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Investigating the Relationship between Satellite Remote Sensing Indicators (GIS) and Soil Salinity of Agricultural Lands of Abarkooh-Mehrabad Plain

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Abstract

In this study, using linear multivariate regression, the relationship between different remote sensing indices (obtained from Landsat satellite images) and surface soil salinity in the study area in 2014 was determined. One of the notable points in the present study is that agricultural areas and rangelands are separated from each other and soil salinity classification has been done only for rangelands. It is inferred that in agricultural lands, soil salinity is a function of farm management, especially irrigation, and it is not possible to determine and model soil salinity without considering this important. Therefore, the soil salinity classification map in this study can be cited in rangeland areas. One of the most important issues that has led to a lack of significant relationship between satellite remote sensing indices and soil salinity of agricultural areas is the type of agricultural cover, which in the study area are mainly perennial pistachio trees. Soil salinity of pistachio orchards at the time of sampling, cannot immediately affect the reflections made from the tree surface and computational indicators by these reflections, and this issue creates a significant relationship between soil salinity and remote sensing indicators

***Keywords**:* Salinity Index, Soil Salinity, Agricultural Lands

1. Introduction

Without exception, all arable and non-arable soils contain some salts, and if the amount of these salts exceeds a certain limit, it limits the growth and yield of the plant. Rebellion is one of the biogeophysical processes caused by desertification and is a prominent feature of soils in arid and semi-arid regions. Soil salinity is greatly affected by humidity and rainfall in the regions so drought constraints are one of the major limiting factors in crop production in the world so in arid and semi-arid regions, the problem of salinity and drought are combined. Identifying areas under risk of salinity, studying vegetation changes and performing remediation operations in arid areas is an inescapable fact. Despite the large area of these lands and the high cost of identifying and detecting saline soils and

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changes in natural cover by traditional methods, the use of new methods is necessary. Rainfall is one of the most important factors affecting vegetation. Drought is one of the recurring phenomena whose effects are not limited to arid and semi-arid areas, but also occur in humid areas and cause a shortage of water resources (Hadian et al., 2014). When the saline water level reaches the surface, evaporation occurs and the salt is concentrated on the surface. Fertile pasture species are replaced by salinity-resistant species, and land cover is dispersed, with no surface protection, and erosion begins. Soil salinity mapping is very important for spatial management, as excess soluble salts in the root development area can cause problems for plant growth. The initial effects of salt on vegetation occur during an increase in the osmotic pressure of soil water, so it is difficult for plants to extract soil water. This is the main reason for the reduction of vegetation in saline areas and has serious environmental consequences of salinity of dry lands. The special effects of ions are of secondary importance, especially in pastures. Plant species and some cultivars of species are different in terms of the ability to extract water from the soil under salinity conditions and therefore plants have a wide range of salinity resistance that is used for improvement operations. However, most natural pastures and crops eventually die under saline conditions. These soils contain large amounts of saline salts and are formed in areas that do not have adequate drainage. More than 90% of the country is located in arid and semi-arid regions. Annual evaporation varies from 700 mm along the Caspian Sea to more than 4000 mm in the desert and southeast of Khuzestan province.

Rehabilitation of saline soils requires a large volume of fresh water. Usually, soils that contain large amounts of salts are washed with fresh water, and this leaching must be accompanied by drainage to remove the salts from the soil profile. Leaching without drainage makes the lands saltier. It is almost impossible to wash the saline soils due to the climate of the country, which is one of the arid and semi-arid regions and is facing water shortage (Ahmadi and Matinfar, 2014).

Therefore, to solve the problem of salinity, we must look for other solutions. Identifying saline areas and preparing soil salinity maps for soil management can be one of the solutions. Due to the lack of up-to-date and up-to-date aerial photographs in developing countries, the best method is to use satellite imagery that provides information at different times and seasons of the year. It also requires less cost and reduces the volume of operations and it is possible to prepare a map in less time. Most of the lands, especially in arid and semi-arid regions of the world, have salt deposits on the soil surface in summer (Ahmadi and Matinfar, 2014).

