THE ROLE OF LAND USE CHANGES ON DESERTIFICATION IN IMAM KHOMEINI AIRPORT REGION-IRAN FROM 1956 TO 2003

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Abstract

The kind of land use and intensity of its change is considered as important desertification indices in different models. Land use change is one of the main anthropogenic factors in the desertification. The current research was carried out around Imam Khomeini airport, with an area of 32000 km^2, in order to evaluate mentioned area's land use changes effects during 1955-2003 on desertification. To study the changes, aerial photos of 1955 (1:55000) and 2003 (1:40000), in addition to IRS (Pan and LISS III) and ETM images of 2003 were used. Boundaries of different land uses were determined based on aerial photos and satellite images. In the next stage, boundaries were controlled in the field. Five kinds of land uses including agricultural land, abandoned agricultural lands, rangelands, industrial regions and complex, were distinguished in the study area. The extent of land uses areas, except to complex, has been changed during the 48 years. Rangeland has least change (1.5%), while 14% of agricultural areas have been changed into abandoned and industrial areas. This research showed that biomass has been decreased to 24355.6 ton during the last 48 years. This leads to the decrease of organic matter and decline of soil quality, which in turn causes a 32.9% increase of area regions with severe and very severe desertification intensities.

Key words: *Iran, Desertification, Imam Khomeini airport, Land use, Satellite images*

Introduction

Population increase, industrial activities development and limited natural resources have severe effects on the environment and degradation and pollution of land, air and water resources are the consequences of such effects. Ecosystem instability and environmental degradation are related to diverse factors and specific limitations including climatic factors, slope altitude, soil type and anthropogenic factors such as inappropriate management and landuse selection.

A brief review of records shows that world population will reach to 10 billion people in 2030 which will affect biological factors. According to the latest information, about 20 million hectares of rainforest disappear each year (Gharagozlou, 2004). It is generally accepted that the world is facing a serious environmental cities which will considerably affect human activities, mass & energy balance and dependent economic sub section. Then sustainable development approach is of high interest to consider environmental safety, refinery and conservation in development programs. Bisht (1996) implies that rapid increase of world population in recent years and poverty have lead to uncontrolled utilization of land resources and consequent degradation of biophysical resources in lesser (Himalya). Therefore, sustainable development requires a comprehensive and applicable land use planning based on land capacity.

Desertification is defined as degradation of fragile and instable ecosystems which may be intensified by human activities and land use change and leads to reduction of biologic production. Desertification process begins with anthropogenic activities and its intensity depends on quality of land resources management and skills.

Population pressure increase as well as economic and political trends affect on land use change which reduces biomass of range and croplands, decreases vegetation cover while increases CO_2 that finally affect microclimate of the region and increases air temperature (Chulum & Ojima, 2002). Dynamics of Carbon global change due to land use change was detected by Houghton et al (1999). Lantz et al (2001) investigated the effect of land use change on carbon content of soil in two regions of Ohio (USA) and showed that land use change affect soil erosion, aggregate formation, biologic activities and drainage of soil that have significant effect on accumulation of organic carbon and CO_2.

Xuejie et al (2003) simulated the effect of land use change on climate in China using a regional model. Land use change so called alteration of soil surface cover because of Albedo, surface roughness, thermal and hydrologic characterizes of soil has important effect on climate change.

In order to sustainable management of ecosystem, human should measure its effects on the environment to distinguish between natural phenomena of the earth and anthropogenic activities (Pauleit et al 2005). It is necessary to have quantitative assessment of the changes caused by human activities in current land use of the earth.

Since rapid change of agricultural lands into urban and industrial areas is the most important tectogenic factor of desertification, then a considerable attention has been paid on type and intensity of land use in desertification evaluation models.

Based on a conducted research in Kazakhstan, Maul et al 1993 concluded that landuse change from rangeland to agriculture land has severely reduced soil fertility especially humus content. In MEDRAP model (2001) land use type and change indices were used for environmental management quality criteria for land sensitivity to desertification.

Tazeh (2004) studied the effect of land use change on desertification in Yazd urban area over 1965-2002 period using tectogenic desertification indices (caused by industrial and urban development). Ekhtesasi & Mohajeri (1996) considered change of agricultural lands, forest and rangelands to non-productive areas such as road, urban and residential region in Iranian classification of desertification in Iran (ICD). Ekhtesasi & Ahmadi (2004) introduced land use change from agricultural land, forest and rangelands to urban and residential areas as one of the indices of urban and industrial development in desertification processes.

Since there is little information about the environmental effect of land use change on vegetation cover dynamics then, it is necessary to evaluate the effect of land use change on environmental factors of the ecosystem.

The southern parts of Tehran were already farmlands but currently have severe changes because of urban development and industrial centers. Therefore, there is a need to evaluate negative as well as positive effects of conservative measures. The study area includes Imam Khomeini Airport and the surrounding area which were agricultural areas in the past decades to minimize the effect of erosion in marl formation as well as land use change, some solution measures are needed.

Materials and Methods

The study area includes Imam Khomeini International Airport with an area of 15000 ha located on 35 km southwest of Tehran between Qom and Saveh high way. The geographic location of the study area is 51° 1´ 15´´ to 51° 11´ 15´´ eastern longitude and 35° 20´ 00´´ to 35° 28´ 07´´ northern latitude. The remains of old villages such as Mamorin, Amok, Haji abad, Zaman abad and Qeshlagh are seen in the region and the annual average precipitation is about 190 mm based on the comprehensive watershed management project of Arad basin (Jihad Keshavarzi organization of Tehran province, 2004).

The geologic formations of the region are categorized in two classes including igneous and sedimentary rocks. Igneous rocks include brown andesites which appear on the highlands surrounding Tehran-Qom highway. These andesites have amphibole and plegio clause and have brown and polished black because of Fe oxides decomposition. The sedimentary formations cover most parts of the region and include Miocene formations including reddish sand stones and marls. Based on the objective of current research to detect land use change in the airport over the period 1956-2003 aerial photo of the region for 1956 in the scale of 1:55000 was obtained and the area of different landuses were determined. Also the aerial photos with the scale of 1:40000, IRS satellite images (LISS III and pan bands) and ETM satellite images related to 2003 were used for current landuse detection. First, aerial photos were interpreted using stereoscope to detect different land uses such as agriculture, bare lands, residential and industrial areas. Then aerial photos were ordered and scanned to enter the data in ILWIS. The topographic map of 1:25000 was used to georeference the location then the area of each landuse was determined.

The IRS-panchromatic satellite images of 2003 were used because of 5m resolution and high accuracy. Also for better detection of different landuses and color composition, LISS III band including three different bands and 24 m resolution were used for precise landuse detection.

ETM+ image including 2, 4 and 7 bands were used to prepare colored images with the resolution of 28 m. However, IRS images are better tools for land use change detection due to higher resolution capability (5.8 m).

The prepared land use map of 2003 was checked using field studies and ground check points. Then land use variation over the period and its effect on soil erosion and desertification was analyzed for this purpose, potential desertification evaluation map of the region was prepared based on the proposed indices by Ekhtesasi and Ahmadi (2004) (Table 1). The applied indices for this map include:

A. Index of erosional facies exposure or erosion intensity using two qualitative and quantitative measures. In non agricultural lands IRIFR 1 while in agricultural areas, IRIFR 2 model were applied. In cases that IRIFR method is not applicable, qualitative scoring was applied using table 1.

B. Density of alive and dead materials which are determined using appropriate plotting.

C. Days with dust storm (Dust storm index) are available from meteorological station which should be interpolated for regions having no data.

Table 1: Indices of wind erosion of evaluating current condition of desertification

Index type	**Current condition of desertification and scoring range**			
	Low (0-25)	**Moderate (25-50)**	**High (50-75)**	**Very high (75-100)**
Appearance of Aeolian feature or determining erosion intensity	- Without erosion factures or soil disturbance over a year	- Deflation features over soil surface and development of desert pavement with prismatic features	Sand seas, disperse Klot and prismatic features, low density pavement development	Active sand dunes dense and adjacent Klot
Score of IRIFR wind erosion model	IRIFR<25	25<IRIFR<50	50< IRIFR<80	IRIFR>80
Density of non-alive cover (gravel>2mm) on soil surface	MC>80	40<MC<80	20<MC<40	MC<20
vegetation cover	PC>40	20<PC<40	10<PC<20	PC<10

Days with dust storm	10<	10-30	30-60	60>

Results and Discussion

In this study, five area categories including agricultural, bare lands, rangelands, as well as infrastructure (man-made) and other regions were classified (Table 2 and figure 1).

Major crops of the region are wheat and barely. The area of agricultural lands in 1956 was 34.3% while it has reduced to 6410.24 ha (20.3%) because of landuse change into infrastructures and barelands.

