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MAPPING THE LAND USES AND ANALYSING THE LANDSCAPE ELEMENTS IN SOUTH-WESTERN IRAN: APPLICATION OF LANDSAT-7 FIELD DATA AND LANDSCAPE METRICS

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Abstract

In the recent years, the human-made land uses have been increased in the natural areas around the world which are the serious threats for nature, environment, and biodiversity. This research was performed to investigate the human-made and natural land uses in Dashte Raz region as a biodiversity hotspot located in southwest Iran. For this purpose, ETM+ satellite image of Landsat-7 for the study area was provided from USGS. First, the study area boundary was digitized in Google Earth. Then, the training areas were selected in each land use in Google Earth and were checked in field surveys using GPS. Then, training areas were found on the satellite image and land use map was provided using maximum likelihood algorithm in Erdas Imagine 2014 software. The accuracy of the land use map was assessed by field control points which were randomly selected in each land use. In the next step, the landscape elements of the study area were analyzed by CA, PERIM, and NP metrics in FRAGSTATS software. Results showed that Landsat-7 has successfully classified the land uses/covers in the study area with an overall accuracy of 87%. Results of landscape metrics showed that forest has been the bed of study area (the biggest land use). The human-made land uses such as villages and agricultural lands have improperly developed in the forests and have destructed this ecosystem in recent years. Thus, a protective management of the study area is very essential to conserve the remained forests. The main focus should be to remove some human-made land uses and to replace them by some other natural land covers. Agriculture development has exposed the study area in a critical situation which may completely destroy the forests in the near future. Therefore, it should be controlled; while other land uses such as gardens can create a proper habitat for some endemic fauna and flora and may lead to conserve the biodiversity of the study area.

Keywords*: Land use mapping; Landscape metrics; Dashte Raz region; Remote sensing (RS); geographic information system (GIS); FRAGSTATS*

Introduction

Population growth has increased the pressure on the nature and has caused the improper utilization of the natural resources in different areas around the world. The land use change has many negative outcomes on nature and creates different reactions of the ecosystems [1]. Human activities in natural areas such as vegetation destruction, building and road construction, and agriculture development can change the natural mechanisms [2]. The land use change is one of the main factors changing the ecological systems which influence biodiversity and climate [3]. To conserve the natural areas, the environmental planning should be based on land sustainable

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development [4]. Land use change may be occurred by natural factors such as drought, erosion, fire, flood, and volcanic events or by human activities such as livestock dependence, grazing, urbanization, building and road construction, and agricultural lands development [5].

So far, many studies have been performed for land cover/use mapping in natural ecosystems around the world using different satellite images. Results of these studies have demonstrated that land use change has destructed a large part of the natural resources and has created many environmental losses in the world. *Stefanov et al.* [6] used TM data to get a land cover map for a semi-arid Phoenix metropolitan portion of the Central Arizona-Phoenix. Logical decision rules were used with the various datasets to assign class values to each pixel. TM reflectance data in 1998 were initially classified for land cover using a maximum likelihood decision rule. An expert system was constructed to perform post-classification sorting of the initial land cover classification using additional spatial datasets. The overall accuracy of this technique was 85% for land cover mapping. *Melesse and Jordan* [7] provided a land cover map using Landsat data in three watershed basins in Florida. Landsat satellite images of 1984 and 2000 were processed using an unsupervised classification. Accuracy assessment of the classified map showed an overall accuracy of 85% for land cover map. The results also showed that the vegetation cover has been decreased from 1984 to 2000 with a respective increasing in surface temperature. *Chauhan and Nayak* [8] investigated the land cover change in Hazira region in India using IRS-LISS III from 1970 to 2002. Results showed that forest area has been decreased and urban and industrial areas have been increased during study period (1970-2002). *Cakir et al.* [9] investigated the forest area change in Macka in Turkey using MMS (1975), TM (1987), and ETM+ (2000) satellite images by GIS and FRAGSTATS softwares. Results showed that area of destructed forests has been increased and area of broadleaves forests has been decreased during 25 years. In addition, number of patches has been increased in the forest area which shows the fragmentation of the ecosystem and it is a serious risk for biodiversity of the study area. *Gobattoni et al.* [2] studied the land use change in central Apennine in Italy from 1954 to 1985. They concluded that the urban development and soil erosion has been increased from 1954 to 1985 due to land use changes. *Fazio et al.* [10] investigated the land use of a forested landscape in Serra San Bruno district in Italy and concluded that a general plan for urban and rural environments with tourism proposes would help to nature protection. Rakesh *Kumar et al.* [11] studied forest cover dynamics in a part of Kanker district in Chhattisgarh Province of India and developed a predictive model using logistic regression method. The forest cover maps for 1990 and 2000 periods were derived from Landsat TM data. These maps were used to predict the forest cover in 2010. The analysis of the forest cover maps showed that forest cover has been decreased about 107.2 km^2 between 1990 and 2010. Furthermore, logistic regression model has successfully predicted the forest cover for 2010 with reasonably high accuracy (ROC = 87%). *Topaloglu et al.* [12] assessed the classification accuracy of Sentinel-2 and Landsat-8 data for land cover mapping in Istanbul city in Turkey. Results showed that the classification of Sentinel-2 image using SVM algorithm has yielded the most overall accuracy (84.17%) and kappa index (0.81) for land cover mapping in Istanbul city.

