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Change Detection of Daghesorkh Playa Using Multi Temporal Datasets (Isfahan Province, Iran)

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ABSTRACT

Remote sensing technology is the key to identify changes of geomorphic units. Mapping and Detection of Changes is one of the main elements of projects related to land use. Daghesorkh playa in Isfahan provonce of Iran is study region. In this paper changes of geomorphic units within the study area will be detected in period of 27 years. To achieve the goals of this research sattelite images of TM (Sep., 1986), ETM+ (August 2000) and OLI (Sep., 2013) sensors, topographic and geological maps were used.
The three multi-temporal images were geometrically and radiometrically calibrated to each other and then the best false color composite (FCC) was prepared .(RGB: 742 ,741 for ETM, TM images and RGB: 752 for OLI image). Geomorphic maps were prepared based on supervised Classification. The overall accuracy of the map resulted from TM image was equal to 92.14 percent. this value for the map resulted from ETM & OLI is respectively equal to 89 and 91.10 percent.
Based on obtained results study area's geomorphic units consist of salt flats, clay flats, fans, clay coating and sand dones. For change detection of study area's geomorphic units post- classification comparison was used. Investigation of the trend of changes indicates during 27 years (1986-2013). In this period fans, salt flat and sand dunes have spread, while rest of the units reduced due to climate and land use changes.
KEYWORDS: *Change Detection, post- classification comparison, Daghesorkh, Multi temporal, Landsat8.*

1- INTRODUCTION

The change detection is a process which allows observing and recognizing the differences and disparities in time series old phenomena and events and patterns of the earth surface. This method is one of the most frequent and most important applications of satellite images in management and evaluation of natural resources, thus it is possible to prepare the map of control change obtained from the process of change detection according to the multi temporal images. Considering the importance of geomorphic maps in providing and implementing designs related to the determination of territorial capability, this process can be used for discovering geomorphic units and studying their trend of changes in different time spans. Various techniques are used for change detection.

The post-classification comparison is the most common used method for change detection which lacks the difficulties related to the radiometric and atmospheric correction, but since the generated pixel-to- pixel maps are compared together in this method, doing precise geometrical correction has particular significance. Considering

the significance of change detection in recognizing the units and geomorphic facies [9].

The present paper includes seven sections. The review of literature of change detection is presented in section two. Section three introduces study area. Materials and methods are presented in section four. In section five results become. Discussion and conclusion are discussed in section six and seven.

2 .REVIEW OF LITERATURE

A lot of research has been carried out in geomorpholoy and change detection. some of them are mentioned here. Fan and colleagues [5] conducted change detection of land cover and for five sities in Kung Japan district. They prepared land use map for studying district by using TM, ETM+ images in 1998 and 2003 by using the post-classification comparison method for showing rate ,type and pattern of changes. In Iran, Falahatkar and Safianian studied [4] the trend of Isfahan'land cover changes during four decades (1955-1972). In this study post classification comparison method was been used. Changes in coastline of Orumiyeh Lake of Iran by using remote sensing and method of taking spectral ratio through bands between

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years 1998- 2001 was studied by Ale sheikh et all [2]. Rezai Moghadam and Sadeghi [8] investigated the changes in salt and gypsum flats of kahak playa in southern khorasan province (in Iran) by using classification methods with the method of maximum probability and phase classification and also studied changes of salt flat in this playa. Kook and Diagle [11] discussed the effects of managerial strategies to reconstruct vegetation cover in Kudilak heights by multi-temporal images belonging to the years 1979-2001 and 2007 and detected changes in the vegetation cover of the mentioned time span.

The study region is Daghesorkh playa in Iran. This area has been studied by researchers with various topics as one of Iran's desert basins. Amongst the foreign researchers Klinsley [6] can be refered to in his studied , he has studied Iran's playa in issues regarding vegetation cover situation, animal species, topography, geology, water resources and so on.

The purpose of this research is the separation of Daghesorkh playa's geomorphic units and studying the trend of changes in present units by means of multi-temporal satellite images. To reach this goal, by using RS technology, the study region's geomorphic map has been prepared by doing supervised classification on the satellite images related to three different time spans and then the change of units in the respective time span was assessed by using the method of post-classification comparison.

3. Study area

Study area is Daghesorkh playa in Iran. The area covers 639 square kilometers in Iran. This playa is composed of the salt flats, clay flats, sand dunes, alluvial plains around it and the alluvial fans on the plain edges and the mountain sides. This basin is located in Iran central Zone. This area is situated in the geographical position of 52˚34´ to 53˚31´ eastern longitude 32˚56´ to 34˚01´ northern latitude. The position of study region has been shown in figure 1.(*Fig.1*)

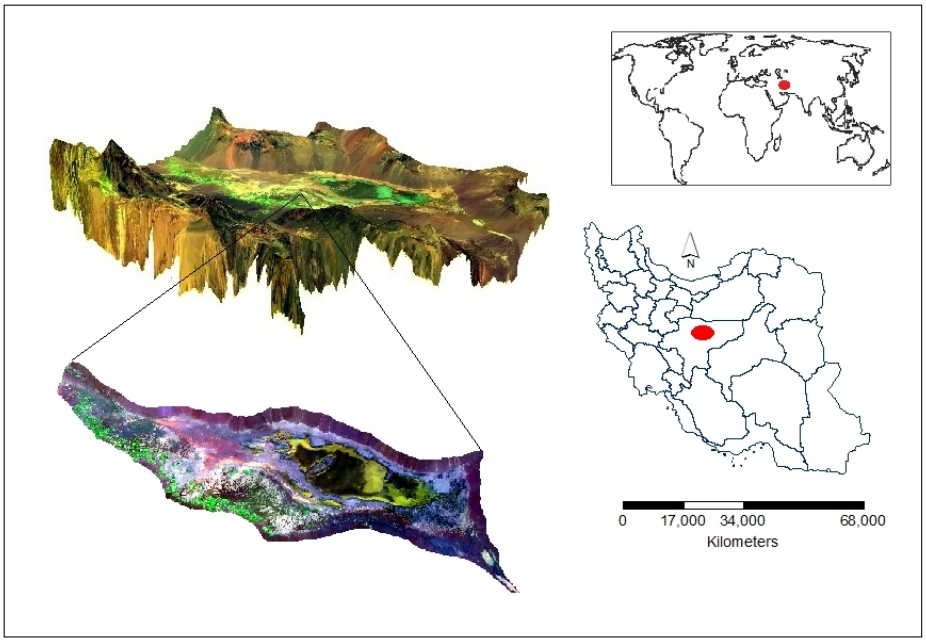


Figure 1: *Geographical location of the study area*

Studies conducted on Iran deserts shows that three geomorphic units; mountain, piedmont and playa are recognizable in Iran's deserts. [1]. There are almost 60 playas with different geological structures in Iran. Most of these regions have an average altitude between 600 to 800 meters. [7]. Daghesorkh basin also accounts as a part of dry regions area in Iran and in this way it has three main units of mountain, piedmont and playa. Types and geomorphic facies with smaller scales are observed on the surface of these units. Figure 2 shows the geomorphic units of the study region. (*Fig.2*)

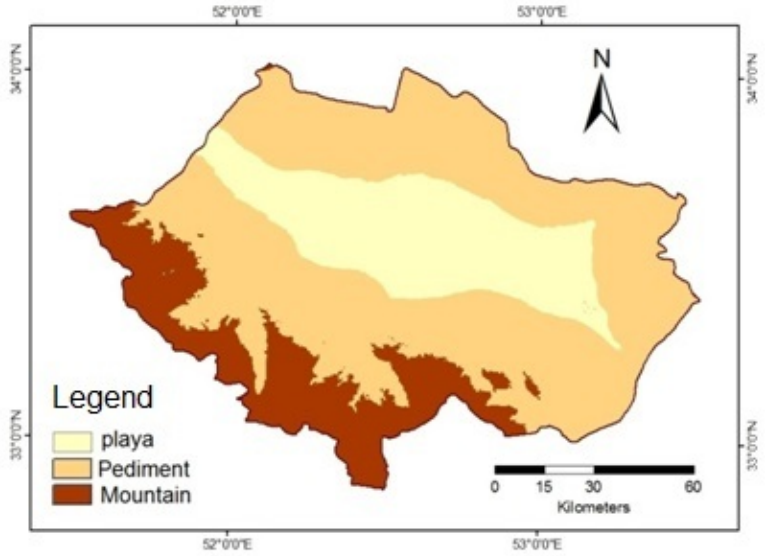


Figure 2:*Geomorphic units of the study region*

In this research facies of units of playa were classified and their changes were detected