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Rapid population growth and increasing need for food have made it inevitable to pay full attention to natural resources, especially water. On the other hand, groundwater has various advantages compared to surface water, among which we can point to its higher quality and less pollution, while in arid and semi-arid areas where surface water is very rare. Groundwater is available as the most important source of water supply. The problem of soil salinity in agriculture is often limited to arid and semi-arid regions of the world. These areas occupy about 41% of the earth's surface. From 1474 million hectares of arable land in the world, about 230 million hectares are dedicated to irrigated cultivation, of which about 45 million hectares (19.5%) are affected by salinity. The rate of soil degradation due to the salinization process is 3 hectares per minute. Saline lands are growing at a rate of about one to two million hectares per year, which is equivalent to the rate of development of irrigated lands each year worldwide. From the total 165 million hectares of land in Iran, about 44 million hectares are saline to varying degrees. In arid and semi-arid regions such as Iran, due to lack of rainfall and lack of uniform distribution, irrigation is an important principle in agriculture in these areas. Today, due to the use of underground water sources and the digging of deep wells, it has caused water salinity in many areas Remote sensing is a new technology whose application has grown significantly in the study of earth resources in recent decades (Fang and Shen, 2020). The TM sensor was first placed on the Landsat 4 satellite in 1982. This sensor has 7 bands in terms of spectrum. The spectral amplitude of the TM bands can be seen in Table 1. The dimensions of TM images are usually 185 × 185 km, which are provided to users with a pixel size of 30 or 28.5 meters; Except for band 6 (thermal band) whose pixel dimensions are 120 meters. Radiometrically, 8-bit TM images are recorded, which is suitable for many applications. The number of bands of this sensor has made it possible to extract a lot of information spectrally from them, and therefore the images of this sensor are among the most widely used images in the world of remote sensing and have been used in almost all branches of remote sensing applications (Rivera-Marin, Dash and Ogutu, 2022). Landsat 5 retired in early 2013, Landsat 8 was launched on February 11, 2013. Landsat 8 is the eighth satellite in the Landsat series and the seventh satellite in the project to be successfully launched into orbit. The satellite is a collaboration between NASA and the US Geological Survey. This satellite has two sensors, one is the Operational Land Image (OLI) and the other is the Infrared Thermal Infrared Sensor (TIRS). The two sensors collect image information for the 9 shortwave bands and the two thermal wavelength bands, respectively. The OLI sensor collects data from nine spectral bands. Seven of these nine bands are compatible with the TM and ETM sensors on previous Landsat satellites, which in addition to compatibility with historical Landsat data, has also improved measurement capabilities (Rivera-Marin, Dash and Ogutu, 2022). Conducted a research to provide a model for salinity mapping using ETM + sensor data and salinity values in southern Ahvaz. Preliminary results showed that there was a significant relationship between surface salinity and main bands 2 and 4, brightness index and vegetation index at the level of 1%. There is a significant correlation between actual and estimated salinity values at the level of 1% and the correlation coefficient was 0.772 (Hasanvandi et al., 2014). In a study, present an integrated approach of remote sensing, geographic information systems, and analysis hierarchy process (AHP) to identify the potential groundwater area in the central eastern desert, Egypt (Morgan et al. 2022).

Zoned the effect of drought on vegetation in the Yazd-Ardakan plain by remote sensing. The results showed that temperature and precipitation are the most important climatic elements affecting the vegetation of the region. With this argument, they introduced the index of drought impact index, which in this study was obtained by combining rainfall, temperature and SAVI vegetation index. Investigated the relationship between rainfall fluctuations and vegetation changes in the period 1996-2008 in some rangelands of Yazd province. In this study, monthly rainfall information of meteorological stations and NOAA satellite images were used. Rainfall maps were prepared using geo-statistical methods and statistical analysis was performed between satellite images and precipitation maps. The results indicate a significant relationship between grass vegetation types and rainfall fluctuations and lack of correlation or poor relationship between shrubs, tree and shrub types with rainfall.

Based on the above records, it seems that the use of a method to determine the salinity of the soil, which can be extended to other areas, is incomplete in the above research. Also, in the absence of such a pattern again for the study area of this study, the research is only known in one year or one chapter. Due to the impact of soil salinity on climatic factors, a comprehensive research vacancy over a longer period of time seems necessary to increase accuracy and also to extend it to other areas.

On the other hand, as mentioned, short-term research may ignore the impact of human factors such as land use change, which is accelerating in the present era

Also, this research prepares soil salinity maps using TM and ETM+ satellite data and intermediation methods in Abarkooh plain agricultural lands and determines the correlation and regression relationships between real data with bands, salinity indices and analysis of first band components (PCA) because Abarkooh plain has been exposed to saline soils due to its location in arid and semi-arid regions. In this research, an attempt has been made to prepare a salinity map for the mentioned area using geostatistical methods and maximum probability classification in order to provide ways to deal with this phenomenon by having a deep and sufficient knowledge of the process of soil salinity changes.The main purpose of this study is to investigate the existing methods and find a suitable method for determining soil salinity in desert areas. Another goal is to help the authorities to use the mentioned executive method for land monitoring.