Some other studies have also been performed for land use mapping in the different natural areas of Iran. *Ahani et al.* [13] investigated the land use changes in Tange Sorkh basin of Shiraz city in Iran using satellite images. The results showed that the forest area has been decreased from 29.8 to 28.3% and the pastures area has been decreased from 36.9 to 26.8% within seven years. *Eskandari and Moradi* [14] provided the land cover map in Sivar area in Iran and analyzed the landscape metrics of study area using FRAGSTATS software. Results showed that rangelands had covered a large part of Sivar area in the past years; however it has been destructed by human-made land uses especially agriculture development in the recent years. *Mahdavi and Fallah Shamsi* [15] investigated the land cover change in Ilam Province in Iran using aerial photos and satellite image (IRS LISS-III) from 1966 to 2007. Results showed that 16000ha of the forest area have been decreased during 41 years. *Mahdavi et al.* [16]

investigated the forest cover changes in Sirvan County of Ilam Province in Iran using MMS and OLI data from 1988 to 2015. Results showed that the forest area has been decreased about 5910 ha during 27 years.

Dashte Raz region with a natural bed in southwest Iran has a unique landscape and special biodiversity which makes it very important in terms of environment. This beautiful village in Dena city in Kohgilooye & Boyerahmad Province (southwest Iran) has been destructed because of many natural and human-made reasons in recent years. Human-made land uses especially agriculture development has mainly been increased in this area in recent years. Considering the extensive destruction of this region in the recent years, this study was performed for land use mapping and landscape analysis of Dashte Raz region using RS, GIS, and landscape metrics. The results of this study could help to natural resources managers to protect and conserve the forests and natural resources of the study area. The land cover map provided in this research will be a suitable tool to manage the natural land covers and to control the human-made land uses regarding to environmental considerations.

Materials and Methods

Study area

Dashte Raz region is located in Dena city in Kohgilooye & Boyerahmad Province in southwest Iran (Fig. 1). It covers an area about 2881.76ha. The study area has located in 528090 to 528829 Eastern longitudes and 3432703 to 3433111 Northern latitudes in zone 39 N of WGS 1984 UTM coordinate system. The elevation mean of the study area is about 2050 meters from sea level. The study area includes the mountainous regions, hills, and plain lands with very heterogeneous land uses/covers (Fig. 1b and Fig. 2).