4. MATERIALS AND METHODS

- Our satellite imagery consist of tow full Landsat TM sensor scenes recorded, two Landsat ETM sensor and two scenes of Landsat 8).
- Topographic map 1:50000
- Geological map 1:250000

The main purpose in this research is to detect the generated changes in the study region's geomorphic units by using satellite images (OLI of landsat8, TM, ETM+). To reach this purpose, following steps have been done. (*fig5*)

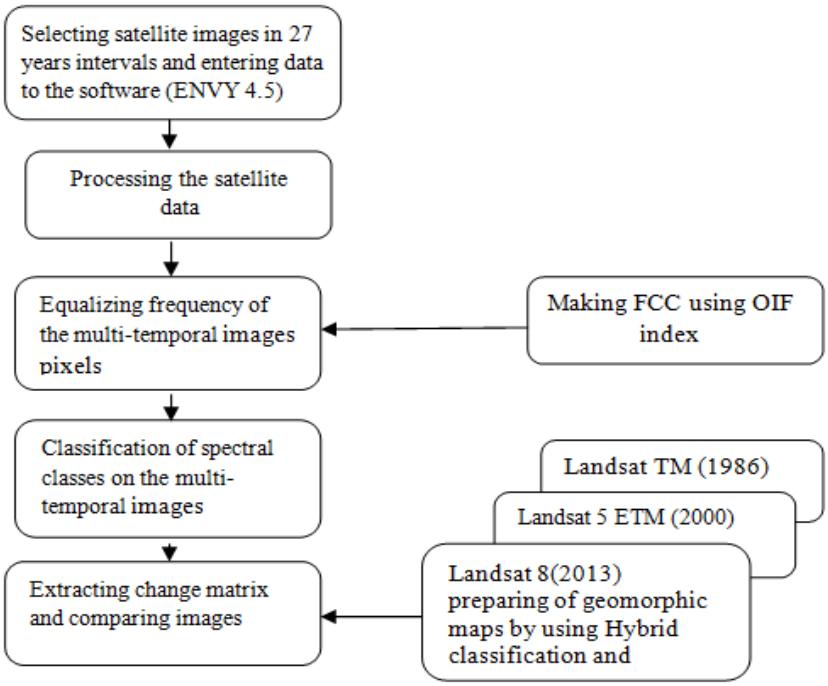


Figure3: *Flow chart for the applied methods*

5. RESULTS

The achieved findings in this research are the result of applying the satellite data preparation steps and the evaluating changes in the study region' geomorphic units, there for the entire mentioned steps or stages and the obtained results are explained in the shape of maps, tables and pictures.

Data preparation

The most important stages for doing the process of change detection is choosing the used data properly in the respective time span. Choosing data is important from different aspects such as the time of taking image, quality, scale and the similar conditions.[3]. Thus effort has been made to use the similar data in the above cases as much as possible. The satellite images used in this research belong to Landsat satellite with the following specifications: (*Table 1*).

Table 1: *Description of remote sensing dataset*

Data set	Scenes ID	Spatial resolution	Acquisition date	Used bands
Landsat TM	163-37	30	September 1986	1,2,3,4,5,7
Landsat7 ETM+	163-37	28.5	September 2000	1,2,3,4,5,7
Landsat8 OLI	163-37	28.5	August 2013	1,2,3,4,5,7

Non- coincidence of taken data can lead into change due to the difference in different seasons of year and not the changes resulted from human activities and climate conditions [10].

The difference in season due to the sunshine angle causes change in shade creating and taking different information from the satellite images. Considering the non concurrence of used images in this research. It has been tried to equalize frequency of images pixels. For doing so the numerical value of events obtained in the evaluated images. The similarity in the sensor and number of information band is also one of the factors determining work quality in order to reconstruct changes. The dissimilarity in the number of bands of old image (TM) with images obtained from ETM and OLI sensor causes quality reduction in this image compared to the new image and this problem can play an important role in the reconstruction of changes. In view of the bands difference in these three images, the accordance of each information bands is checked.

Inserting data

In this stage six reflexive bands of TM , ETM+ Sensor of landsat7and OLI Sensor of landsat8 image were recalled in ENVI 4.5 software environment, Then all the bands of each image were gathered in a layer and saved with ENVI format.

Geometric and radiometric correction

The format for satellite image data is level-1G ETM+, so there were no need for radiometric correction but it is necessary to make geometric correction on the other three images in order to overlap with OLI image. In order to do so, first TM satellite image scenes was automatically lied under geometric correction with OLI image of the region by using 1st degree polynomial equation by the method of nearest neighbor with 15 control spots in 0.0001 error percent, then TM satellite image scenes and one OLI image scenes in accordance with the topographic map and water way layer.

Image Processing

In order reconstruct the satellite image of the study region in this research the method of linear stretch was used. False color composites (FCC) were made to make the best composite. Basically the best combination of FCC for displaying facies is the RGB: 741, 742 of TM & ETM images and RGB: 752 from OLI image. In this stage, before making false color composite, some studies were used through OIF Index for producing images of better quality.

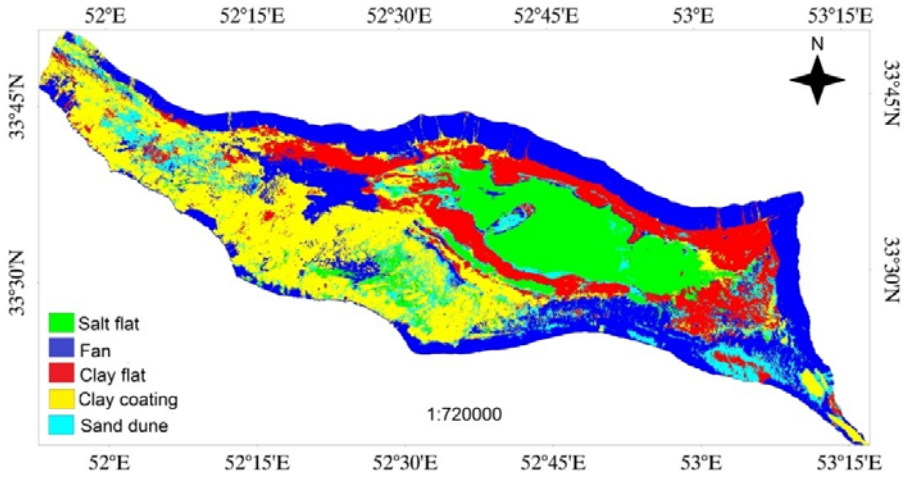
Data analysis

Data analysis in this research includes determining the degree of changes of images by using the post-classification comparison method. The post-classification comparison method is the simplest technique for the analysis of changes based on classification. In this method each image of multi-spectral images is classified separately and then the generated images are compared. If the same pixels in the old and new three images are laid under one category, no change has been made in the image but by inserting equal pixels of one category in the other category, change has been made in the new class [10]. For making use of post-classification comparison method, First it is necessary to make one supervised classification, then compare them together. Below the procedures to do so are being explained.

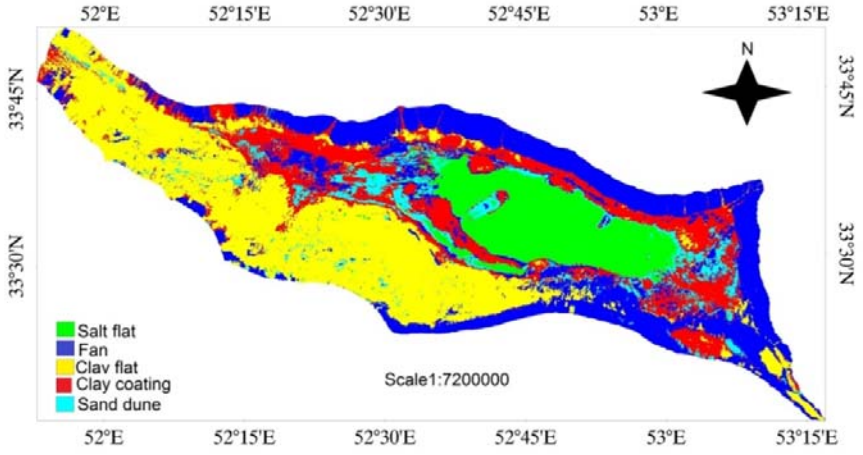
Preparing geomorphic maps

For preparing the facies map the supervised classification method was used. In this stage five spectral classes including 5 geomprphic facies (Salt flats, clay coating, Fans, Clay flat and Sand dunes) was

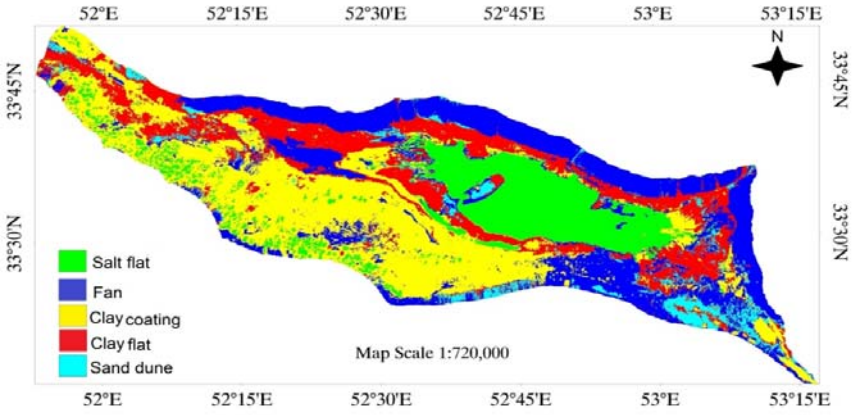
classified. We separated by using topographic map, geological map, and Google Earth satellite image on the ETM+ (2000), TM (1986) and OLI landsat 8 (2013) of the study region. Below The map of the study region units extracted from three images is given (*Fig 4*). It is necessary to explain that due to non-coincidence the equalization of the pixels of multi- temporal images was made before classifying images. The image obtained from this change was utilized for classification.



TM image



ETM image



OLI image

Figure3: *Geomorphic map's study region in time span of 27 years (1986-2002)*

Determining the precision of maps

After producing maps of units and facies , the kappa coefficient and overall accuracy, additional error and deletion error for the produced maps were calculated. The extent of overall accuracy for the map resulted from TM image was equal to 92.14 percent and this value for the map resulted from ETM & OLI is respectively equal to 89 and 91.10 percent (*Table2,3,4*).

Table 2*. Error matrix of geomorphic map, TM image, 1986*

Geomorphic units	salt flat	Fan	Clay coating	Clay flat	Sand dune	Total
salt flat	97.51	0	3.97	0.12	0	30.54
Fan	1.01	98.67	0.68	1.45	0.13	23.23
Clay coating	0.06	0.64	79.49	4.4	0	16.48
Clay flat	0	0.01	13.94	89.53	2.84	27.36
Sand dunes	1.42	0.68	1.92	4.5	97.03	2.4
Total	100	100	100	100	100	100

Overall accuracy: 92.14 Kappa coefficient: 89.49

Table 3. *Error matrix of geomorphic map, ETM image, 2000*

Geomorphic units	salt flat	Fan	Clay coating	Clay flat	Sand dune	Total
salt flat	100	0	0	0.24	0	0
Fan	0	89.99	0.1	9.49	0.13	32.56
Clay coating	0	1.14	88.34	6.93	0	0
Clay flat	0	8.39	11.42	77.99	2.84	0.13
Sand dunes	0	0.48	0.14	5.35	97.03	67.31
Total	100	100	100	100	100	100

Overall accuracy: 89.37 Kappa coefficient: 85.7

Table 4. *Error matrix of geomorphic map, OLI image, 2013*

Geomorphic units	salt flat	Fan	Clay coating	Clay flat	Sand dune	Total
salt flat	100	0	0.04	0	0	30.52
Fan	0	91.34	1.4	2.94	0	21.8
Clay coating	0	0.42	84.83	8.39	0	18.52
Clay flat	0	1.1	13.69	85.32	0	26.39
Sand dunes	0	7.14	0.03	3.35	100	2.76
Total	100	100	100	100	100	100

Overall accuracy: 91.10 Kappa coefficient: 88

Table 5: *Accuracy assessment of resulted geomorphic maps based on supervised classification method*

Geomorphic unit	ETM image		TM image		OLI image	
	Producer's accuracy	User's accuracy	Producer's accuracy	User's accuracy	Producer's accuracy	User's accuracy
Salt flat	100	99.78	97.51	97.42	100	99.97
Fan	89.99	88.29	98.67	96.39	91.34	95.06
Clay coating	88.34	88.55	79.49	91.63	84.83	86.99
Clay flat	77.99	84.08	89.53	90.29	85.32	89.2
Sand dunes	67.31	8.14	97.03	8.59	100	7.68
Total	100	99.78	97.51	97.42	100	99.97

In the table above (*Table 5*) the extent of precision in separating spectral classes in the produced maps has also been obtained based on multi- temporal images. According to the obtained tables the maximum precision relates to ETM and OLI images. The lower radiometric and spectral separation power this image is related to TM image compared with the region's ETM+& OLI image. This factor can have a part on decreasing image quality in displaying the facies and consequently on the classification.

Change detection

After making sure of the generated maps, action was taken to evaluate changes. In this stage after classifying the spectral classes of ETM+, TM, OLI satellite images, the map of first-time facies (1986) were compared with second-time ones (2000) and the second-time ones with third-time (2013). The results obtained from applying this method are tables which show the degree of changes in the area of spectral. The obtained results are given in the table 6 and 7.

Table 6 indicates the units change in the time period since 1987 to 2000 . According to this table, in new image clay flats, salt flats have increased than the old time image and salt flats, fans ,sand dunes and clay coating area has decreased.

Table 7 indicates the units change in the second-time period since 2000 to 2013 with comparing three ETM and OLI images.

Table 6: *Change of spectral pixels of study area's image during 1986-2000*

		Old image(1986)						
New image (2000)	**Geomorphic units**	**Salt flat**	**Fan**	**Clay coating**	**Clay flat**	**Sand dune**	**Total row**	**Total class**
	Salt flat	388.7	7.32	11.07	6.11	17.48	430.76	430.76
	Fan	11.16	686.0	18.62	85.27	59.86	861.03	861.03
	Clay coating	46.03	114.1	712.39	67.26	145.38	1085.29	1085.29
	Clay flat	6.57	104.1	106.24	334.52	47.27	598.8	598.8
	Sand dunes	22.18	47.56	48.25	54.36	43.09	215.44	215.44
	Total class	474.7	959.5	896.61	547.53	313	0	0
	Difference ofimage	-43.95	-98.54	188.68	51.26	-97.66	0	0

Table 7: *Change of spectral pixels of study area's image during 2000-2013*

		Old image(2000)						
New image (2013)	**Geomorphic units**	**Salt flat**	**Fan**	**Claycoating**	**Clay flat**	**Sand dune**	**Total row**	**Total class**
	Salt flat	409.71	2.23	82.34	5.18	25.7	525.16	525.16
	Fan	12.05	626.23	42.59	73.96	47.76	802.64	802.64
	Clay coating	7.34	42.71	803.52	125.96	84.58	1064.3	1064.3
	Clay flat	0.59	98.52	145.52	346.39	37.94	629.02	629.02
	Sand dunes	1.06	90.85	11.3	47.24	19.45	169.92	169.92
	Total class	430.76	861.04	1085.34	598.8	215.44	0	0
	Difference ofimage	94.4	-58.4	-21.03	30.2	-45.53	0	0

In accordance to figure 5 at this time span, salt flats, clay flats has increased in area and class related to the sand dunes. clay coating and fans has decreased in area. In the table approximate area of each facies separated from old and new image has been calculated in the study region. In figure 5 graphs show the trend changes of area's facies in time span years too.(1968-2000).(*Fig 5*)

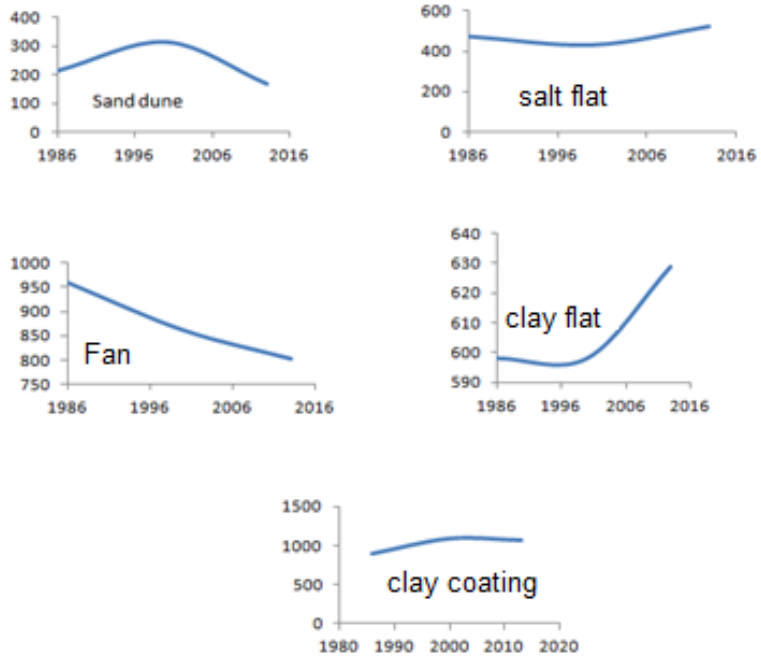


Figure5. *The trend changes of area's facies in time span of 27 years (1986-2013)*

6- DISCUSSION

The main purpose of this article is classification and detection of red playa geomorphic changes in the period of 27 years. To achieve this, datas from Landsat 7, 8 were used. geometric correction is one of the

most important steps of image processing before classification of images.In this stage ETM and TM images corrected by oli image with 0.0001 RMSE..

False color composites (FCC) were made to make the best composite. Basically the best combination of FCC for displaying facies is the RGB: 741, 742 of TM & ETM images and RGB: 752 from OLI image. In this stage, before making false color composite, some studies were used through OIF Index for producing images of better quality.

After making of fcc images was classified by supervised classification method. The extent of overall accuracy for the map resulted from TM image was equal to 92.14 percent and this value for the map resulted from ETM & OLI is respectively equal to 89 and 91.10.

Changes in the study area were evaluated in the two time periods (1987-2000 and 2000-2013). Changes was evaluated by comparing of tables. In accordance with the tables obtained geomorphic units of study area have changed. salt flat, coating clay, clay flat have been increased and sand dunes and fan have been reduced in the mentioned period. Recent droughts and reduction of river discharge that flowing playas are reasons of these changes. Climate changes and increased evaporation causes a large part of playa converted to salt and clay flats. Clay flat convert to bloated lands by increased evaporation. Due to the inability of old image for classification of facies in clay flats some of these changes are effect of the low quality of old images. When the wind blows a lot of sand covered other facies so much of them entered the other spectral classes.

Some of differences in the area of spectral class pixels observed related to some of the units is because similar spectral classes pixels has inserted in the respective class and might and display the class real area increment. On the other hand the difference or disparity originated from the difference in sensor type, time of imaging on day, month, season and climate conditions in both images causes difference of pixels related to some spectral classes in the new time image than the old time one.

7- CONCLUSION

The results obtained in this research show that remote sensing technology is valuable key for separation of geomorphic facies and change detection of them in different time periods. Scientists detected changes of landcovers by remote sensing but no study has been done in the field of geomorphology so we need to detect changes of geomorphic units and facies by this technique. Digital and software methods are important in study of geomorphic units but have errors there for the use of visual method is recommended.

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