2. Material and Methods

2.1. Study Area

The location of Abarkooh-Mehrabad plain in Yazd province is shown in Figure (1). The average minimum and maximum temperatures in Abarkooh region are 11 and 27 degrees Celsius, respectively, the total annual rainfall is 67 mm and the total annual evaporation is more than 3300 mm. The land use map of the region is presented in Figure (2).

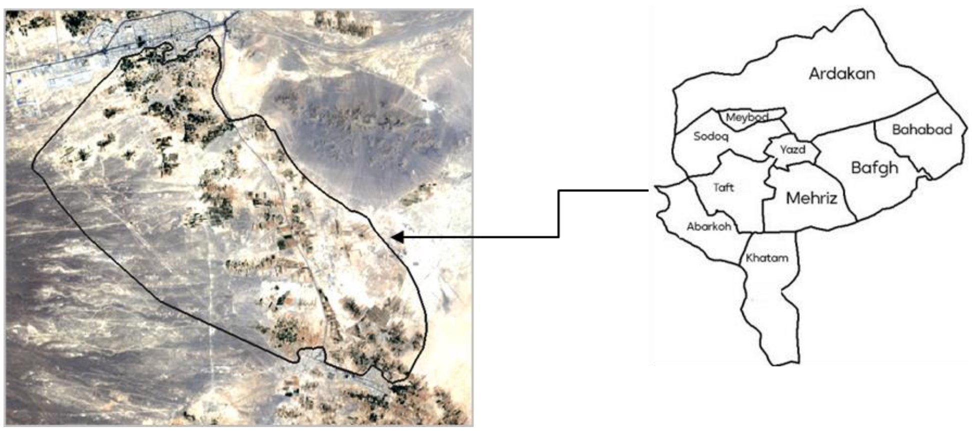


Figure 1. Location of the study area in Yazd province and the study area

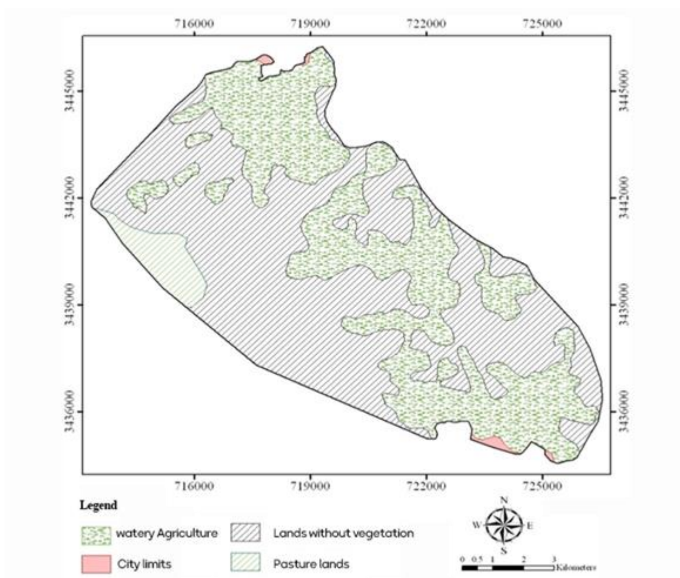


Figure 2. Land use map of the region

2.2. Sampling Method

The sampling method was superficial from a depth of 0 to 10 cm and at each point except the main point, a series of auxiliary samples were taken in three directions with an angle of 120 degrees and a distance of 50 meters from the main point and mixed with it. Also, the geographical location of the central points was determined with the help of GPS. Other reported that by applying this sampling method, the error due to local changes in soil is minimized, resulting in a uniform state for adjacent pixels in an area of about 0.8 hectares. Due to the fact that each pixel of Landsat 5 and 7 satellite images is a range of 30 by 30 meters. Therefore, in each composite soil sampling, a range of information consisting of 9 pixels, 90 m long and 90 m wide, was collected (Metternich and Zinck, 2002).

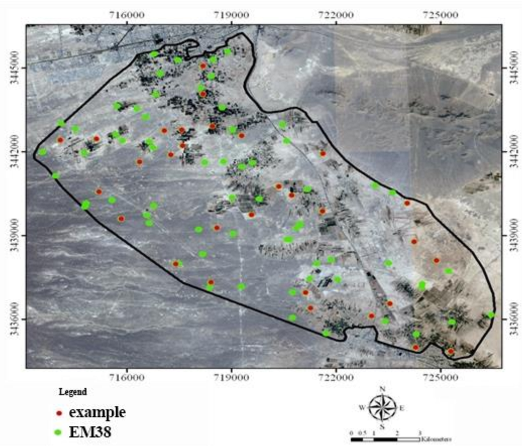


Figure 3. Location of sampling points (using electromagnetic conductor and soil sampling) in the range