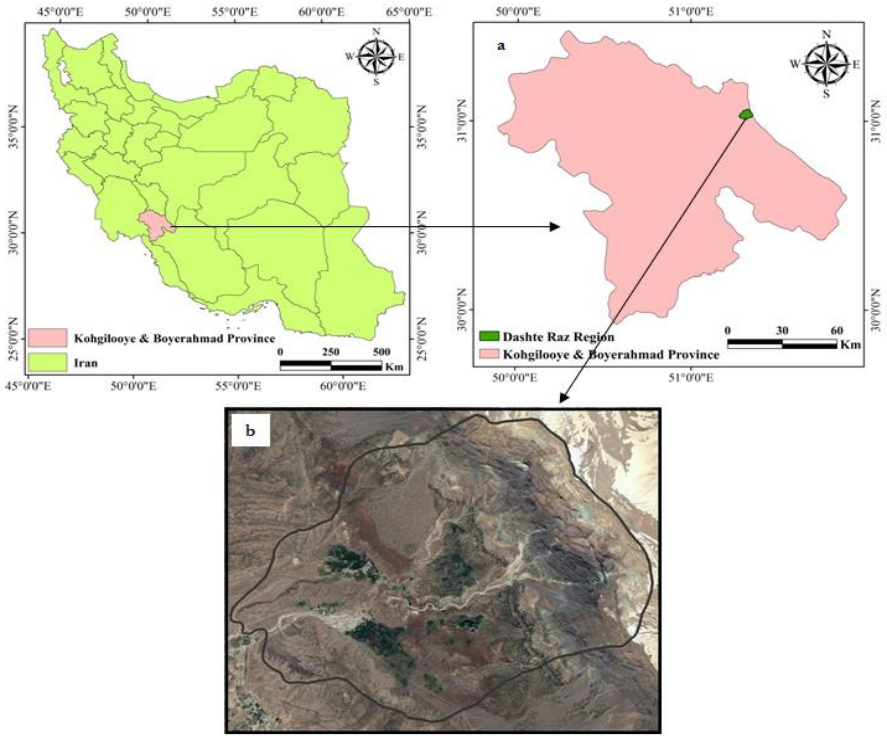

Fig. 1. Location of Dashte Raz region in Kohgilooye & Boyerahmad Province and Iran (a), and Landsat-7 satellite image of Dashte Raz region (b)

Fig. 2. Landscape of Dashte Raz region

Data

ETM+ satellite image of Landsat-7 for the study area (June 2015) was downloaded from USGS (United States Geological Survey) website (Fig. 1b). Combination of band 2 (green), band 3 (red), and band 4 (near infrared: NIR) with 30-meter spatial resolution was used to obtain a layer stacked image in Erdas Imagine 2014. In addition, the study area boundary was determined and digitized in Google Earth. Furthermore, 80 field control points were taken for accuracy assessment of land use map by field surveys.

Methods

Land use mapping

First, the primary human-made and natural land uses in the study area were investigated in Google Earth to select the proper training areas (as point) in all land covers (forest, rock, Dashte Raz village, Dashte Raz garden, Khoongah village, Khoongah garden, developed garden, agricultural land, water pool, Environment Protection Unit, Shrine, and Cemetery). Then, the approximate locations of the training areas were determined. For each land cover, 20 training areas in point format were randomly selected in Google Earth. Then, these points were transferred to GPS (model: Garmin, GPSMap 64 Sc) to find them in the field. These points were found in the field surveys, and their land covers were exactly investigated. Then, their locations were recorded again by GPS as training areas for land use mapping.

The layer stacked satellite image was clipped in size of study area boundary (Fig. 1b). In addition, the road map of the study area was obtained from Forests, Rangelands and Watershed Organization of Iran (FRWOI) which was used for geometric corrections of ETM+ satellite image of the study area. Then, the radiometric corrections were performed on ETM+ satellite image.

In this research, the supervised classification method was used to classify the layer stacked ETM+ satellite image and to obtain the classified land use map. The training areas checked by field surveys were found on the layer-stacked ETM+ satellite image and the land use map was provided using maximum likelihood algorithm in Erdas Imagine 2014 software. Then, human-made and natural land uses in the study area were classified. Finally, the land use map was provided for the study area.

The accuracy of the land use map was assessed by field surveys. Therefore, in addition of the primary field surveys for selecting the training areas, the secondary field surveys were performed to assess the accuracy of land use map. For accuracy assessment of land use/cover

map, overall accuracy (OA) was calculated. It is noted that the location of validation areas was completely different from training areas and they were randomly selected on classified land use map. For this purpose, all validation control points were transferred to GPS and then all of them were controlled by field surveys. For each land cover, we considered 10 control points for accuracy assessment of land cover map in the field. We didn't consider control points for water pool, Environment Protection Unit, Shrine, and Cemetery because of their limited area. Totally 80 control points were checked in forest, rock, Dashte Raz village, Dashte Raz garden, Khoongah village, Khoongah garden, developed garden, and agricultural land in the field surveys (Fig. 3). Then, overall accuracy was obtained for classified land cover map.

Landscape elements analysis

For landscape analysis of the study area, land use map of Dashte Raz region was converted to Raster (Grid) format and it was transferred to FRAGSTATS software. The metrics used in this software were included CA (area of land use), PERIM (perimeter of land use), and NP (number of polygons in each land use) to determine the area and perimeter of land uses (patches) in the land use map and to analyze the landscape metrics. Then, the natural bed (the biggest land use) of Dashte Raz region was determined.

Results

Map of Dashte Raz region

Total area of Dashte Raz region is about 2881.76ha which all of its land uses has been shown in figure 3. Dashte Raz region has 12 land uses including forest, rock, Dashte Raz village, Dashte Raz garden, Khoongah village, Khoongah garden, developed garden, agricultural land, water pool, Environment Protection Unit, Shrine, and Cemetery (Fig. 3).

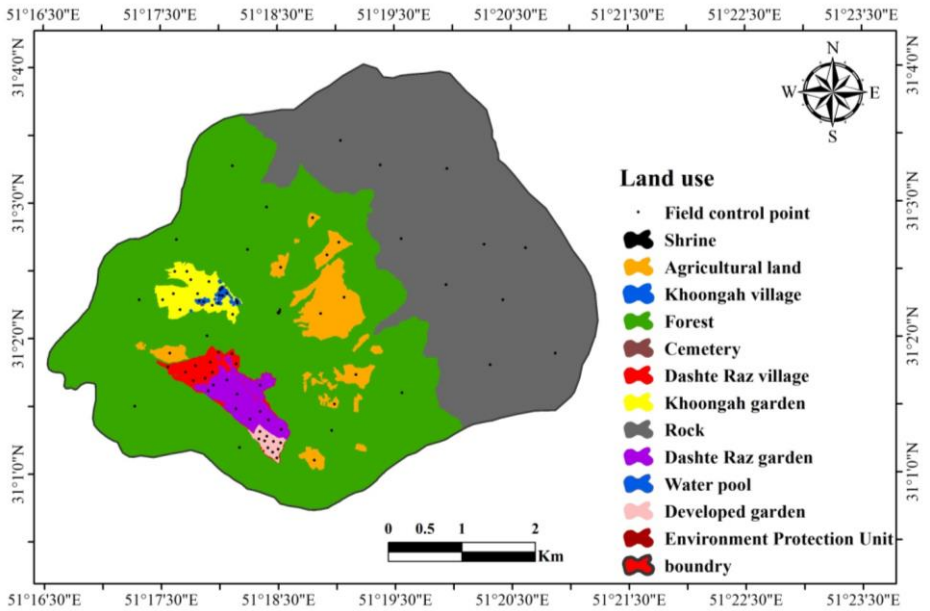

Fig. 3. Land use map of Dashte Raz region and field control points in different land uses

The accuracy assessment of land use map by overall accuracy has been shown in table 1. The results show that Landsat-7 has successfully classified the land uses/covers in the study area with total overall accuracy of 87%. Among all land uses/covers, rock and Khoongah

garden have successfully been classified in land use/cover map (OA: 100%) (Table 1). Then, forest, developed garden, and agricultural land have been the most accurate classified land uses (OA: 90%). Dashte Raz village and Dashte Raz garden have been classified in land use map almost good (OA: 80%). Khoongah village has been the least accurate classified land use (OA: 70%) which may be because of its heterogeneous patches (Fig. 3).

Table 1. Accuracy assessment of land use map using field control points

Land use/cover	Number of control points (reference) in the field	Number of true classified control points use map	Overall accuracy (OA) (%)
Forest	10	9	90%
Rock	10	10	100%
Dashte Raz village	10	8	80%
Dashte Raz garden	10	8	80%
Khoongah village	10	7	70%
Khoongah garden	10	10	100%
Developed garden	10	9	90%
Agricultural land	10	9	90%
Total	80	70	87%

Landscape elements analysis of Dashte Raz region

Results of landscape analysis of Dashte Raz region using CA, PERIM and NP metrics in FRAGSTATS software has been shown in table 2. Results show that forest with an area of 1444.68 ha is the bed of study area. Rock (1155.63 ha) is the second-largest land use/cover in Dashte Raz region (Table 2). Water pool, Environment Protection Unit, Shrine, and Cemetery have covered the least areas in Dashte Raz region (Table 2).

Table 2. The area, perimeter and number of polygons of all the land uses in Dashte Raz region

Land uses	Area using CA metric (ha)	Perimeter using PERIM metric (m)	Number of polygons (patches) using NP metric
Forest	1444.68	63037.41	1
Rock	1155.63	23339.30	1
Dashte Raz village	32.462	5617.93	34
Dashte Raz garden	59.12	8525.76	3
Khoongah village	2.065	3539.9	34
Khoongah garden	52.74	7992.91	1
Developed garden	11.71	2184.72	1
Agricultural land	122.91	23650.91	21
Water pool	0.07	106.57	1
Environment Protection Unit	0.023	26.64	1
Shrine	0.21	213.14	1
Cemetery	0.14	159.85	1
Total	2881.76	138395.04	100

Conclusion

The optimal development of land depends on adequate and accurate knowledge of the current land use. Land use mapping is the first step to protect the sensitive natural ecosystems. As Dashte Raz region has been destructed by human-made land uses in recent years, this research was performed to determine the current land uses and to analyze the landscape metrics of this area. Land use mapping showed that the rural people have created the different uses in the study area during last years. These human-made land uses have improperly been developed in the forests of the study area. The improper and extensive development of the human-made land uses have destructed the forests and therefore have reduced the fauna and flora biodiversity in the study area. Distribution of the patches due to human interferences is very extensive in

Dashte Raz region. Therefore, many negative changes have occurred in the natural resources of the study area.

The landscape analysis of Dashte Raz region along with field surveys demonstrated that forest has been the bed of study area (1444.68ha). Therefore, a wide area of the region had been covered by forests as the habitat of unique fauna and flora in the past years. Forest has been a major area for plant and animal biodiversity. Although a large part of the study area has still been covered by forests (1444.68ha), it is clear that the forest area has been decreased by human interferences during recent years. The human-made land uses such as agricultural lands, Dashte Raz village, and Khoongah village are enormous in Dashte Raz region which development of these human-made land uses in the future will reduce the forest area again. Results of some other studies also showed that forest area has been reduced in many natural areas of Iran [13, 15-17]. Similar results have also been obtained by other researches in different areas around the world [7-9, 11].

The second land use with the widest area in Dashte Raz region is rock which has covered 1155.63 ha of the study area. As rock is a natural land cover, it is a supportive habitat for some animal and plant species. Agricultural lands are very extensive in Dashte Raz region and their patches can be a serious risk for the natural environment of the study area. If agriculture development doesn't be controlled in the future, a larger part of the forests will be destructed; by decreasing the forest area, population of some animal and plant species will be decreased. Therefore, agriculture development will be a serious risk for biodiversity of the study area. *Eskandari and Moradi* [14] also concluded that the human-made land uses especially agriculture development has destructed the natural resources in Sivar village in Iran. *Gobattoni et al.* [2] also stated that the human activities such as agriculture development have destructed the natural resources in Italy. Other human-made land uses in the study area such as water pool, Shrine, and Cemetery are very limit in the region. If they won't be developed in the future, these land uses won't be a serious threat for the forests and natural resources of the study area. On the other hand, the proper management of Dashte Raz and Khoongah gardens can create a proper habitat for endemic fauna and flora and may provide a suitable bed for plantation by endemic plant species. This helps to the natural resources protection and biodiversity conservation of the study area. The garden can provide an important financial support for rural people, as well. In addition, a propertourism plan along with natural resources protection can be performed in the study area for more financial support of the rural people. As *Fazio et al.* [10] also state that a comprehensive tourism program in the rural environments based on sustainable development will help to conserve the natural resources.

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