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Assessment of changes trend of land cover with use of remote sensing data in Hamoon wetland

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Abstract

Vegetation cover and measurement of its changes as a principle is required in the areas of natural resources for the better and more effective planning of programmers. Remote Sensing (RS) as a technique is an appropriate instrument for monitoring land use and vegetation cover. For the purpose of evaluating changes of detection and vegetation cover in Hamoon wetland as one of important wetlands in Iran, was used of satellite images from remote landsats TM of 1987, 1995, 2005 and also remote satellite LissIII of 2010. Simultaneous measurements of vegetation cover was conducted with field monitoring in the study area for verification in July 2010. The maps of land use and land cover was prepared by combined classification. Also for decreasing effects of soil reflectance was used from vegetation indices that get low impacts from soil reflectance. In this research significant correlation was observed between plant parameter and plant indexes of SAVI. This index had the most description sufficiency of vegetation cover percentage. By the mentioned index, the map of vegetation cover and land use percentage was supplied in the 5 classes also with use of GIS and RS techniques. Class 1, Vegetation cover less than 20%, class2 is 20-60%, class3 is >60%, also supplied watery layers and Saline soil layers. In order to detect changes, then the maps were combined and revealed that the amount of vegetation cover on the class 1 decreased from 1987-1995 and incresed from 1995 – 2005 and 2005- 2010. vegetation cover of Class 2 increased between 1987 -1995. It decreased from 1995- 2005 and 2005 – 2010. The vegetation cover of class 3 increased between 1987- 1995 and decreased in 2005 and increased in 2010 again. This range had fuluctuations. The reason of fluctuations in Hamoon wetland vegetation cover was changes in rainfall and water input into the Hirmand River.

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Introduction

Nowadays, knowledge acquisition about the health of vegetation and soils, plays an important role in their management. For the assessment and monitoring vegetation cover in the global and regional scale, access to field data is often difficult and limited. Remote sensing is a usefule technology in this field. It can provide a broad and integrated view of a region, and combine the observations for the results of the measurement of remote sensing may field maps the provide Product specification. Through measuring the ratio of the reflection spectra, a distinct and more specific vegetation and its changes over time is observed. Also vegetation indices can be used in global scales to quantify the annual net production and separate vegetation in zonal, continental and global scales. (Sanaei nejad et al, 2009). Satellite images have the feature such as timeliness, multi-spectral nature, replication, wide coverage and increased spectral and spatial resolution. Thus they can be used to study different stages of vegetation change (Zubairi, 2006).

Some studies were conducted to evaluate changes of vegetation cover with use of remote sensing data. Masoud et al (2006) used data from Landsat ETM + and TM for assessment of soil salinity in a desert area near the Mediterranean Sea. They examined changes of land cover for this purpose and prepared landuse maps. They used SAVI index to prepare vegetation cover map of desired desert region and reduce the effects of soil background. Yuan et al (2005) used satellite data of Landsat for classification of land cover and detection of changes in an urban area of Minnesota, United States in 7,700 square kilometers. They used the method of combined classification to classify the images. they stated that this method could show both of changed areas and the process of their changes. Kamusoko et al (2006) used MSS, TM and ETM + image to detec landuse, land cover and change of an area in Zimbabwe and chose a combined classification method. They compared between MSS false-color images with field sampling and performed processing of OIF[1] on the bands for preparation of false color composite (FCC), because they were going to investigate situation of the land surface in the images taken in the previous years and because of unavailability of field data from the area. Also, for the maximum variance between bands of blue, green and infrared color were used from color combination of RGB: 1, 2, 4. One of the main problems in vegetation changes is the lack of accurate georefrence information from the past. Although it is time consuming and difficult to access region, Satellite images and remote sensing technology makes it possible to process these images and be aware of the changes in vegetation easily. Produced information from this way help researchers to plan better vegetation management (Rahdari, 2010).

The aim of present study is to find the rapid acceptable method for assessment and classification of vegetation cover in Hamoon wetland. Satellite images and vegetation indices are used for this purpose.

Materials and mthods

Study area and sampling

This study was conducted in Hamoon wetland in the west of Zabol city, Iran. The region covers an area over 293,031 hectares in 30° 25' - 31° 27' latitude and 60° 56' - 61° 43' Longitude (Fig. 1).