2.3. Geographical Position of AbarKooh Plain

Abarkooh is located in the southwest of Taft city and Yazd province. Abarkooh city is considered as a part of Central Iran in terms of geological studies. In the southern margin of Abarkooh plain, a series of heights with northwest-southeast extension with Permian and Triassic sediments has been spread. In the heights of "Gypsy Kesh" and south of Hanshek, an outcrop of metamorphic formations can be seen, the age of which is unknown and probably traces the old Precambrian rock. This series of metamorphisms includes schist, dolomitic thin-layer feldspar, and marbled limestones. Around Hanshek, Upper Triassic limestones are strongly marbled under the influence of this metamorphosis and have a tectonic contact with the above series. These metamorphic rocks have risen in the Infra Cambrian and have been out of the water until the end of the Triassic, which is why the Early Triassic and Triassic were deposited on them. The first orogenic movements of the region are related to the Late Triassic, which is probably from the early stages of orogeny, but the existing tectonic form of the region was created by movements after the Pliocene. The salt desert that created the evaporation basin has been extended as a "graben" slope along the Herat and Marvast deserts on one side and the Esfandaran Taghistan plateau and the Gav Khoni swamp on the other side

2.4. Methods

Satellite Data Used

In order to provide the required data, first the scope of studies on the topographic map with a scale of 1.250,000 was determined with the help of Google Earth images. According to latitude and longitude, the number of transitions and the order of satellite imagery were also determined.

Field information was collected and ancillary information was prepared to collect field data. In this study, the position of sampling points was calculated using the Latin meta-cube method. To determine the location of sampling points in this way, it is necessary to use auxiliary information in this regard. This auxiliary information can be satellite imagery bands or spectral ratios derived from them, digital altitude model, climate, physiography or any basic information available. In this study, Landsat satellite image bands and digital altitude model were used as auxiliary information. To extract basic information values for use in software, a network must first be created on the image according to the pixel size of the satellite image, and then the information values must be extracted at the center of each pixel. Due to the fact that the pixel size in the images used was 30 meters, so a 30-meter by 30-meter grid was placed on the study area. Then, 100 points were selected from the points in the network to determine EC with electromagnetic conductor (EM38) and 30 points for sampling. Figure 4 shows the location of sampling points within the study area.

Electromagnetic Conductor Device

At present, although there are several tools for fast and low-cost monitoring of some soil parameters, exhausting field surveys at large levels and sampling from different depths are still considered as one of the necessary steps in the preparation of terrestrial data. In this study, by introducing and using a tool called field sampling guide (based on multiple scientific evidences and documents in different parts of the world, the number of 38 electromagnetic EM can) in order to monitor the salinity of different soil depths to a considerable extent and thus reduce the cost and time of sampling and testing measures.

3. Results and Discussion

In this study, with the aim of preparing soil salinity maps using remote sensing data, soil salinity indices were applied to the images. Table (1) shows the salinity indices used in this study (Metternich and Zinck, 2002).

Then the correlation between EC and digital data from satellite images was investigated to use the results in the next steps to prepare a soil salinity map of Abarkooh-Mehrabad plain in Yazd.

Table 6 shows the indicators used for the appropriate salinity model in the region. After determining the appropriate model, the model error was validated using the correlation relationships between the actual and estimated salinity values and also by calculating the mean error and standard deviation indices. Statistical analysis was performed using SPSS software.

$$RMSE = \left(\frac{\sum_{i=1}^{n} (p_i - o_i)^2}{n} \right)^{1/2} \quad (1)$$

$$MAE = \frac{\sum \left| O_i - P_i \right|}{N} \quad (2)$$

3.1. Preparation of Salinity Map by Supervised Classification Method

In this study, a supervised classification with 4 salinity classes and using the maximum probability method was applied on the image and salinity map was prepared. Quantitative variance and correlation of spectral values of different bands are calculated for sample regions and the same property is used to associate an unclassified pixel to one of the groups or spectral samples. In other words, the variance matrix and the mean vector, which define the variance and correlation of the spectral values, are used to investigate the distribution of spectral values and the statistical probability of the relationship of a pixel to one of the sample groups. Using the probability intensity factor, each of the image pixels is assigned to the relevant group after statistical test and calculation of their probability of belonging to the sample spectral groups. Selective training classes based on satellite image interpretation included 4 soil classes (4-0, 4-8, 16-8 and more than 16 dS). After classification, the generated map was finally processed. For this purpose, a majority filter with a 3*3 window was applied to the map to merge the very small polygons that were generated into larger adjacent polygons (Jahantigh, 2016).

3.2. Evaluation and Review of Salinity Maps

To measure the accuracy of the map, the overall accuracy was calculated from the ratio of the correctly classified pixels to the total number of sample pixels. