculate each quality criteria, and
DSI = desertification severity index.
Severity of the desertification was classified as high severe, severe, moderate or low severe according to the ranges of the values (Sepehr *et al*., 2007). The weight of the indicators and the class of the desertification were achieved by SQI manual (Sepehr and Hassanli, 2005). Table 1 illustrates the criteria, indictors, weight of indicators and desertification classes.

Assessing desertification intensity and processing data were done using $ArcGIS_{10}$ software, module spatial analysis, raster calculator, and an image processing system ($ENVI_{4.2}$).

Table 1. Classification of indices

Criteria	Indicators (layers/index)	Weight (Quantitative)	Class (Qualitative)
Soil quality	Soil texture	< 1.13	S1 (High)
	Stone fragment		
	Organic matter		
	Soil depth	1.13–1.45 (%)	S2 (Moderate)
	Electrical conductivity (EC)		
	Soil drainage		
	Soil Slope	> 1.46	S3 (Low)
Climate quality	Precipitation	1	C1 (Humid)
	Evapotranspiration	1.1–1.5	C2 (Semi-arid)
	Aridity index	1.6–2	C3 (Arid)
Vegetation quality	Fire Risk	< 1.13	V1 (High)
	Erosion protection	1.13–1.38	V2 (Moderate)
	Drought resistance	> 1.38	V3 (Low)
	Plant cover (%)		
Erosion quality	Wind erosion	1	E1 (Low)
		1–1.4	E2 (Moderate)
	Water erosion	1.4–2	E3 (High)
Demographic quality	Land use	1–1.3	D1 (High)
	Population density	1.3–1.5	D2 (Moderate)
	Grazing intensity	> 1.5	D3 (Low)
	Policy and management		
Desertification severity classes		1.54–2	High severe
		1.38–1.53	Severe
		1.23–1.37	Moderate
		1–1.22	Low severe

In addition, the socio-economic factors including population, poverty and economics, people rights and institutional regulations, and socio-cultural criteria were achieved by interviews with 370 local communities and 280 experts. We extracted the map of local settlements density by the gathered data and compared them to desert mapping because they could be effective in numerous environmental characteristics. These criteria have relationships with desertification phenomena or environmentally critical situations, engagement of the extent of the data and the ease of updating the data quickly and economically.

The all processes of mapping Environmentally Sensitive Areas (ESA’s) presented as a flow chart in Fig. 3.