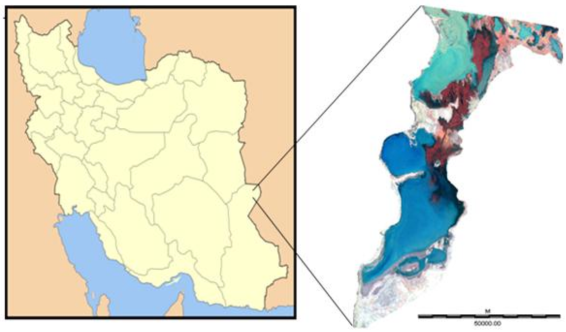

Fig. 1. Location of the study area.

Firstly, applied different methods of processing remote sensing data (RS) were prepared from different data layers. Then the layers combined in

[1] Optimum index factor

Geographic information system (GIS). This study was conducted with the data and information from satellite sensor images of TM landsat 5 in 1987, TM Landsat 5 in 1995, TM Landsat 5 in 2005 and the IRS LISS-III sensor image in 2010. Also topographic maps with 1:50000 scale, climate information, field monitoring, vegetation sampling, Idrisi Kilimanjaro, Idrisi32, ERDAS Imaging 8/6 and Excel software were used for this purpose. finally, it was determined 5 classes of land use and land cover for the region (table 1).

Table 1. Land cover and land use properties in region.

Code	Class name	Class features
1	Water	Regions with both deep and shallow water
2	Vegetation (20-60%)	Regions with rangeland and percentage of canopy vegetation cover between 20-60%
3	Vegetation cover >60%	Regions with rangeland and canopy vegetation cover more than 60%
4	Salt land	Lands with accumulation of Large amounts of soluble salts in the soil surface layer (these lands are mostly flat and they have very poor drainage and high ground water level)
5	Vegetation cover <20% (barelands)	Lands vegetation cover less than 20%

In order to demonstration of vegetation map due to the canopy cover, lower threshold of canopy cover of 20% was determinated. then, the location of areas with homogeneous canopy cover greater than 20% were determined by using GPS and prepared values of the parameters. In this study, vegetation cover classes according to the sampling was shown in three-classes canopy cover. These canopy cover included: <20%, 20-60% and > 60%. Thus, 10 vegetation indices for images of each year were prepared (Table 2).

Table 2. Prepared indices and models of vegetation cover for satellite images and measurements of description coefficient.

Vegetation index	Vegetation Model	description coefficient R^2
NDVI	Y = 392.7X + 64.66	0.77
SAVI	Y = 179.3X + 24.89	0.85
RVI	Y = -97.41X + 125.43	0.76
DVI	Y = 0.72X – 7.7	0.7
PVI 1	Y = 1.26X – 7	0.69
PVI 2	Y = 1.11X + 30.17	0.67
PVI 3	Y= 0.89X -14.46	0.63
PVI	Y = 1.26X + 7.02	0.7
TSAVI1	Y = 164.97 + 33	0.77
WDVI	Y = 0.44X + 400	0.49

According to field monitoring, the canopy cover value of 20 percent on image of 2010 is the boundary between land cover and bare land. Re-classification of images separated vegetation layer from the other parts. After preparation of vegetation map, vegetation layer was removed from satellite images. Water map were prepared through using normalized water index NDWI from satellite images (Fig. 2). Salt land layer were obtained through PCA processing of satellite images (Fig. 3). Comparison between False-color composite and components obtained from the PCA processing showed salt lands at the first component were separeted from bare land. And re-classification on the first component of this process, were separated and segregated salt lands of bare land. As each prepared layer was separated from the images, Only soil layer remained (Fig. 4).

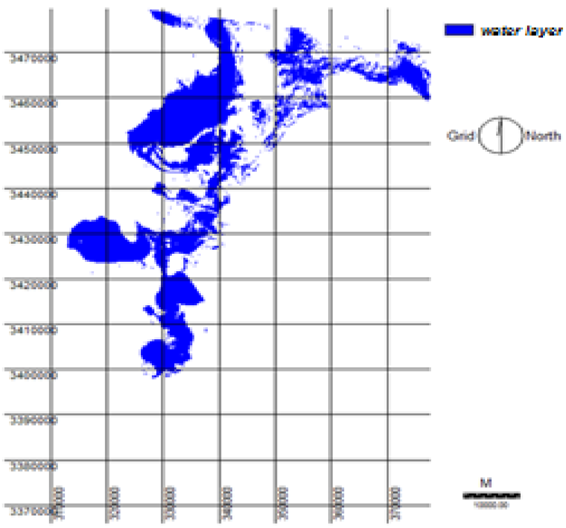

Fig. 2. prepareing Map of water with use of NDWI index.