Table 2: Land uses in the studied area between 1956 and 2003

Land uses	1956		2003	
	ha	%	ha	%
Agricultural lands	10838.53	34.3	6410.24	20.3
Bare lands	0	0	1637.72	5.2
Range lands	19994.87	63.3	20494.62	64.8
Other lands	706.03	2.2	706.03	2.2
Infrastructures	64.11	0.2	2354.93	7.5
Total	31603.54	100	31603.54	100

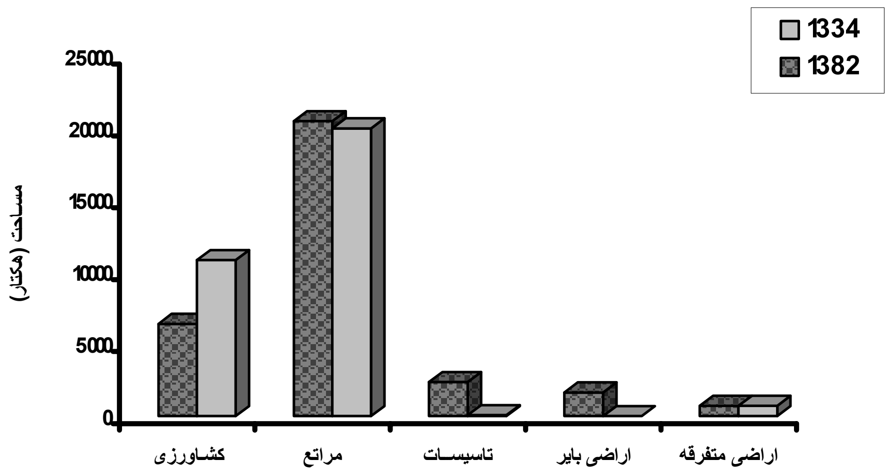

Figure 1: The changes of land uses occurred in Imam Khomeini Airport during the years of 1995-2003

Barelands composes of lands in which cultivation was done but left uncultivated for many years. It consists of 5.2% of the region. Rangelands include the areas with no cultivation because of physical limitations and inadequate water resources. These areas are covered by annual and perennial plant species with about 1994.9 ha (63.3%) in 1956 while current area of these lands has been increased to 20494.6 ha (1.5% more than the previous period). Other lands are those without vegetation cover and show evidences of anthropogenic change. These areas are mostly marl formations and include 2.2% (706 ha) of the region. Infrastructures include industrial factories and airport with an area of 0.2% in 1956 that have been increased to 7.3% at this time (7.3% increase).

Table 3: The desertification intensity in the studied area in 1955 and 2003

Desertification intensity	1955		2003		Changes
	ha	%	ha	%	
low	1309.4	4.1	3139.2	9.9	5.8
medium	28779.8	91.2	16587	52.4	-38.8
severe	0	0	5094.5	16.1	16.1
very severe	1476.4	4.7	6811.8	21.5	16.8

The potential desertification map caused by wind erosion of the region was prepared using the scored assigned to indices of IRIFER model including biotic and non-biotic land covers, and also days having dust storm (Figure 2 and 3). Based on the mentioned figures and also table 3, it is noticeable that in 1956 a major part of the region (91.2%) had moderate desertification and marl covered regions having high and very high desertification had only 1476.4 ha (4.7%). Currently the area of high desertification condition has been increased because of land use change and anthropogenic factors even it has reached to 37.6% mostly around the airport.

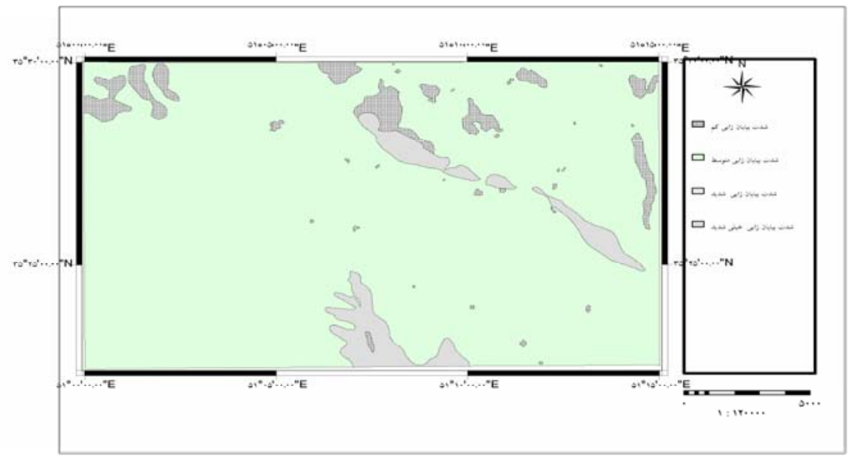

Figure 2: The desertification assessment map of studied area prepared using wind erosion indicator for 1955

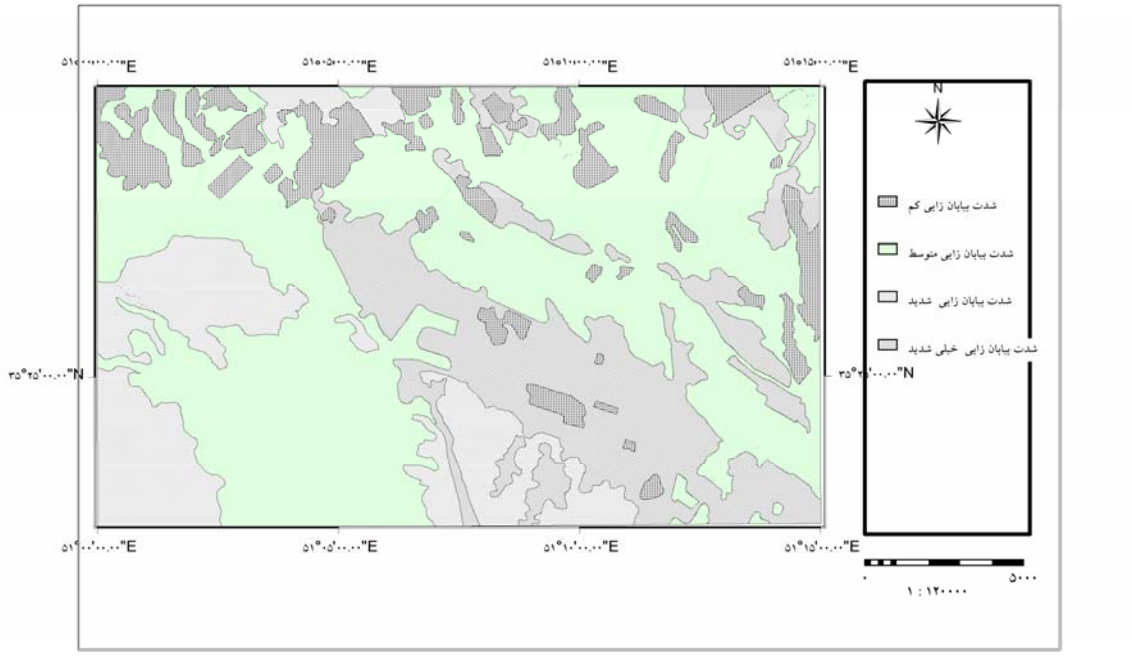

Figure 3: The desertification assessment map of studied area prepared using wind erosion indicator for 2003

Conclusion

The study of different land uses around Imam Khomeini Airport shows that five types of landuses including agriculture, bare range, other type and infrastructures have been encountered to changes over past 48 years. Currently, range lands cover the most part of the region (64.8%). These areas have not been considerable changed over the period because of natural limitations including topography, soil and water resources. However rangelands had 1.5% increase over this period.

The area of agricultural lands has been decreased to 14% because of inadequate irrigation water, economic condition and immigration. Barelands have mainly no natural vegetation cover but have annual invader plant species. These conditions have increased soil susceptibility and consequently lead to invisibility and damages to the airport facilities. These areas were not seen in 1956 but currently they cover 5.2% of whole area.

One of the important characters of desertification is biomass reduction. In this region, agricultural lands area has been decreased and allocated only for wheat and barely. In this case, the biomass production has been decreased to 24355.6 ton over the period (5.5 ton per year). This has decreased aggregate composition and soil biologic activities and since organic matters are very important in soil aggregation (Lantz et al 2001), then biomass and organic matter reduction can be considered as degradation factors and erosion is the study area.

This investigation showed that 91.2% of the area had moderate desertification condition in 1956 that increased to 37.6% in 2003. Since the regions with severe and very severe desertification are located in changed lands then vegetation cover degradation and land use change are the responsible factors of desertification in the study area.

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