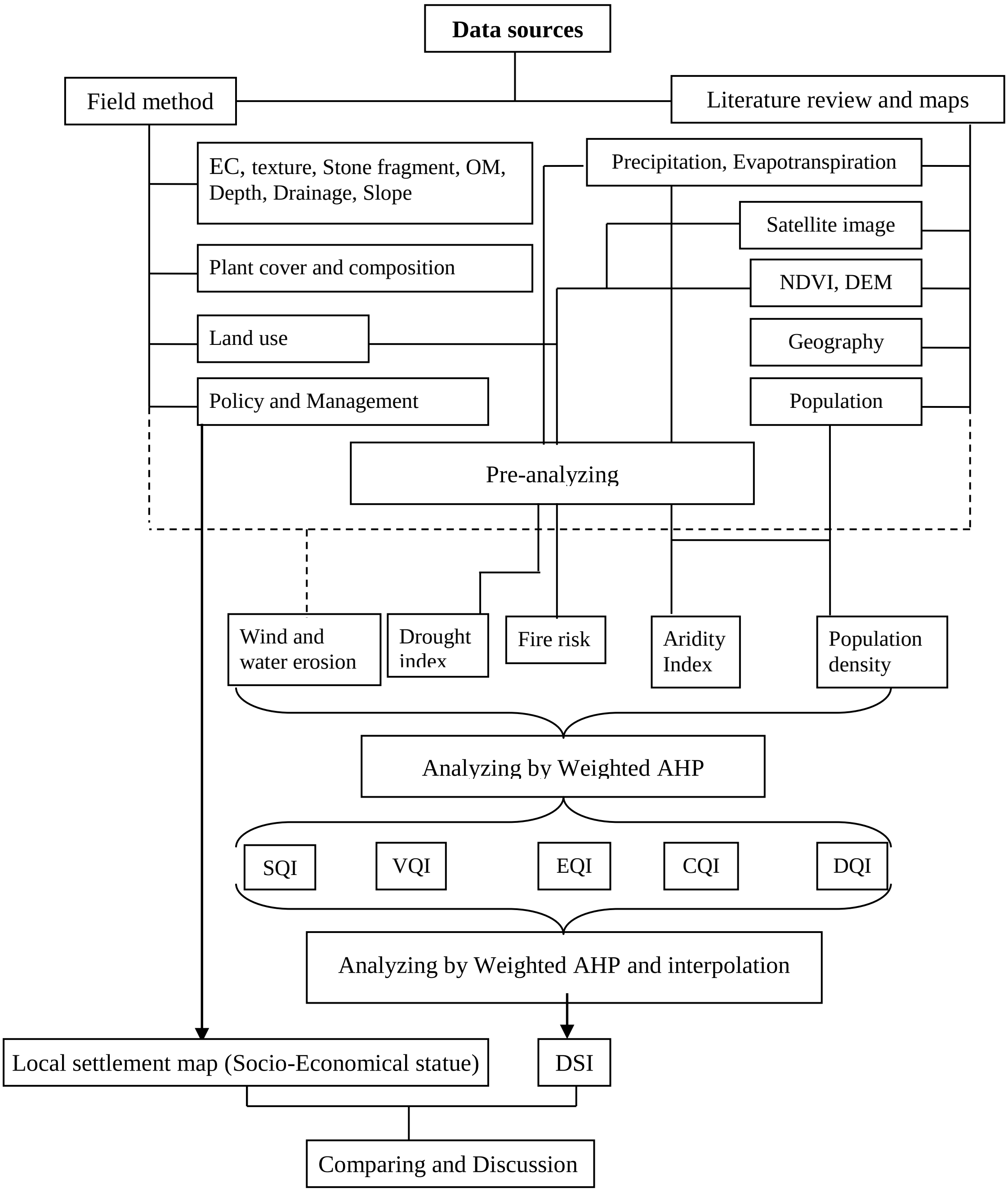

Fig. 3. Flow chart of mapping Environmentally Sensitive Areas (ESA's)

Results

Five layers (based on soils, climatic, vegetation, erosion, and demographic quality indices) were used for mapping desertification sensitivity in the studied area.

Erosion Quality Index (EQI)

The classes of the desertification status based on the erosion ratio indicators showed in Fig. 4. Results showed that the region is in both Classes 1 and 2 of the erosion status and it is in low and high classes of erosion. About 60% of this region is in the low erosion class (Table 2).

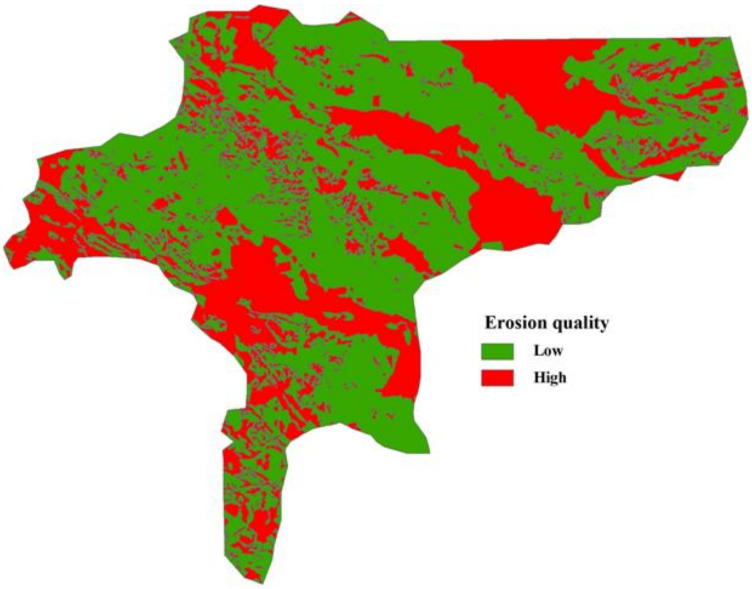

Fig. 4. Map of the erosion quality in the study area

Soil Quality Index (SQI)
According to the results, 52.5% of the total area (i.e., 40932.75 km^2) have moderate soil quality index, and 42.14% of the total area have low soil quality index (i.e., 32828.05 km^2) (Fig. 5 and Table 2). The eastern and northeastern regions have low soil quality.

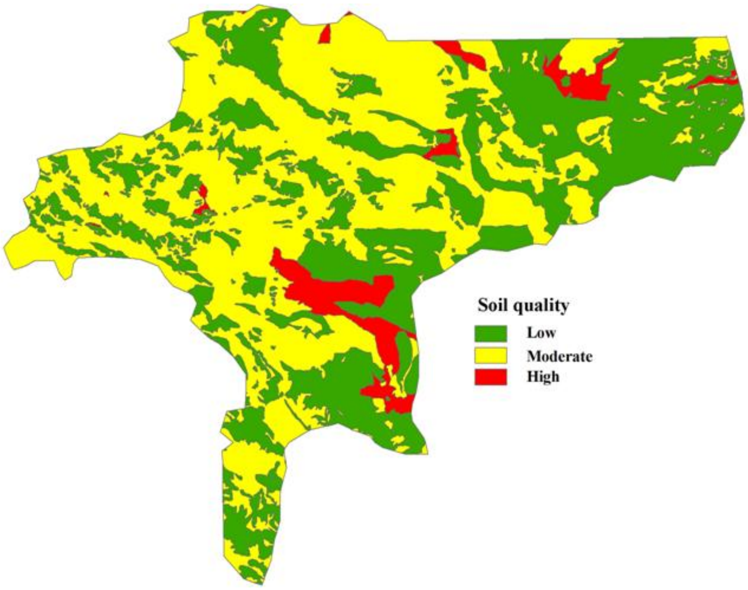

Fig. 5. Map of the soil status in the study area

Vegetation Quality Index (VQI)
The vegetation quality index (VQI) was assessed by plant cover percent, erosion protection, drought resistance and fire risk parameters. The data indicated that 61.75% of the total area (i.e., 48103.58 Km^2) have moderate vegetation quality index and 38.25% of the total area (i.e., 29791.41 Km^2) have low vegetation quality index (Fig. 6 and Table 2).

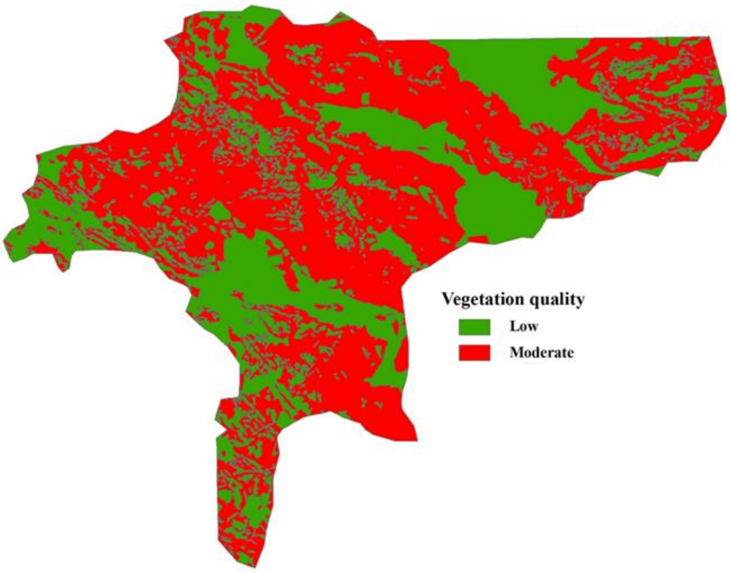

Fig. 6. Map of the vegetation quality in the study area

Climate Quality Index (CQI)

It is clear that the area has the arid (72.93% with 56807.11 km^2, value 1.4) climatic index mostly (Table 2). The western and southern regions were dominated by the semi-arid and humid climatic index (Fig. 7).

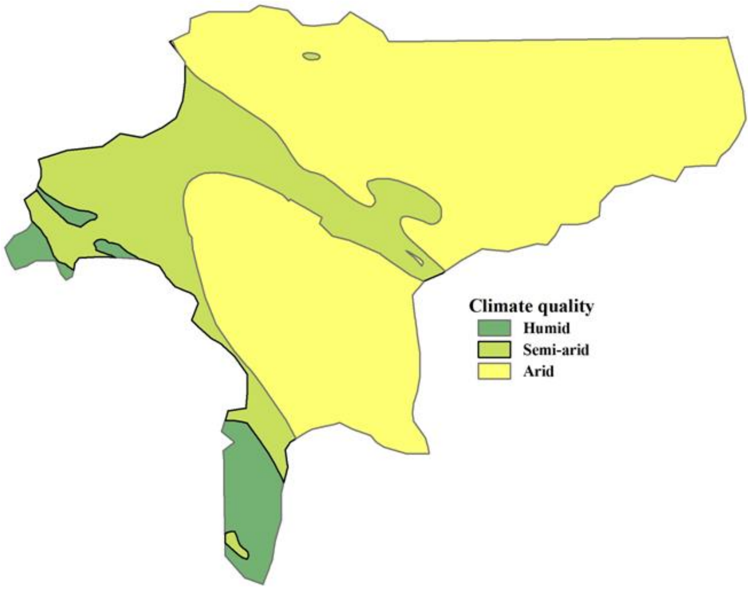

Fig. 7. Map of the climatic quality in the study area

Demographic quality index (DQI)

The obtained data on Demographic Quality Index (DQI) revealed that the area of high demographic quality index is found in the northern part of the region (32.47% with 25296.50 Km^2 of the total area), and 67.22% (i.e., 52358.58 km^2) of the total area have moderate demographic quality (Fig. 8 and Table 2).

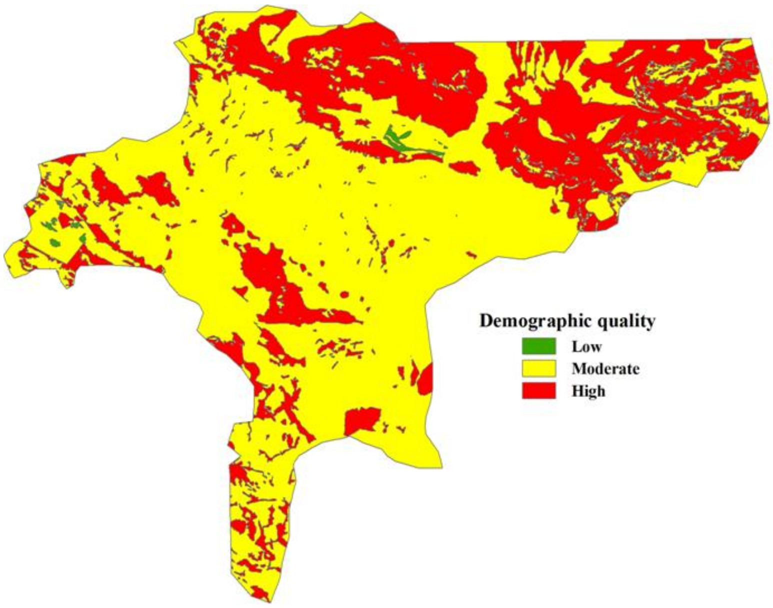

Fig. 8. Map of the demographic status in the study area

Desertification status

Table 2 shows the surface areas of each desertification classes. The desertification classes have been calculated as the climatic, soil, demographic, vegetation, and erosion indicators. The results revealed that the areas of high severe and severe desertification found in the northern and eastern parts of the region as they represent more than 50% (i.e., 41553.32 Km^2) of the total area. The areas of the moderate and low severity desertification represent less than 50% (i.e., 36334.86 km^2) of the total area allocated in the western and southern regions.

Table 2. Extent of the desertification class with the fluctuation groundwater table indicator

Class		High severe	Severe	Moderate	Low severe
Soil	Score	-	1	1.6	2
	Area (Km^2)	-	4133.19	40932.75	32828.05
	Area (%)	-	5.31	52.55	42.14
Climate	Score	-	1.6	1.3	1
	Area (Km^2)	-	56807.11	16819.65	4291.73
	Area (%)	-	72.93	21.59	5.51
Vegetation	Score	-	-	1.37	1.47
	Area (Km^2)	-	-	48103.58	29791.41
	Area (%)	-	-	61.75	38.25
Erosion	Score	-	1.3	-	1.6
	Area (Km^2)	-	29967.61	-	47927.38
	Area (%)	-	38.47	-	61.53
Demographic	Score	-	1	1.33	1.56
	Area (Km^2)	-	25296.50	52358.58	239.91
	Area (%)	-	32.47	67.22	0.31
Desertification	Score	1.55	1.41	1.38	1.23
	Area (Km^2)	6867.07	34686.25	33800.47	2534.39
	Area (%)	8.81	44.53	43.39	3.25

The map of local settlements density showed that high local settlements density is in the western and southern parts, the moderate settlements is in the central parts, and the low local settlements is in the eastern part of Isfahan province (Fig. 9).

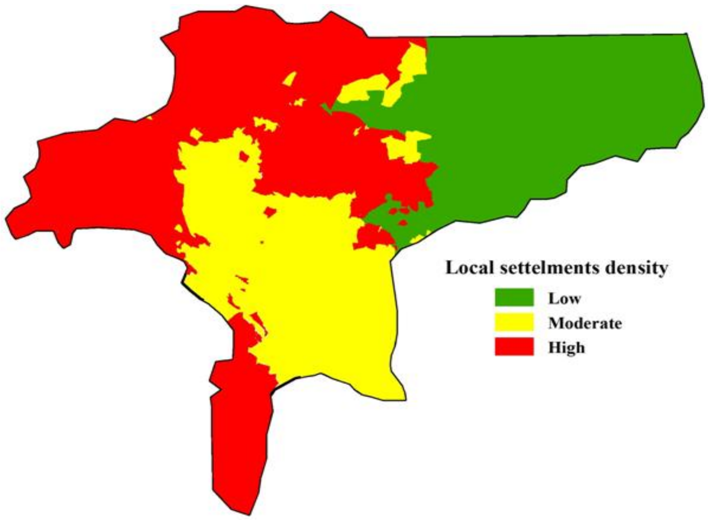

Fig. 9. Map of the local settlements density in Isfahan province

Fig. 10 shows that the map of the current desertification status has classified the study area in four classes of desertification. Desertification is the most important subject in arid and semi-arid ecosystems (Kosmas *et al*., 1999). The factors affecting desertification vary by location. The map of desertification status was prepared according to final score of soil, vegetation, erosion, demography and climate (Fig. 10). The results illustrated that the study area comprises of four sensitivity classes of high to low desertification severity. The areas of severe desertification represent 44.53 % (i.e. 34686.25 km^2) of the total area allocated in parts of the northern and eastern regions. The southern parts of Isfahan province have low sensitivity for desertification (3.25 % with 2534.39 Km^2 of the total area).

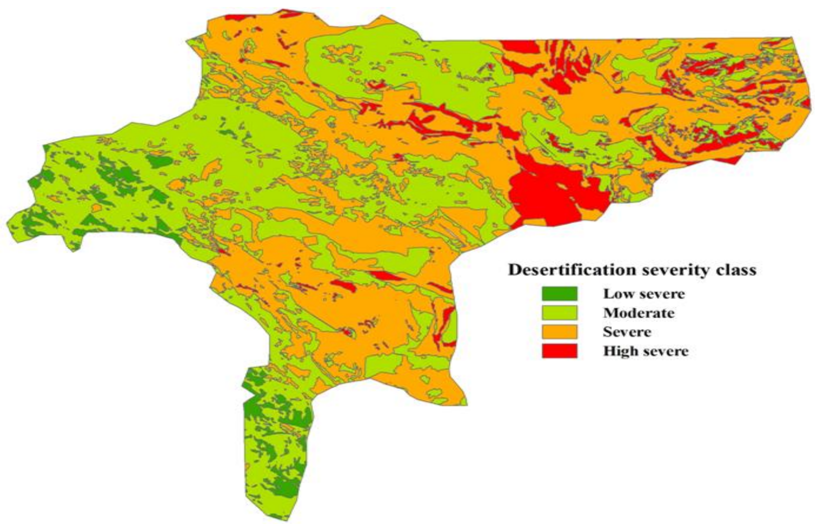

Fig. 10. Map of the desertification severity in the study area

Discussion

According to the results presented in Table 2 and Fig. 10, the critical sensitive areas for desertification in Isfahan province are found in the northern, eastern and central parts, which include 53.34% of Isfahan (Including Aran-o-Bidgol, Isfahan, Khor, Naeen, Kashan, parts of Natanz and Ardestan cities). The bare lands and cultivated lands (as seasonal pasture) with high erosion quality are high sensitivity desertification. These parts have arid climate, high demography, low vegetation and low soil quality. The western and southern parts of Isfahan province are of low and moderate severity desertification. There is low desert severity at the protected area and management projects in the area.

The natural factor affecting this destructive phenomenon in the study region is climate. Climate parameters are out of control by human beings. Most of the region has an arid climate that receives variable rainfall. With analysis of all the desertification indicators, it was found that the main prevention factor of desertification is improving the climate variables including precipitation. Average precipitation (during 2001 to 2017) has decreased 20% in the eastern part and 80% in the west of Isfahan province. According to Doraiswamy *et al*. (2002), high variability in the north of Isfahan can be explained by frequent droughts. Among the soil parameters, the EC indicator in the region is evident to high class, especially in eastern parts of the region. Investigations showed that the sensitive desertification region is mostly located in very shallow and shallow soil depths. The EC has been related to increased harvest levels especially cultivation and increased soil salinity in the study area. Also, soil degradation is a result of road expansion.

Over 50% of Isfahan province is rangeland (53.78% with 41898.66 km^2), 73.10% of which are good rangelands and 26.89% of them are poor and degraded rangelands. Overall, 1.83% of the rangelands are of the lower severity, located in good rangelands in western and southern parts of the Isfahan province. Almost all the rangelands (91.23% of the rangelands with 38203.74 km^2) in Isfahan have a severe and/or moderate desertification status. Therefore, the rangeland ecosystem has become very fragile by vegetation degradation. According to the Millennium Ecosystem Assessment (MEA) (2005), deeper policy and institutional failures are due to problems of water scarcity, soil erosion, and salinization. Although the government has performed many management projects in recent years, it seems that according to Sadeghi Ravesh *et al.* (2010), they are not adequate due to extensive arid regions in Isfahan province. Drought phenomenon appears with drying lakes and forest destruction in the west and soil erosion in the east of Isfahan province. This brings many problems for inhabitants. Unfortunately, the majority of dry-land areas in Isfahan province (nearly 53%) are more suited to sustainable pastoralism than agriculture. Nomadic pastoralism as local settlements over the centuries has been suited to the ecosystem carrying capacity. The local residents of the western and southern rangelands had protected the rangelands well by traditional practices (Fig. 9). According to Fig. 9, the traditional sections in the rangelands are dense in the west and south of the rangelands. However, according to the Millennium Ecosystem Assessment (MEA) (2005), reducing the people’s ability to adjust their economic activities in stresses caused the sedentarization of nomads in marginal drylands and their migration, resulting in lower crop production, exacerbated by natural factors such as drought.

Land users, especially in the northern and eastern regions as endangered lands by desertification are not able to respond adequately to indirect factors (i.e., population pressure and globalization), so they increase the pressure on the land inappropriately. Consequently, land productivity is decreased and degradation and poverty are increased. Where conditions permit, the settlements of dryland can avoid degradation if their agricultural practices are improved, and their pastoral mobility is enhanced in a sustainable way.

Recently, land managers use consolidated plan of cultivated rice, *Pistacia*, and *Halocnemum* in Naeen town, seedling production and carbon sequestration in Arano Bidgol and Isfahan by local populations, and cooperation of the private and investor sectors in ecotourism of Khor and Biabanak in desertification plans. It seems that sharing the lands by the people (the actual owners of the lands) is the only successful way of the desert sustainable rehabilitation. So, community-based land-use decision-making bodies, and social networks as local institutions can contribute to prevent from desertification by allowing land users to manage and use ecosystem services more effectively through the enhanced access to land, capital, labor, and technology. For example, land tenure practices and policies are important contributions to desertification by the land users that cause to encourage them to overexploit land resources. When local communities, especially farmers and herders lose control or long-term security over the land that they use, environmentally sustainable practices are gradually lost.

Conclusion

Generally speaking, one of the critical issues in arid environments of Isfahan province is desertification in the eastern, northern, and central parts that include Kashan, Arano Bidgol and Khor with low and moderate local settlements. The local settlements especially nomadic have positive roles in the natural resources conversation and combating desertification. They are able to eliminate desertification to minimum and vice versa. The desertification status and local settlements density maps are essential in management efforts to combat desertification via local settlement abilities. Therefore, understanding the problems in these areas is essential to management efforts in combating desertification via rangeland inhabitants. In addition, training at all levels is a general need requiring an urgent effort. Despite an increased awareness of combating desertification, funding has remained very low and disproportionate (only 50% allocated) to the challenges posed by the problem. This has led to low extension of afforestation programs, low level of infrastructure for training and research, and insufficient funds for maintenance activities and management practices.

References

Akhtar-Schuster, M., Amiraslani, F., Diaz Morejon, C.F., Escadafal, R., Fulajtar, E., Grainger, A., Kellner, K., Khan, S.I., PerezPardo, O., Sauchanka, U., Stringer, L.C., Reda, F., Thomas, R.J., 2016. Designing a new science-policy communication mechanism for the UN Convention to Combat Desertification. Journal of Environmental Science and Policy 63: 122-131.

Amiraslani, F., Dragovich, D., 2011. Combating desertification in Iran over the last 50 years: An overview of changing approaches. Journal of Environment Management, 92(1): 1-13.

Amiraslani, F., Dragovich, D., 2010. Cross-sectoral and participatory approaches to combating desertification: The Iranian experience. Journal of Natural Resources Forum, 34: 140–154.

Arnalds, O., 1990. Characterization and erosion of Andisols in Iceland. Ph.D. Dissertation, Texas A&M University, College Station, Texas, 179p.

Arnalds, O., Archer, S., 1999. Case studies of rangeland desertification. Proceedings of an International Workshop in Iceland, September 1997, RALA Report No. 200. Agricultural Research Institute, Reykjavik, Iceland, 159p.

Arnalds, O., Hallmark, C.T., Wilding, L.P., 1995. Andisols from four different regions in Iceland. Soil Science Society of America Journal, 59: 161-169.

Arnalds, O., Thorarinssdttir, E.F., Metusalemsson, S., Jonsson, A., Gretarsson, E., Arnason, A., 2001. Soil erosion in Iceland. The Soil Conservation Service and Agricultural University of Iceland, Reykjavik, Iceland, 121p.

Aslinezhad, N., 2013. Assessment of desertification potential using IMDPA model in Jolgeh Chahhashem of Iranshahr region.

Master Science Thesis. University of Zabol Press, 113p. (In Persian).

Azimi, M., Heshmati, Gh.A., Farahpour, M., Faramarzi, M., Abbaspour, K.C., 2013. Modeling the impact of rangeland management on forage production of sagebrush species in arid and semi-arid regions of Iran. Journal of Ecological Modeling, 250: 1-14.

Basso, F., Bove, E., Dumontet, S., Ferrara, A., Pisante, M., Quaranta, G., Taberner, M., 2000. Evaluating environmental sensitivity at the basin scale using geographic information systems and remotely sensed data: An example covering the Agri Basin (southern Italy). Journal of Catena, 40: 19-35.

Becerril-Piña, R., Mastachi-Loza, C.A., González-Sosa, E., Díaz-Delgado, C., Bâ. K.M., 2015. Assessing desertification risk in the semi-arid highlands of central Mexico. Journal of Arid Environments, 120: 4-13.

Doraiswamy, P., Muratova, N., Sinclair, T., Stern, A., Akhmedov, B., 2002. Evaluation of MODIS data for assessment of regional spring wheat yield in Kazakhstan. In: Proceedings of International Geoscience and Remote Sensing Symposium, IGARSS. 24e28 June 2002, Toronto, Canada, pp. 487-490.

Dutta, S., Chaudhuri, G., 2015. Evaluating Environmental Sensitivity of Arid and Semiarid Regions in Northeastern Rajasthan, India. Journal of Geographical Review, 105(4): 441–461.

Ekhtesasi, M.R., Ahmadi, H., 1995. Quantitative and qualitative evaluation of wind erosion and estimation of sediments. Iranian Journal of Natural Resource, 5(2): 15-28. (In Persian).

Fernandes, G.C.J., 1992. Effective selection criteria for assessing plant stress tolerance. in proceeding of on the symposium. Taiwan, 13–16 Aug. 1992. By: C. G. Kuo. AVRDC.

Fisher, R.A. and Maurer, R., 1978. Drough resistance in spring wheat cultivars. Australian Journal of Agricultural Research, 29: 897-912.

Food and Agriculture Organization (FAO). 2002. Land degradation assessment in drylands. 2 pages. Available at http://www.fao.org/ ag/agl/agll/lada/.

Forghani, F., 2008. Iran deserts. 5 pages. http://www.summitpost.org/iran-deserts/375835 #chapter-2.

FRWO, 1994. Desert and desertification in Iran. Bureau of sand fixation and combating desertification, Forest Range and Watershed Management Organization Press, 12p. (In Persian).

Ghilishli, F., Mirdeilami, S.Z., Moradi, E., Pessarakli, M., 2016. Effects of fertilizers on plant diversity, density, and uniformity in Golestan rangelands. Journal of Plant Nutrition, 39(10): 1441-1448.

Glantz, M.H., Orlovsky, N.S., 1983. Desertification: A review of the concept. Desertification Control Bulletin, 9: 15-22.

Glenn, E., Stafford, S.M., Squires, V., 1998. On our failure to control desertification: implications for global change issues, and a research agenda for the future. Environmental Science and Policy, 1: 71-78.

Harasheh, H., Tateishi, R., 2000. Desertification mapping of west ASIA-AGIS and remote sensing application. 7 pages. http://www.gis.Development.net/aars/acrs.

Heshmati, G.A., 2007. Vegetation characteristics of four ecological zones of Iran. International Journal of Plant Production, 1(2): 215-224.

Heshmati, G.A., Squires, V.R., 2013. Combating desertification in Asia, Africa and the Middle East. Springer Netherlands, 476p.

Holechek, L., Pieper, R.D., Herbel, C.H., 1989. Range Management: Principles and Practices. Prentice Hall, Endlewood Cliffs, New Jersey, 456p.

Khosroshahi, M., Abbasi, H., khashki, M.T., Abtahi, M., Seyedakhlaghi, S.J., 2013. Determination of Iran desert lands based on soil attributes. Journal of Desert Management, 1: 35-44.

Kosmas, C., Ferrara, A., Briasouli, H., Imeson, A., 1999. Methodology for mapping environmentally sensitive areas (ESAs) to desertification. Mediterranean desertification and land use (MEDALUS). Journal of the European Union, 18882: 31-47.

Ladisa, G., Todorovic, M., Trisorio-liuzzi, G., 2002. Characterization of area sensitive to desertification in southern Italy. Proceeding of the 2nd International Conference on New Trend in Water and Environmental Engineering for Safety and Life: Eco-Environmental, Capri, Italy, 23p.

Magnusson, S.H. 1994. Plant colonization of eroded areas in Iceland. Ph.D. Thesis. Lund University, Sweden, 145p.

Mashayekhan, A., Honardoust, F., 2011. Multi-criteria evaluation model for desertification hazard zonation mapping using GIS (Study area: Trouti watershed, Golestan, Iran). Journal of Rangeland Science, 1(4): 331-339.

Mehrabi, A.A., Zehtabian, G.H., Rostami, N., Malekian, A., 2008. Investigation of the socio-economic criteria, indicator and indices in desertification. Journal of Desert, 13: 67-74.

Millennium Ecosystem Assessment (MEA), 2005. *Ecosystems and Human Well-being:* Desertification Synthesis. Millennium Ecosystem Assessment (MEA). World Resources Institute, Washington, DC. Press, 2, 39p.

Mojiri, A., Jalalian, A., 2011. Relationship between growth of *Nitraria schoberi* and some soil properties. Journal of Animal and Plant Sciences, 21(2): 246-250.

Myers, B., Allan, G., Bradstock, R., Dias, L., Duff, G., Jacklyn, P., Landsberg, J., Morrison, J., Russell-Smith, J., & Williams, R. 2004, *Fire Management in the Rangelands*, Tropical Savannas CRC, Darwin.

National Action Program (NAP). 2004a. National action program for combating desertification and mitigation of impacts. Iran, Tehran, 125p. (In Persian).

National Action Program (NAP). 2004b. The National action program to combat desertification and mitigate the effects of drought of Islamic Republic of Iran. Forest, Range and Watershed Management Organization. Pooneh press, Tehran, Iran, 48p. (In Persian).

Rosielle, A.T. and Hambelen. J., 1981. Theoretical aspect of selection yield in stress and non-stress environment. Journal of Crop Science, 21: 943–946.

Sadeghi Ravesh, M.H., Ahmadi, H., Zehtabian, G.R., Tahmores, M., 2010. Application of analytical hierarchy process (AHP) in assessment of de-desertification alternatives, case study: Khezrabad region, Yazd province. Iranian Journal of Rang and Desert, 17(1): 35-50. (In Persian).

Saidi, S. and Gintzburger, G.A., 2013. Spatial desertification indicator for Mediterranean arid rangelands: A case study in Algeria. The Rangeland Journal, 35(1): 47-62.

Santini, M., Caccamo, G., Laurenti, A., Noce, S., Valentini, R., 2010. A muli-component GIS framework for desertification risk assessment by an integrated index. Journal of Applied Geography, 30: 394-415.

Sepehr, A., Hassanli, A.M., 2005. Holding back the tide with the desert encroaching on productive land at alarming rate, the need for information to underpin effective countermeasures is a top priority. GEO connexion. International Magazine, 6: 26-28.

Sepehr, A., Hassanli, A.M., Ekhtesasi, M.R., 2007. Quantitative assessment of desertification in south of Iran using MEDALUS method. Journal of Environmental Monitoring and Assessment, 134: 243–254.

Squires, V.R., 2010. Desert transformation or desertification control? Journal of Rangeland Science, 1(1): 17-21.

Stoddardt, L.A., Box, T.W., Smith, A.D., 1975. Range Management. McGraw-Hill Book Company, New York, 433p.

Tavares, J.D.P., Baptista, I., Ferreira, A.J.D., Tavares, J.D.P., Baptista, I., Ferreira, A.J.D., Amiotte-Suchet, P., Coelho, C., Gomes, S., Amoros, R., Reis, E.A.D., Mendes, A.F., Costa, L., Bentub, J., Varela, L., 2015. Assessment and mapping the sensitive areas to desertification in an insular Sahelian mountain region (Case study of the Ribeira Seca watershed, Santiago Island, Cabo Verde). Journal of Catena, 128: 214-223.

Thomas, D.S.G., 1997. Science and the desertification debate. Journal of Arid Environments, 37: 599-608.

Thorarinsson, S., 1981. The application of tephrochronology in Iceland. Tephra Studies, In: Self, S. and Sparks, R.S.J. (Eds.), D. Reidel, London, pp. 109-134.

Tongway, D., Hindley, N., 2000. Assessing and monitoring desertification with soil indicators. pp. 89-98, In: Arnalds, O. and Archer, S. (Eds.), Rangeland desertification. Originally published by Kluwer Academic Publishers, 211p.

Toranjzar, T., Poormoridi, M., 2013. Desertification Evaluation Using IMDPA Model (Case Study: Taraz Nahid, Saveh, Iran). Journal of Rangeland Science, 3(1): 83-94.

United Nations Convention to Combat Desertification (UNCCD). 1994. United Nations Convention to Combat Desertification in those countries experiencing serious drought and/or desertification particularly in Africa. Final Text, United Nations, 15p.

Verstraete, M.M., 1986. Defining desertification: A review. Journal of Climatic Change, 9(1): 5-18.

Whyte, A., 1977. Water control and desertification, the resettled nomads of DehLuran, Iran. Journal of Economic Geography, 53(4): 372-375.