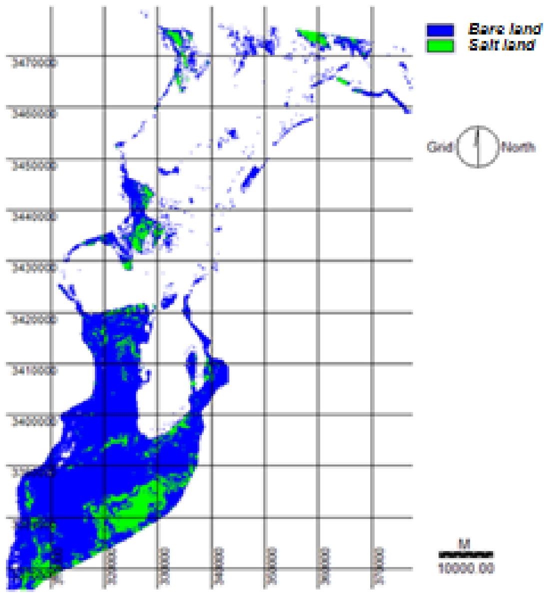

Fig. 3. prepareing map of salt lands with use of PCA analysis.

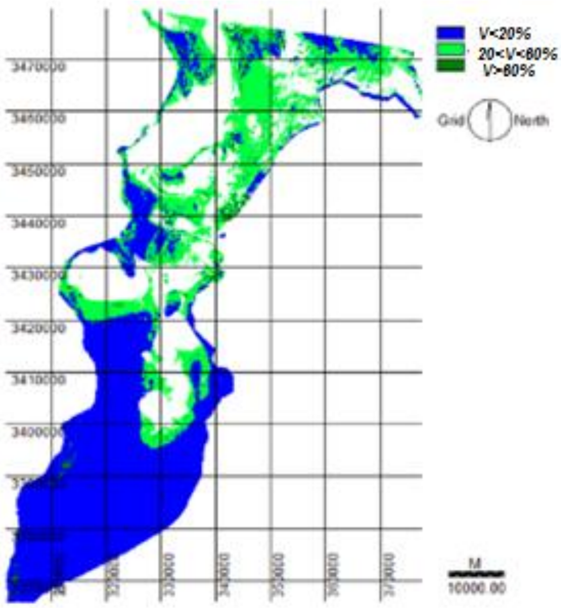

Fig. 4. preparing the soil map.

Finally, maps of land use by the method of hybrid classification in GIS was obtained for the years 1987, 1995, 2005 and 2010 respectively.

After the production of land use and land cover maps for different years, determination of the accuracy of produced maps by investigation of the accuracy of produced maps with the ground truth was performed. The year of 2010 was in the same time with taking sattelite images. So in mentioned year by field monitoring in more than 35 poly-gons, the properties of each region to the radius of 250 meters were sampled. These poly-gons were related to different land uses (except vegetation). The land uses were selected in the systematic random sampling using IDRISI software (Khajedin, S.J, 1995). Then geographic location of ground control points were re-registered using GPS for each land use. So 3 to 4 percent of the area of each land use and land cover were considered as ground control areas. It was to determine the accuracy of the produced maps (Arzani. H, 1998). To evaluate the accuracy of the prepared vegetation maps, selected 10 plots were selected in random choice from each class of vegetation. Characteristics of selected plots were compared with the map of the percentage of vegetation cover. For Preparation of control areas points for landuse and land cover map in 1987 and 1995 was used form false color composite and these year's maps in the scale of 1:50000. Also for all produced maps, overall accuracy, Kappa coefficient, the user precision, precision of manufacturer and Omision and Comision errors were calculated. Sampling was conducted in the plant types. To investigate correlation between satellite data and percentage of vegetation cover, Sampling was taken using plot sampling and measurement two major diameters of canopy. Therefore, at least 5 plots at a distance of 100 meters from each other were thrown each make correlation with satellite data. It was tried to take sample in the areas far from the phenomena such as roads and residential areas that affect the surrounding vegetation. Minimum distance of 200 meters was considered for this purpose. It helped to take sample in homogeneous region with percentage of vegetation cover. These actions were performed to make correlation with sensors. With considering these actions, the variance reached the minimum level of cover between plots. The method of minimum effective area showed plot dimensions 10 × 10. Fig. 5 shows the distribution of sampling points in the study area.

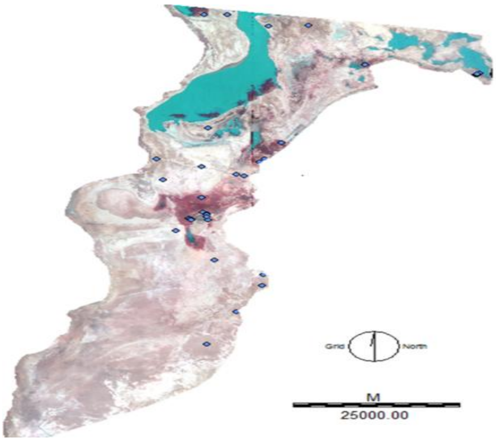

Fig. 5. Distribution of sampling points in the study area.

Results

Changes Map prepared between 1987 and 1995, 1995 and 2005, 2005 and 2010 and also in 1987 and 2010 includes 10 classes. Class 10 shows areas without any change. The other classes indicate changes in the map of land use and land cover. The following table shows the area of land use and land cover in the three classes of vegetation and two-classes of land use between 1987 to 2010 (Table 3).

Table 3. The area of land use and land cover between 1987 to 2010 (per Hectare).

Sensor / Class	Sensor-TM 1987	Sensor-TM 1995	Sensor-TM 2005	LISS III Sensor-2010
Water	27487	143321	85820	29539
Vegetation 20-60%	58031	17430	74616	40769
vegetation 60%>	7665	77918	4181	12379
Salt land	120386	39073	21650	34513
vegetation 20%> (bare land)	79461	15287	106763	175831

The results of this study indicated that the SAVI vegetation index has the highest description coefficient in the region. The most accurate map was produced by the components of SAVI. It was assumed that this index has the highest correlation coefficient for the other images. This coefficient was 0.85%. SAVI is an index that minimize differences of spectral reflectance of vegetation. Differences of spectral reflectance of vegetation is created by the effect of the different types of soil background. SAVI index Key of soil is shown in the equation as L.

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

L = 1-(2*a*NDVI*WDVI) = ((2*(NIR)^2-(RED)^2) +(1.5*NIR+0.5*RED))/(NIR+RED+0.5)

Soil coefficient is used for minimizing difference of reflectance created by soil background and difference in density of vegetation. L values is between 1 for bare soil and 0 for cover 100%. In the most studies in Iran, this value is 0.5. The creation of correlation between the amounts of vegetation cover and SAVI index was calculated scientifically. Also the amount of vegetation cover in protected areas that have had less changes due to vegetation protection and some regions that have had weak coverage (according to the saying native people) was determined scientifically. The canopy cover was estimated in more than 100 points according to visual interpretation of false color composite obtained for each image and land samples of vegetation in 2005. Prepared models using SAVI index and description coefficients are shown in table 4. Percent map of vegetation cover was prepared using produced models for the images of 1987, 1995, 2005 and 2010. Figs. 6 to 9 show percentage of vegetation cover maps for the years 1987, 1995, 2005 and 2010 respectively. Table 5 shows map precision of landuse and land cover using satellite LISS III and the amount of its coefficients. Also figs. 10 to 13 shows the changes maps of land cover and land during mentioned years.

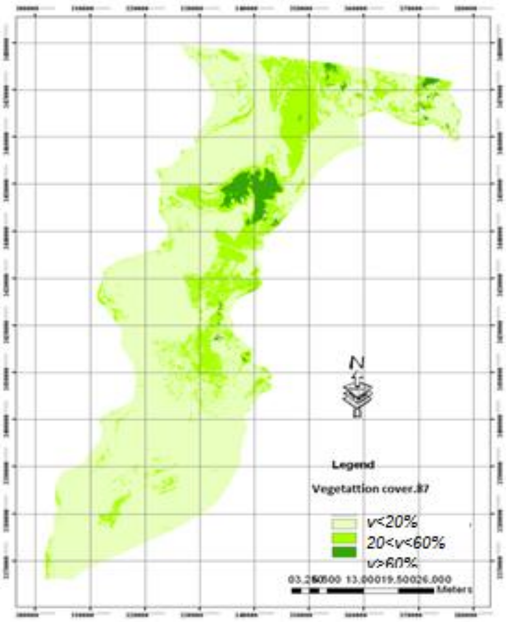

Fig. 6. percent map of vegetation cover using Landsat TM 1987.

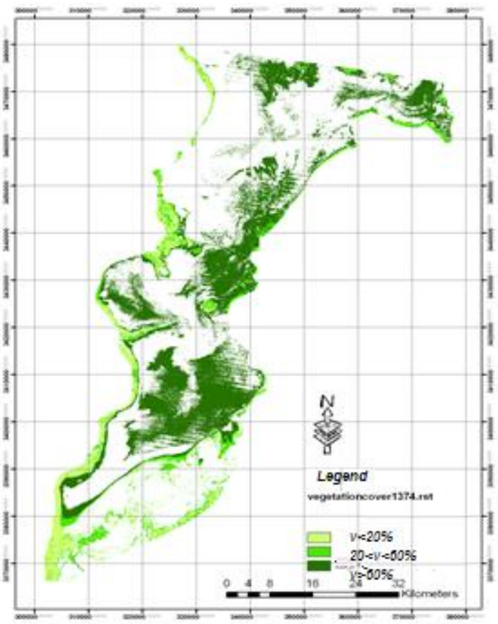

Fig. 7. percent map of vegetation cover using Landsat TM in 1995.

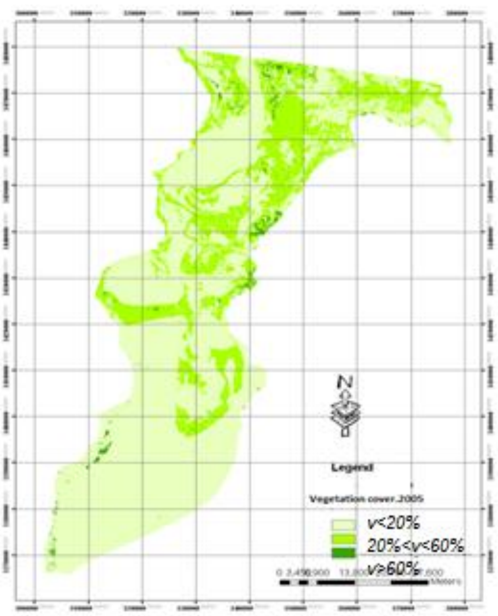

Fig. 8. percent map of vegetation cover using Landsat TM 2005.

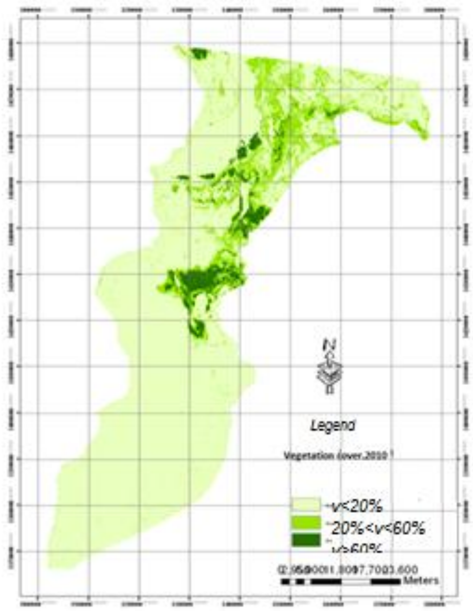

Fig. 9. percent map of vegetation cover using Landsat IRS 2010.

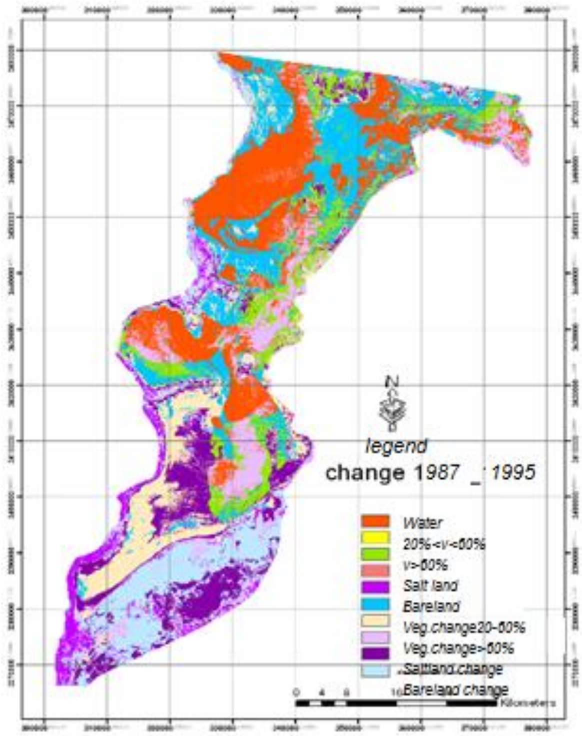

Fig. 10. changes map of land use and land cover between 1987-1995.

