Investigation Of Vegetation Cover And Its Distribution Around Salt Lake Of Sirjan And Changes In Vegetation On Agricultural Lands

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Abstract

Using the characteristics of satellite data, monitoring, evaluating, and controlling actions that affect the environment in some way can be achieved and even predicted quickly and accurately. This study aimed to investigate the vegetation cover and its distribution around the Salt Lake of Sirjan and changes in vegetation on agricultural lands. The salt pan of Sirjan (salt pan of Khairabad) with an average height of 1688 meters above sea level in geographical position between 29°10'N to 29°41'N and 55°20'E to 55°31'E is located in the west of the Sirjan city. In this study, using remote sensing data, as well as using the NDVI plant index on two series of satellite data of 2002, 2008, and 2013, the type and amount of vegetation were studied and their changes and expansion. The research technique was to use correlational and comparative methods. This study sought to examine changes in vegetation for over 15 years. In this regard, ASTER satellite images were examined over 15 years at intervals of 5 years. The results showed that the density of vegetation and its distribution around the salt lake is changing, and there was no relationship between changes in agricultural lands and changes in the level of Salt Lake of Sirjan.

Keywords; Vegetation, Salt Lake of Sirjan, Agricultural lands.

Introduction

The Iranian plateau is located on the arid belt of the Northern Hemisphere, with about 60% in the arid climate and 35% in the semi-arid region. Low rainfall in the Central Plateau (less than 100 mm), poor distribution, extreme temperature fluctuations that reach more than 50 degrees in summer, lack of relative humidity (average in the Central Plateau less than 20 to 30%), rapid winds, and very high evaporations and several times the amount of precipitation are all factors that create difficult conditions for plants to grow. If the problems caused by the salinity and alkalinity of the soil are added to them, the specific biological system of these areas will be clarified.

Iran, with an area of 1.65 million square kilometers, is located in the arid and semi-arid region of the globe. Most of this area is desert and desert. Meanwhile, Kerman province, located in the southeast of the country, is one of the major areas of arid and desert areas of Iran. Since studying these areas requires detailed fieldwork, seasonal constraints, and natural barriers, especially in desert areas and other problems, including cost, time, facilities, and equipment, provide many limitations, the most appropriate method is to use remote sensing and its effective techniques.

Using satellite imagery and remote sensing techniques, it is possible to achieve a wide range of projects globally, regionally, nationally, provincially, and locally at a lower cost and time. Besides, the ability to repeat satellite data over hours to days during the month or year has made it possible to study changes and monitoring of terrestrial phenomena. The capability of satellite data has led scientists and researchers in this field to increase their activities and expand the results of their studies to climate change and global fluctuations and to measure environmental factors. Agricultural and natural resources studies, desertification monitoring, flood degradation, drought, changes in seawater and lakes, climate change, water and soil, and air pollution, changes in cities and residential areas are some of the tools used for accurate management and many of these studies are possible through using satellite information. Efforts by experts and managers in space technology and remote sensing have led to the use of satellite information and data to take steps to apply proper and knowledge-based management.

Salinity is one of the indicators of changing the quality of land, which exists on a large scale in different parts of the country, and its size and importance are increasing every day. Despite its importance, this problem has received less attention from researchers (Baghestani Meybodi, 1997). About 7 million hectares of the country's lands are saline lands, which are mostly uncultivable and are practically considered national lands. These areas are scattered in different parts of the country, which is a habitat for saline plants (Jafari, 1994). The results of Kazemi's research (2017) showed that among the plant indices, SAVI had the highest correlation coefficient among quantitative data of canopy percentage, and its numerical values, which was used to study the vegetation of the area. Boyko (1966) was one of the first to propose halophyte plants for desalination of water and soil. Although Boyko's chosen hypothesis does not distinguish between sodium and other salts, it was suggested because these plants can accumulate sodium salts and divert them from the soil substrates in which they grow. A number of vascular halophytes collect high levels of sodium and other salts in the tissues of the airways and then discard them (Graham et al., 1987). In an effort to select plants that are suitable for soil improvement in saline environments, Holmes (2001) conducted extensive laboratory and field studies of plant ecology in temperate environments. Chorchi et al. (1995) reported studies of plant capability testing called Suaeda fruticosa for the accumulation of sodium and other salts. According to the experiment, 9.06 percent of the wet weight of the leaves and 4.29 percent of the wet weight of the stem were absorbed salts. On average, a single plant can accumulate 935 grams of salt in leaves and 232 grams in fresh stem tissue.

Excretory halophytes are considered to be the second component of plant modifiers. Atriplex belongs to the family Chenopodiaceae, which accounts for about 20% of all halophyte species (Glenn et al., 2001) and is known for its high concentration of sodium ions in its internal tissues. The potential of using Atriplex as a forage or livestock species and a useful species that also reduces the amount of sodium and soil salt has been the focus of many researchers. One hectare of Atriplex can produce up to 16,000 kilograms of usable dry fodder in one year (McClellan, 2003).

Sirjan desert is very diverse and eye-catching so that it has made this part of the province, where no living thing lives, the most diverse and variable in the country. During the hot days of the year, due to the scorching sun of the desert and the evaporation of water, this region becomes a large salt marsh, which forms one of the most original landscapes in Iran. This white plain is formed on the way from Kerman province to Shiraz and is located 27 km from Sirjan road near Kheirabad village and includes 35,000 hectares of plain, which is completely white and full of salt. Accordingly, the purpose of this study was to investigate vegetation cover and its distribution around Salt Lake of Sirjan and changes in vegetation on agricultural lands.

Introducing the study area

The study area called the salty pan is from the Sirjan desert catchment area, which is located 35 km west of Sirjan city. The salt pan of Sirjan (salt pan of Khairabad) with an average height of 1688 meters above sea level in geographical position between 29°10'N to 29°41'N and 55°20'E to 55°31'E is located in the west of the Sirjan city. The average rainfall is 100 mm and the average temperature is 17.1 degrees Celsius and the prevailing wind direction on this pan is 135 degrees southeast.

Sirjan Desert is asymmetrically located in a narrow valley in front of the western water border of Chaleh. Alluvial fans from the northeast, along with huge dunes, reduce the surface of the desert. In the limited areas between the alluvial fans and the dunes, there are settlements with farms, many of which are now covered with sand. The groundwater level in this desert is high so that groundwater flows from beneath the dunes of the north to the south and enters the desert. The low and smooth areas of this region include salt marshes in the west and the fertile plain of Ebrahimabad in the east of Sirjan city. This region is one of the geological zones of Sanandaj-Sirjan. The study area is temperate and dry. It is relatively mild in summer and cold in winter with snow and rain and in spring with rain.

Research Method

In this study, using remote sensing data, as well as using the NDVI plant index on two series of satellite data of 2003, 2013 and 2017, the type and amount of vegetation were studied and their changes and expansion. The research technique was to use correlational and comparative methods. In this regard, the relevant satellite images were first prepared and processing was performed on these images. The data and information used for the present study were ASTER satellite imagery. As one of the important goals of this study was to investigate and detect changes over a period of time, ASTER measuring plant products related to Terra satellite for 2003, 2013, and 2017 were used.

The spectrum range in which the images were taken were 3 bands in the visible and near-infrared (VNIR subsystem), 6 bands in the short-wavelength infrared (SWIR subsystem), and 5 bands in the thermal infrared range (TIR subsystem). Images received in the three spectral ranges have a different spatial resolution. VNIR bands had a resolution of 15 meters and SWIR bands had a spatial resolution of 30 meters, while infrared thermal images had a spatial resolution of 90 meters. The numbers of bands, the spectral amplitude, and the absolute accuracy of the 14 bands of this sensor are given in Table (1).

Table 1- ASTER spectrum ranges.

Band	Title	Wavelength (µm)	Resolution (m)	Description
1	Visible and near-infrared	0/0-600/520	15	VNIR
2	Visible and near-infrared	0/0-690/630	15	
N3	Visible and near-infrared	0/0-860/760	15	
B3	Visible and near-infrared	0/0-860/760	15	
4	Short infrared	1/1-700/600	30	SWIR

5	Short infrared	2/2-185/145	30	
6	Short infrared	2/2-225/185	30	
7	Short infrared	2/2-285/235	30	
8	Short infrared	2/2-365/295	30	
9	Short infrared	2/2-430/360	30	
10	Thermal infrared	8/8-475/125	90	
11	Thermal infrared	8/8-825/475	90	
12	Thermal infrared	9/8-275/925	90	TIR
13	Thermal infrared	10/10-950/250	90	
14	Thermal infrared	11/10-650/950	90	

This study sought to examine changes in vegetation for over 15 years. In this regard, ASTER satellite images were examined over 15 years at intervals of 5 years. These images were prepared for the extraction of vegetation after performing the necessary pre-processing such as geometric, atmospheric, and reflection corrections. In order to identify and extract vegetation cover in the Sirjan salt basin area, the Normalized Difference Vegetation Index (NDVI) was used and after preparing the vegetation map for each period, the vegetation zones were compared in different periods.

Findings

Checking the quality of satellite data

Before using satellite imagery, this data should be examined for geometric and radiometric errors. Because the study area was in two forms of satellite imagery, the two images were compared using mosaicing, as shown in Figures (1) and (2).

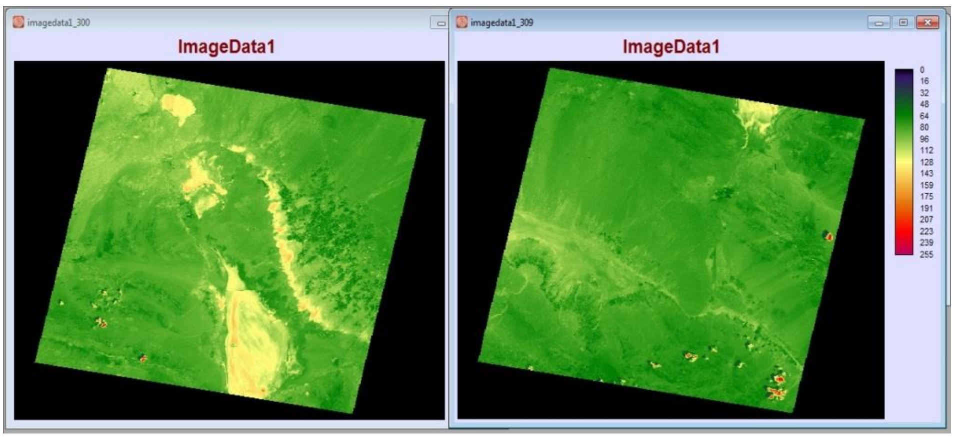

Figure 1- Two images before mosaicing

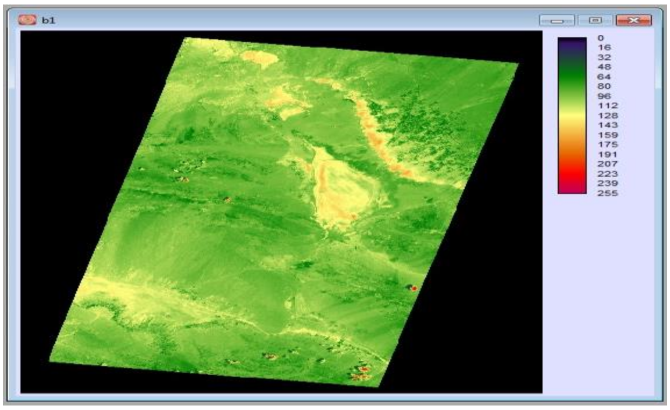

Figure 2- Images after mosaicing.

The geometric correction operation of ASTER measuring bands related to 5 June 2008, 17 May 2013, and 19 May 2002, was performed in Idrisi software using 15 ground control points with RMSE error, 0.46 pixels. To check the accuracy of the geometric corrections, using the topographic map of the study area, the vector layer of the roads, as well as the paths taken through GPS, were used. Figure (3) shows a corrected sample image.

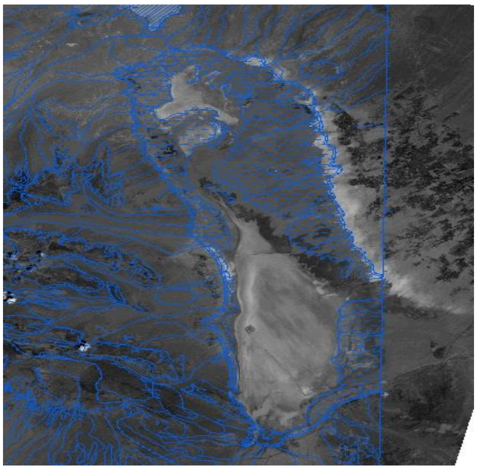

Figure 3- Geometric corrections using a basic map.

Figures (4), (5), and (6) of the atmospheric reflection correction are given for images from 2002, 2008, and 2013.

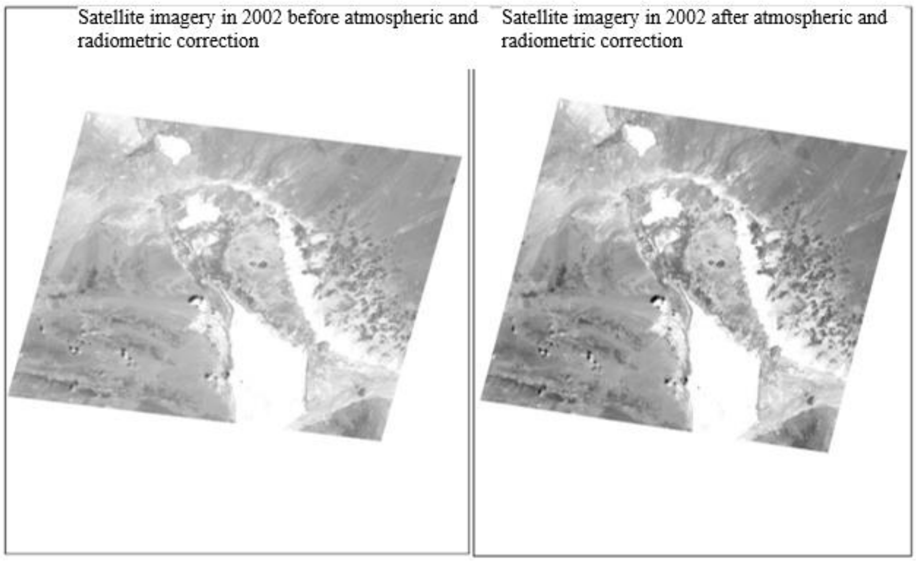

Figure 4-Atmospheric correction and reflection correction of the 2002 image.

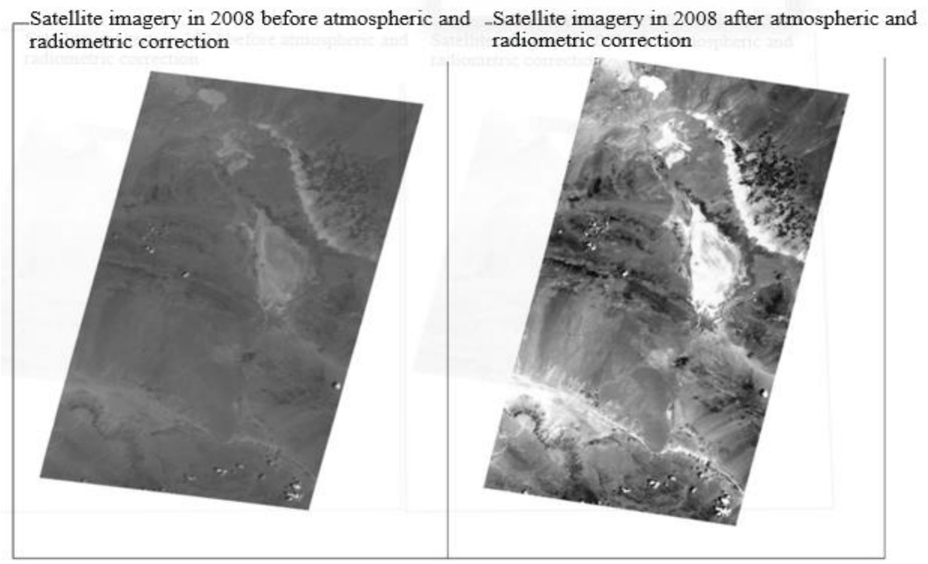

Figure 5- Atmospheric correction and reflection of the 2008 image reflection.

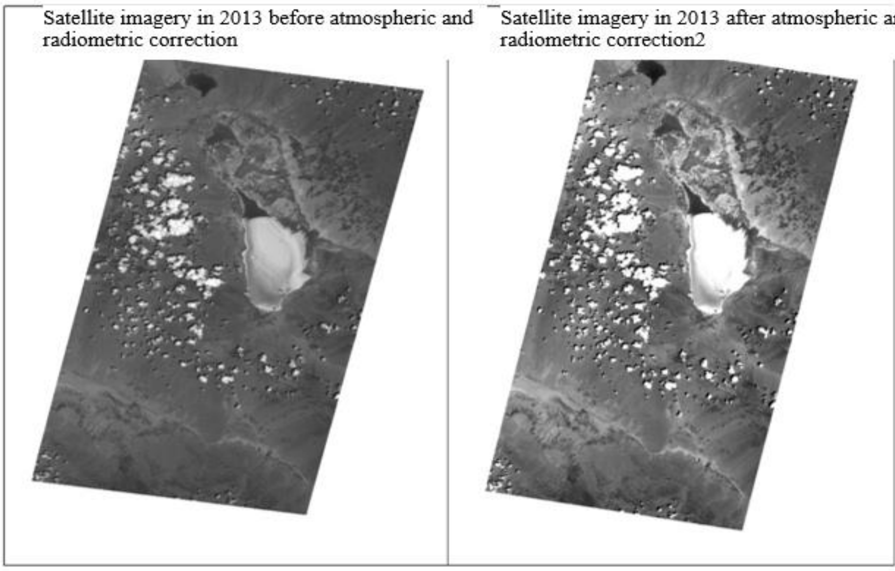

Figure 6- Atmospheric correction and reflection correction of the 2013 image.

In this study, only the methods of bonding ratios were used to create known plant indices and the analysis of the main component to create important components.
A study of the results of vegetation level modeling in the group of main bands VNIR of ASTER sensor used in this study shows that only two near-infrared (band 3) and red (band 2) bands, with a correlation coefficient of 92% and 95%, respectively, and a standard error of 0.03, establish significant relationships at the 99% level with vegetation characteristics. In this group, the near-infrared band shows the highest correlation with the vegetation surface characteristic.

Calculation of plant index

The NDVI, which is based on spectral values, is widely used to identify vegetation growth conditions. Figure (7) shows the NDVI for 2002, 2008, and 2013. As can be seen, the NDVI was between 0.85 and 0.38 in 2002, between 0.81 and 0.27 in 2008, and between 0.79 and 0.78 in 2013.

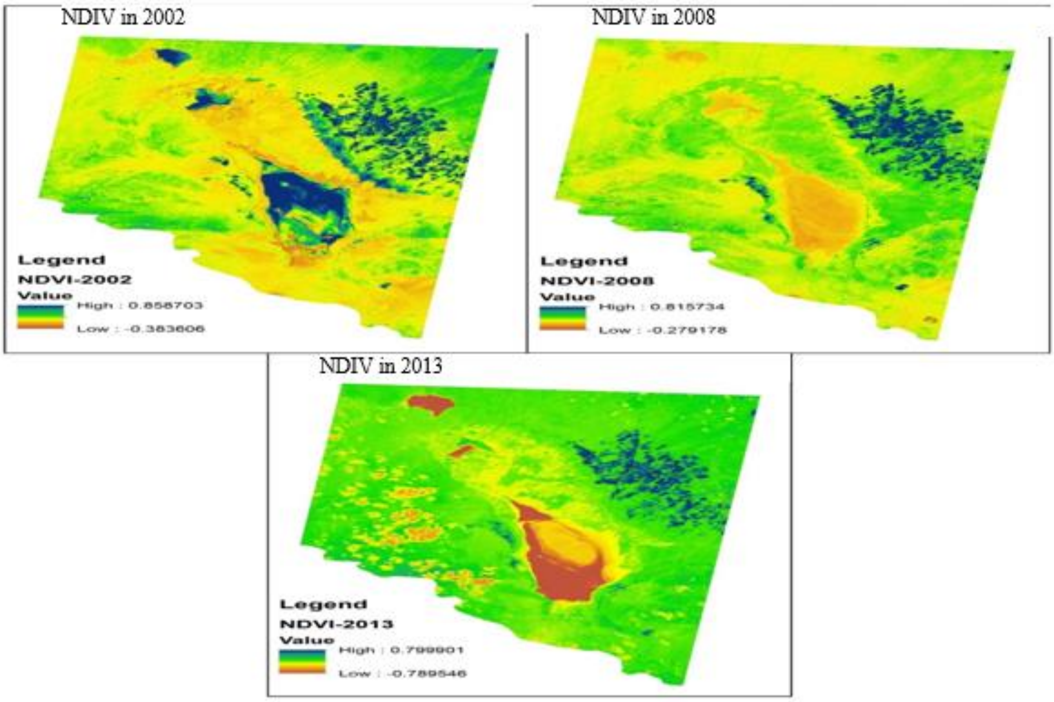

Figure 7- NDVI for 2002, 2008 and 2013

Table 2- Features of vegetation classes for the three periods 2002, 2008, and 2013.

	2002	2008	2013
Classes	Vegetation	Vegetation	Vegetation
Good vegetation	0.86 to 0.1	0.816 to 0.96	0.78 to 0.15
Medium vegetation	0.039 to 0.039	0.096 to 0.044	0.15 to 0.042
Very poor vegetation	0.039 to -0.022	0.044 to -0.008	0.042 to -0.073
No vegetation	-0.022 to -0.383	-0.008 to -0.279	-0.073 to -0.789

In the next step, according to the error matrix tables, the indicators of producer accuracy, user accuracy, overall accuracy and kappa coefficient, calculation, and accuracy of the final map were tested. The results are presented in Table (2).

Table 3- Vegetation changes in 2008 compared to 2002

Changes in 2008 compared to 2002			
Change Code	Reference Class	New Class	Pixel Sum
1	1	1	25687
2	1	2	374127
3	1	3	56766
4	1	4	168
5	2	1	70503
6	2	2	8734583
7	2	3	3757336
8	2	4	50320

9	3	1	52676
10	3	2	2302032
11	3	3	2091801
12	3	4	212850
13	4	1	112466
14	4	2	928917
15	4	3	145151
16	4	4	757133
Class 1: No vegetation Class 2: Very poor vegetation Class 3: Medium vegetation Class 4: Good vegetation			

Table 4- Vegetation changes in 2013 compared to 2008

Changes in 2013 compared to 2008			
Change Code	Reference Class	New Class	Pixel Sum
1	1	1	157154
2	1	2	85477
3	1	3	18532
4	1	4	171
5	2	1	913907
6	2	2	3375257
7	2	3	8040662
8	2	4	12229
9	3	1	67866
10	3	2	1349377
11	3	3	4567838
12	3	4	67398
13	4	1	305
14	4	2	4956
15	4	3	184582
16	4	4	831115
Class 1: No vegetation Class 2: Very poor vegetation Class 3: Medium vegetation Class 4: Good vegetation			

As you can see, the biggest change in class 7 code has occurred with a total of 8040662 pixels. In other words, very poor vegetation in 2008 has become medium vegetation. After this class, the change code 10 (medium vegetation to very poor vegetation) is in second place and the change code 5 (very poor vegetation to the class without vegetation) is in the third place.

Conclusion

Vegetation as a dynamic and effective factor in the biological, climatic, and living conditions of the region should be continuously examined quantitatively and qualitatively. Methods of remote sensing, especially satellite imagery, are among the methods of studying vegetation that can help computations in terms of speed and accuracy. Satellite data, if available with regular and calculated planning, can be of great help in environmental planning, especially under certain conditions such as environmental crises.

As the results showed, after extracting vegetation using the NDVI taking into account the mean and standard deviation in satellite images of each period, the vegetation of the study area was divided into four categories: good vegetation, medium, very poor, and no vegetation. The results showed that in 2002 the area of the good vegetation class was 19278 hectares, which increased to 22971 hectares in 2008 and decreased by 20499 hectares in 2013 compared to 2013. The average vegetation in 2002 was 104,985 hectares, which changed from 13,6128 hectares in 2008 to 10,8340 hectares in 2013. Table (5) presents the vegetation classes and the area of each class.

Table 5- Vegetation classes and area of each floor

Vegetation class	The area in 2002 (hectare)	The area in 2008 (hectare)	The area in 2013 (hectare)
Good	19278	22971	20499
Medium	104985	136128	108340
Very poor	283786	253242	284308
No vegetation	34730	30334	29632

According to this table, it is observed that vegetation has changed in each period compared to the previous period. Accordingly, the density of vegetation and its distribution around the Salt Lake is changing.

Also, according to Table (5), the good vegetation class, which includes agricultural lands, is 19278 hectares in the first period, and the vegetation class, which includes the lands of the Salt Lake and the surrounding salt marshes, is 34730 hectares. is. In 2008, agricultural land with an area of 22,971 hectares increased by 0.19 percent compared to 2002, and land without vegetation decreased to 3,0334 hectares. In 2013, agricultural land and unvegetated lands were reduced. In general, the comparison of three consecutive periods of different classes of vegetation does not show a significant relationship and there is no relationship between changes in agricultural lands with changes in the level of Salt Lake of Sirjan.

Referneces

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