Yang, X., Zhang, K., Jia, B., Ci, L., 2005. Desertification assessment in China: An overview. Journal of Arid Environments, 63: 517-531.

Zakeri, H.F., Khalil, R., ShafaiBajestan, M., 2015. Soil erosion and sediment yield risk assessment using an empirical model of MPSIAC for upstream watershed of Abbaspour and masjed-soleiman dams, SW-Iran. Journal of Bullen of Environment Pharmacology Life Science, 5: 73-82.

نقش ساکنین بومی در بیابان‌زدایی مراتع بیابانی اصفهان

سیده زهره میردیلمی[الف]*، عزت اله مرادی[ب]، محمد پسرک‌لی[ج]

[الف]دانش آموخته‌ی دکتری، رشته‌ی علوم مرتع، اجتماعی- مدیریتی، دانشگاه علوم کشاورزی و منابع طبیعی گرگان، استان گلستان، ایران. *(نگارنده مسئول)، پست الکترونیک: Zohremirdeilamii@gmail.com

[ب]دانش آموخته‌ی دکتری، رشته‌ی علوم مرتع، اکولوژی، دانشگاه علوم کشاورزی و منابع طبیعی گرگان و رئیس اداره‌ی منابع طبیعی و آبخیزداری شهرستان سمیرم، استان اصفهان، سازمان جنگل‌ها، مراتع و آبخیزداری کشور، ایران

[ج]استاد گروه علوم گیاهی، دانشکده‌ی کشاورزی و علوم زیستی، دانشگاه آریزونا، توسان، AZ 85721، ایالات متحده امریکا

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چکیده. بدون شک، تخریب زمین از طریق کاهش کمیت و کیفیت منابع طبیعی در بیابان‌زایی نقش دارد. هدف از انجام این تحقیق، ارزیابی بیابان‌زایی در مراتع استان اصفهان در سال ۱۳۹۵ است و اینکه چگونه ساکنان مراتع در کنترل بیابان‌زایی ایفای نقش می‌کنند. معیارها (اقلیمی، خاکی، مدیریتی، پوشش گیاهی و فرسایش)، شاخص‌ها (بافت خاک، اندازه‌ی ذرات خاک، ماده‌آلی، عمق، زهکشی، شیب و هدایت الکتریکی خاک، بارندگی، تبخیر و تعرق، خشکی، خطر آتش‌سوزی، حفاظت فرسایش، مقاومت به خشکی، درصد تاج‌پوشش، فرسایش آبی و بادی، کاربری، تراکم جمعیت، شدت چرا، مدیریت و سیاست) و پارامتر/ مولفه‌های (کاربری، مدل رقومی ارتفاعی، NDVI، جاده‌ها، چشمه‌ها، سابقه آتش‌سوزی، شدت تنش، دامنه‌ی تحمل، تعداد واحد دامی، زمین‌شناسی، مورفولوژی، سرعت باد، خصوصیات خاک، نوع و درصد تاج‌پوشش گیاه، فرسایش بادی، رطوبت خاک، نوع و توزیع ذرات شن و مدیریت اراضی) با استفاده از روش MEDALUS در بیابان‌زایی بکارگرفته شدند و با استفاده از این شاخص‌ها در نرم افزار $ArcGIS_{10}$ نقشه‌ی خروجی تهیه شد. اهمیت مباحث اقتصادی-اجتماعی و در نظر گرفتن چارچوب واقع‌بینانه بر اساس معیارها و شاخص‌های کیفی از جمله مبانی این تحقیق هستند که بر اساس موقعیت ایران، بومی‌سازی شدند. شاخص‌های اقتصادی-اجتماعی در قالب پارامترهای جمعیت، فقر و اقتصاد، حقوق عرفی و مقررات سازمانی و اجتماعی- فرهنگی طبقه‌بندی شدند. این معیارها از طریق مصاحبه با جوامع محلی و کارشناسان بدست آمدند. نقشه‌ی وضعیت بیابان‌زایی بر اساس نقشه-های کیفی تهیه شد. در نهایت، نقشه‌ی تولیدی با نقشه‌ی تراکم ساکنین بومی مقایسه شد. نتایج حاکی از آن است که ۹۱/۲۳ درصد مراتع بیابانی اصفهان (با مساحتی بالغ بر ۳۸۲۰۳ کیلومتر مربع) در طبقه‌ی بیابان-زایی شدید و متوسط با تراکم جمعیت بومی پایین و ۱/۸۳ درصد از مراتع (با مساحتی بالغ بر ۷۶۶ کیلومتر مربع) در طبقه‌ی بیابان‌زایی ضعیف با تراکم بالای ساکنین بومی قرار دارد که حاکی از اثرگذاری مثبت ساکنین بومی بر بیابان‌زدایی است. در مناطقی که ساکنین بومی و عشایر اسکان دارند، بیابان‌زایی در کمترین مقدار خود است و بالعکس. نقشه‌های شدت بیابان‌زایی و تراکم ساکنین بومی توأماً در اقدامات مدیریتی برای بیابان‌زدایی با تکیه بر قابلیت‌های ساکنین بومی به عنوان یکی از نقشه‌های ضروری است.

کلمات کلیدی: ارزیابی بیابان‌زایی، MEDALUS، ساکنین بومی، کیفیت