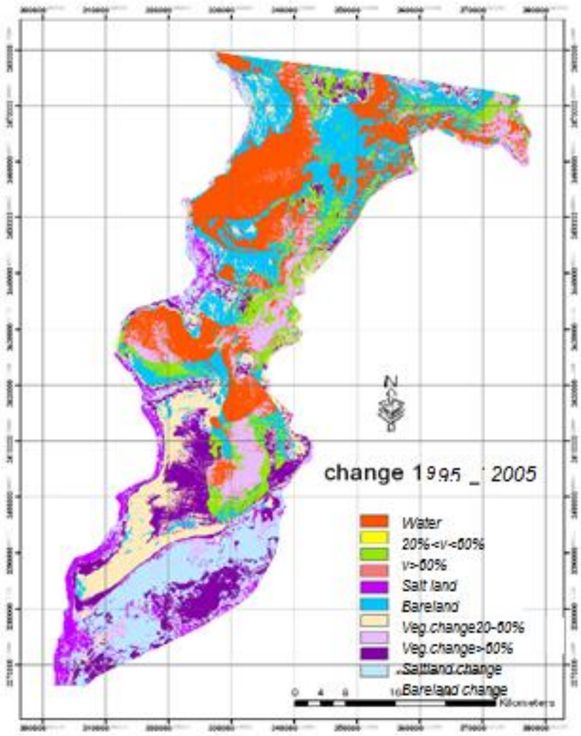

Fig. 11. changes map of land use and land cover between 1995-2005.

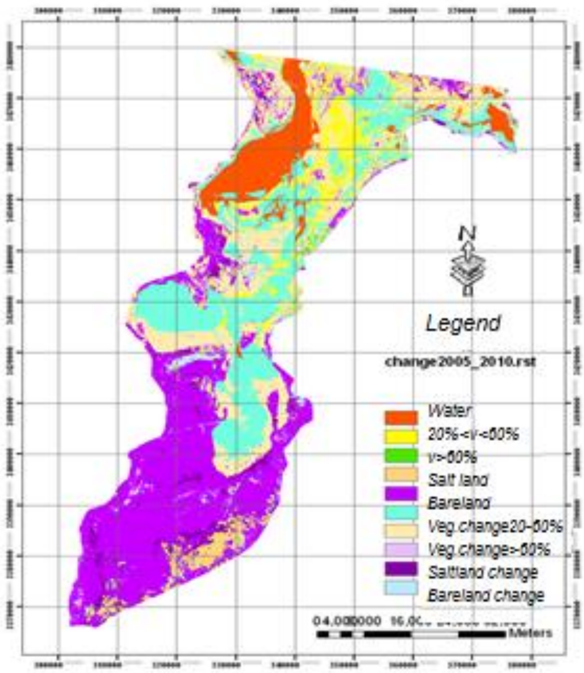

Fig. 12. changes map of land use and land cover between 2005-2010.

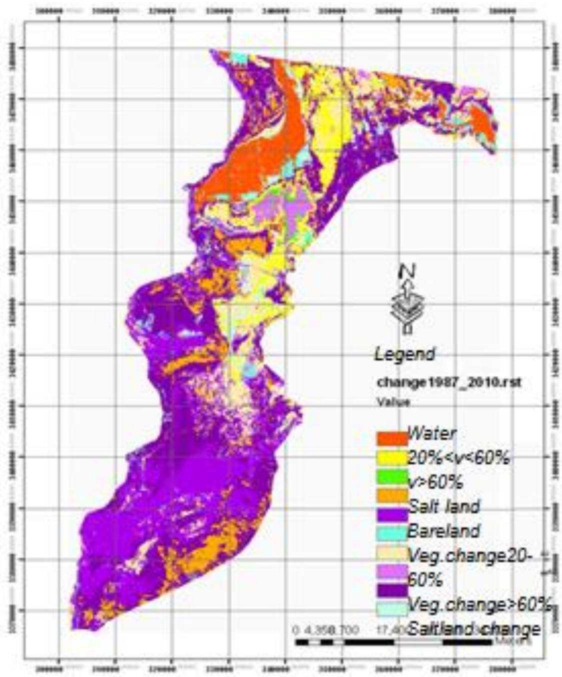

Fig. 13. changes map of land use and land cover between 1987-2010.

Following figure shows changes of the bare land with vegetation cover from 0 to 20% (Fig. 14). During study period, the trend has been ascending. Bare land was 79.458 hectares in 1987. This amount decreased to 15.287 hectares and the trend has been in sharp descending in 1995.

Table 4. Models Selected from Regression Analysis for preparing canopy vegetation map.

Index SAVI	Equation	Description Coefficient R^2
TM – 2005	Y= 2 40.95x + 16.13	0.73
TM – 1995	Y= 333.46x+25	0.89
MSS – 1987	Y = 285.79x + 27	0.85

Trend of changes in vegetation cover of class 2 (20-60%) has been shown in fig. 15. In this period, the surface of vegetation cover in class of 20-60% has been 58,030 hectares in 1987. Although this area is higher than plant canopy area in 2010, it is in a dry period and the vegetation had low-density. There has been an increase in canopy cover from 1987 to 1995. Increase in canopy cover has reached its highest amount in 1995. It is 143.321 hectares. Then the area has been reduced until 2005.

The change trend of class 3 with canopy cover above 60% had been shown in fig. 16. It shows a trend of descending- ascending. Amount of this canopy cover has been 7664 hectares in 1987. This trend shows a sharp increase until 1995 and reaches to 77.918 hectares in this year. This vegetation cover shows a positive trend.

Fig. 17 shows changes trend of moisture and water amount in the region during this study. Thus the changes trend has been descending from 1987 toward 1995. Rainfall and input of water amount increased to this area and canopy cover had an ascent from 27.520 hectares in 1987 to 143.321 hectares in 1995. The main reason for the ascent has been rainfall and flow of much water from rivers especially Hirmand river to the wetland in 1995. water input of Hirmand river to the wet has been several times during this period. But there is a decline in watery areas again. It is due to drought and lack of rainfall during 1995 to 2005. Consequently, water input of Hirmand river was decreased to the region and canopy cover descended 85.817 hectares. In the process, again reducing the amount of water and has declined land watery in the region. So amount of water and watery lands reached 29.536 ha in 2010. the reasons outlined in this situation in 2010, and a decrease in rainfall patterns.

Fig. 18 shows the changes in salt lands during the period of study. According these diagrams the salt lands in 1987 have been in the highest level during the period of study. It was 120,384 hectares. That reason is low rainfall in this year. Also drought and heat of the sun causes salts to come upward to the land surface by capillary property. These salt lands have formed the most regions in this area. this trend reduced to 21.648 hectares toward 1995. Its reason is the high rainfall during this period and especially in mentioned year. the amount of salt lands decreases to the lowest level in 2005 again and reaches to 21,648 hectares. Also this decrease is due to the increase in rainfall in the region. This trend has a low increase and reaches 34,511 hectares until 2010. Low increase is due to the decrease in rainfall and input of water to the area and also change in land use of pasture to agricultural lands and leaving these lands after land use changes. So the lands converts to salt lands.

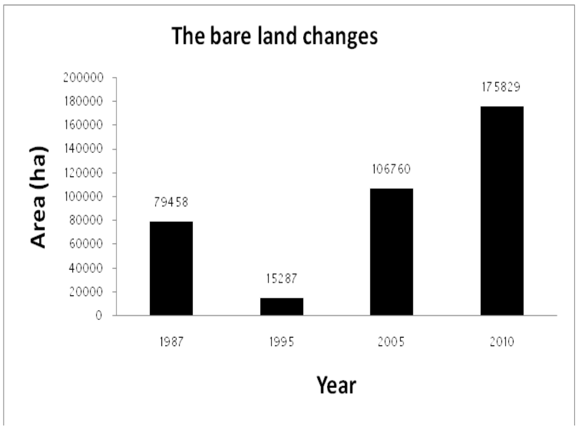

Fig. 14. the change trend of bare lands in 1987 to 2010.

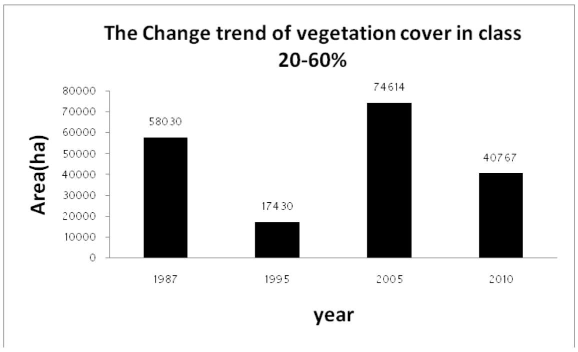

Fig. 15. the change trend of vegetation cover 20-60% in 1987 to 2010.

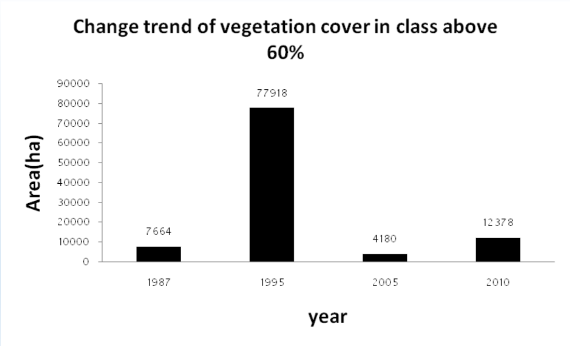

Fig. 16. the change trend of vegetation cover above 60% in 1987 to 2010.

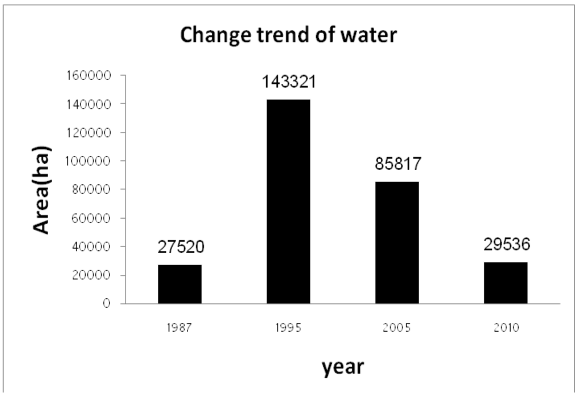

Fig. 17. changes trend of water in 1987 to 2010.

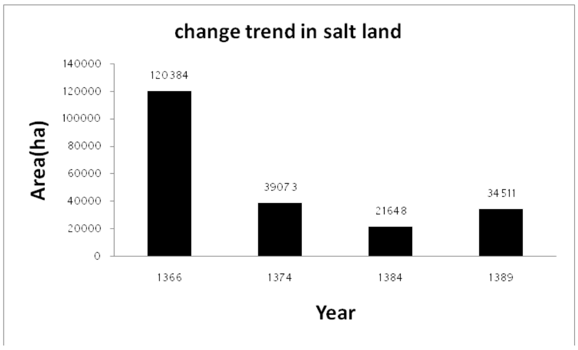

Fig. 18. the change trend in salt land in 1987 to 2010.

Discussion

Changes trend of vegetation cover of class 1(the bare lands) with canopy cover of 0-20% is due to heavy rainfall and input of rivers' water to the region in 2005. Bare lands have increased to 106,760 hectares in 2005. 175,829 hectares was the highest level of bare lands during the period of study and it occured in 2010. Created bare lands with vegetation cover less than 20% are due to change of land use and incorrect use of pastures and their change to agricultural lands. Also decreasing of rainfall is very effective in this trend.

Increasing the vegetation cover of class 2 in 1995 is due to increasing heavy rainfall during this period. Also Hirmand River has had a good deal of water in this period. Farmers have had irrigated and rain-fed agriculture during this period. It is one of reasons that the level of vegetation cover increases. Also Tamarix and Phragmites have grown up until 2005. Densities of annual grasses and Poaceae and *Aeluropus lagopoides* lands around Khaje Mountain was very high in this year. Vegetation cover has had descending trend and its area decreased during 1995 to 2005. Even the area reached to 86,817 hectares in 2005. The reason was drought and low amount of rivers water and falling groundwaters . The trend showed more reduction to 29,536 hectares in 2010.

Changes in the class 3 with the vegetation cover above 60% shows a descending - ascending trend. Amount of vegetation cover have been 7664 hectares in 1987. This trend increases toward 1995 and amount of vegetation cover reaches to 77,918 hectares in this year. This increases in percentage of vegetation cover in 1995 is due to high rainfall in this year and increase in amount of water input of the region. The trend decreases between 1995 to 2005. Amount of vegetation cover reaches to the lowest amount during these three periods of study in 2005. Although rainfall is high, density of vegetation cover is not enough. So vegetation cover does not achieve to density of 60%. There is low density of vegetation cover in 2005. Only there are afew points with dense vegetation cover around villages and Qrqory region . The trend reaches to 12,378 hectares in 2010.

Field monitoring in 2010 showed that *Aeluropus* lands with density above 80% were located around Khaje Mountain and surrounding villages. These lands were 12,378 hectares. The range trend is positive and ascending during this period.

The assessment of changes trend in vegetation cover using satellite images between 1987 to 2010 showed fluctuation of changes. The reason of fluctuations in the percentage of vegetation cover was water input from Hirmand River in different years. Also the amount of rainfall varied during these years and it had significant effect on the vegetation in the region.

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