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Land Use and Land Cover Change Detection of Mouteh Wildlife Refuge Using Remotely Sensed Data and Geographic Information System

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Abstract: Environmental managers are interested to know land use/cover types and their change detection in time series for sustainable land management. Remotely sensed data due to periodic covering, data integrity and provide data in different range of electromagnetic radiation and possibility to use by different hardware and software, having high ability to prepare land cover/use maps. Major aim of this study is to prepare land use/cover and their change detections by using RS and GIS techniques. In this paper MSS images for 1972, TM scene for 1986, TM scene for 1998 and LISS III scene for 2005. First images georeferenced. Land use/cover maps were prepared by several image processing. Vegetation cover's map was prepared in percentage by using SAVI index and field surveys. Land cover produced by using hybrid image classification approach. Land cover and land were classified into natural, semi natural and manual. Then changes were detected by post classification comparison approach in four past decades. Results suggested that manual land use increased from 176(ha) in 1972 to 1035(ha) in 2005.

Key words: Land management . Image classification . Change detection . Land use/cover . Mouteh wildlife refuge

INTRODUCTION

Land use/cover arrangement makes landscape patterns. Land use/cover Change detection is very essential for better understanding of landscape dynamic during a known period of time having sustainable management. Land use/cover changes is a dynamic, widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities, which in turn drives changes that would impact natural ecosystem [1, 2]. Change detection is one of the landscape ecological aims. Preparing landscape characteristics maps can help to change detection. Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement [3]. Today Earth resources satellites data are very applicable and useful for land use/cover change detection studies [1].

Post classification comparison is usual a change detection method. It is suitable for studies with different sensors and different characteristics. Producing accurate land use/cover maps is so important that accurate change detection using post classification comparison method [4, 5]. Post classification results are dependent on accuracy of land use/cover maps. Thus preparing accurate land use/cover is very important for correct change detection and landscape analysis [4-6]. Natural conservation area plays vital role in biodiversity. Today opposite land use with conservation aims increase in conservation area. Therefore change detection is essential for sustainable land management that Mouteh wildlife refuge is on of them [3].

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MATERIALS AND METHODS

In this study, Landsat MSS data of 1972 and TM of 1987, TM of 1998 and IRS-LISS III of 2005 were selected and used to classify land use/cover in the study area. Field study was done in June 2005. Therefore images were selected for this month.

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Table 1: Land use/cover description

Code	Land use/cover	Description
1	Cover 0-10%	Area with lower 10% vegetation crown cover.
2	Cover 10-20%	Area with between 10-20% vegetation crown cover.
3	Cover 20-40%	Area with between 20-40% vegetation crown cover.
4	Cover 40%<	Area with upper 40% vegetation crown cover.
5	Salt land	Low land with near surface groundwater.
6	Farmland	Areas currently under crop, orchards and fallow and in addition land under irrigation, cultivated land or land being prepared for raising crops.
7	Tamarisk and junk	Area that is covered by tamarisk and junk almost there are nearby salt land and surface water.
8	Shist	Black rocky area with which.
9	Mine	It involves mine activities in past to now.
10	Rock	Area that is rocky and shelved. This area is suitable habitat for ibex.
11	Fallow	Farm land without crop.
12	Settlement	An area where there are permanent inhabitants, man-made structures and activities, such as towns.

Study area: Mouteh wildlife refuge with special attribute is located in Esfahan province and extends between 51°-02'E and 50°-13' E and approximately between 34°-01'33°-23' N covering an area of 204000 ha. It's mean annual rainfall is about 263 mm. It's climate, according to Domarton approach, is semiarid. This refuge is unique collection of plant and wildlife special big mammalian. During four past decades many refuge habitats were destroyed. Special mining activities, over grazing had many effects on its habitat value.

Image pre-processing: IRS-LISS III using 30 ground control points (GCPs) with a root mean square error (RMSE) ranging from 0.5 pixel and then other scenes were registered one to another with RMSE <1. Images were resampled to a 30m pixel size using the nearest neighbor re-sampling method [1]. The images were not radiometrically enhanced before the hybrid classification in order not to interfere with the spectral information [4]. Topographic correction was done by DEM and sun azimuth and sun elevation extracted from image's header file.

Data collection: 12 classes were adopted for image classification based on the modified Anderson land use/cover scheme levels I and II and the author's a priori knowledge of the study area: Cover in four vegetation crown cover percent classes(1-4), (5) Saltland; (6) Farmland; (7) Tamarisk and junk; (8) Shist; (9) mine; (10) rock; (11) Fallow; (12) Settlement (Table 1).

Vegetation cover sampling was done with 290 plots in heterogeneous cover areas and Data were collected from each land use/cover.

Image processing: False color composite images (FCC) were produced. Either principle component analysis (PCA) was done on each image. Then for each image vegetation index SAVI that is standardized for sparse vegetation was prepared [7].

Soil adjusted vegetation index (SAVI) was derived and it was applied as follows:

$$SAVI = \left(\frac{(NIR - R)}{(NIR + RED + L)} \right).(1 + L)$$

Where L is an adjustment parameter based on nonlinear extinction of red and NIR thought the landscape. L was set to 0.5 for wide variety of vegetation [8].

Data analysis: Our classification approach is based on: (a) unsupervised classification using the Iterative Self-Organizing Data Analysis (ISODATA) algorithm for determining spectral class. (b) A supervised maximum likelihood classification (c) vegetation crown cover percentage models for each image were produced by using simple linear regression between vegetation indices as independent variable and field sampling as dependent variable. Vegetation crown cover classes were produced in four classes (Table 1). Fusion of each layer [(a)(b)(c)] land use/cover maps for each year were prepared. Then accuracy of maps was assessed. It is assumed that rock's schist had no changes in the study period. Then with respect to landscape ecological concepts, suitability of each class for animals and their naturalness, land use/cover were re-classed into 3 classes: nature, semi nature and artificial. Following classification of 1972 and 2005 images, a post-classification comparison change detection algorithm was used to determine changes in land use/cover from 1972 to 2005. Change maps were produced. They involve area with change and no change was showed in 13 classes. 12 classes that show changes in each class and class 13 that shows area with changes.

Table 2: Land use/cover area in 1972-2005

	Area-ha				
Class	MSS-1972	TM-1987	TM-1998	LISS III-2005	Naturalness
Cover 0-10%	31663	8044	88902	81690	Semi-natural
Cover 10-20%	118655	92990	60413	59143	natural
Cover 20-40%	21789	71220	27055	32575	natural
Cover 40%<	1855	2104	930	3047	natural
Salt land	9334	6402	3409	4086	natural
Farmland	496	1503	1322	1850	natural
Tamarisk and junk	460	364	184	300	natural
Shist	6440	6440	6440	6440	Semi-natural
Mine	165	212	549	828	artificial
Rock	13525	13525	13525	13525	natural
Fallow	0	1381	1432	703	Semi-natural
Settlement	9	201	218	249	artificial

RESULTS AND DISCUSSION

According hybrid supervised/unsupervised classification approach, four thematic land use/cover maps produced from the adopted classification techniques (Fig. 1-4).

In order to assess thematic accuracy, the stratified random sampling design [7]. For each land use/cover map, minimum 150 pixels were selected, which were then checked with reference to past studies and false color composite images and interview with native people [7]. Commission and Ommission errors for each class were calculated. The results indicate an total accuracy of 90 percent and a Kappa index 0.85 that shows maps have sufficient accuracy for post classification comparison approach [4]. Computed percentage of each land use/cover class show that in 1972, crown cover 10-20% was 52 percent and had highest area in refuge. In 1987, crown cover 10-20% and 20-40% respectively with 45 and 34 percent had highest area in Mouteh. In 1998 crown cover 0-10% and 10-20% respectively were 43 and 29 percent and in 2005 crown cover 0-10% was 40 percent of study area In this period mining area had increases 22 times (Table 2).

During study period in 1987 natural area with 92 percent had the highest area and in 1998 with 52 percent had lowest area in Mouteh wildlife refuge. In 1998 semi natural areas with 47 percent of study area was the most extent of this class in study period (Table 3).

For change detection post-classification comparison approach was employed. In this study, Because of divers and variety changes during study period, it was not possible to show all changes in change detection map. Result sugested that area were

Table 3: Naturalness classes area

	Year			
Naturalness	1972	1987	1998	2005
Natural	166114	188113	106839	114526
Semi-natural	38103	15865	96774	88833
Artificial	174	413	767	1077

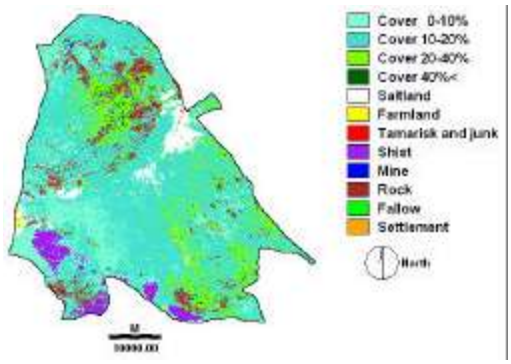

Fig. 1: Land use/cover map for 1972

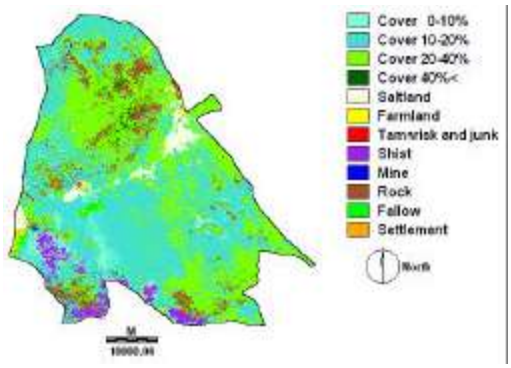

Fig. 2: Land use/cover map for 1987

Table 4: Changed area during 1972-2005

	ha-changes area			
Changes classes	1972-1987	1978-1998	1998-2005	1972-2005
Crown Cover 0-10%	25160	397	26983	6939
Crown Cover 10-20%	49145	67200	30250	71697
Crown Cover 20-40%	1437	49706	11879	15326
Crown Cover 40%<	1592	1800	563	1409
Salt land	4904	3373	956	6065
Farmland	291	752	311	297
Tamarisk and junk	239	219	68	313
Mine	0	0	0	0
Fallow	0	0	0	0
Settlement	0	0	0	0
Total changes	82768	123447	71010	102046
No changed area	121232	80148	132108	101954

Table 5: Change matrices during 1972-2005

	LISS III									
MSS	1	2	3	4	5	6	7	9	11	12
1	24666	3785	1508	172	117	804	47	101	388	17
2	50562	41975	17841	1309	622	486	65	478	270	64
3	3119	10796	11399	1144	93	103	19	46	14	5
4	102	302	954	259	6	31	13	1	0	0
5	2621	2291	635	81	3209	207	8	78	45	100
6	80	42	50	24	88	193	0	0	0	13
7	80	57	74	76	8	14	140	0	0	4
9	0	0	0	0	0	0	0	168	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	9

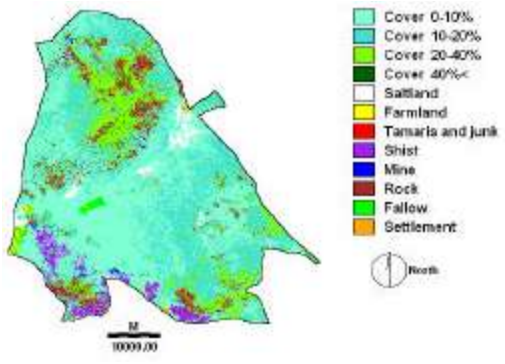

Fig. 3: Land use/cover map for 1998

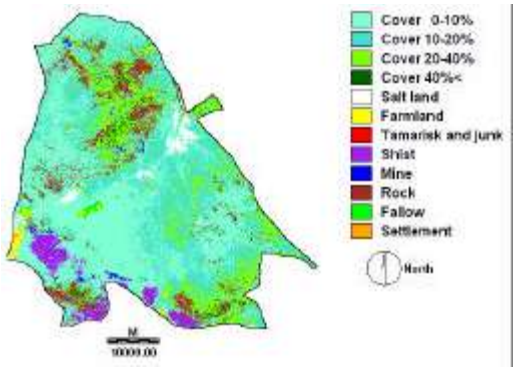

Fig. 4: Land use/cover map for 2005

shown changed area and unchanged areas in 13 classes. Table 4, showes extent changed area and un changed area.

Table 4, shows that between 1972-1987 highest changes were in class 2 (crown cover 10-20%) with 24 percent of study area, between 1987-1998 highest change were in class2 and 3 respectively with 37 and 24 percent. during 1998-2005 highest changes were occurred in class2 with 35 percent of total mouteh wildlife refuge area. In general during study period

(1972-2005) highest change has happened in class2 that 60 percent of this class has been changed, pixel by pixel nature of this change allows spatial distribution of land use/cover changes to be quantified.

A change detection matrix with 144 combinations of change information was derived for 1972-2005 that shows changes trend and their value. Surveying of matrix change in first period (1972-1987) showed that highest changes trend in class 2, was converted into 3 classes that its change mount was 39 percent of this class area in 1972. Either change matrix indicated major land use/cover changes trend in second period (1987-1998) was class 2 to class 1 and class3 to class2 vegetation crown cover with 67 percent and 47 percent respectively. Change matrix for 1998-2005 indicated that class 2 was converted to class 1 and 3. Major land use/land cover changes in this period were up to 27 percent and 21 percent these classes area in 1998 respectively. Also in this period 23 percent of class 1 had changed to class 2.

During study period (1972-2005) class 1 and 2 had maximum changes between all land use/cover classes. During this time class 1 had increased 257% while as class 2 had decreased 200% but in core area of refuge vegetation crown cover had increased that it is accrued because of good conservation in core zone. In study time, cover class 2 and 3 respectively had decreased to cover class 1 and 2. Mining area and fallow land were developed in cover class 1 and 2. Table 5, Shows change trend during study period.

CONCLUSION

Rapid artificial land use extending and the accompanying land use/cover changes have prompted concerns over the degradation of the environment and ecological health in mouteh wildlife refuge. The phenomenon of environmentally degraded informal settlements and mines seems to be a particularly crucial issue to mouteh's habitats and its wildlife.

The choice of the modified Anderson classification scheme is based on the major land use/cover classes throughout the study area and need to constitutes discriminate land use/cover classes using images with differences in spatial resolution, that is Landsat MSS, TM and LISS III [9-12].

The post-classification analysis of the dynamics of land use/cover changes using satellite data together with GIS indicates increased land use/cover changes due to rapid artificial land use growth in study area between 1972 and 2005. The analyses conducted have revealed that the artificial areas have expanded significantly leading to removal of natural vegetation. Artificial expansion was noted to be farmland, mine, Settlement and fallow leading to environmental degradation. This study has shown that lack of relevant spatial information, crucial for planning, may be alleviated with remote sensing data that can provide opportunities for periodical survey of land use/cover changes and their spatial distribution.

Spatial patterns of land use/cover over different time periods in particular can be systematically mapped, monitored and accurately assessed from satellite data accompanied with conventional ground data. In study period, during 1987-1998 maximum degradation have accrued. For explanation of this research's results, we should expect that change's area is n't best indicator for artificial land use impact on environmental degradation. Mine development is a major factor for habitat decrease, because more direct effects of this land use have indirect negative effects. Developing of roads, settlement and other urban development due to of mining are indirect effects of it. With survey of change matrixes we can find that suitable wildlife habitats are destroying and this is warning for extensive environmental degradation.

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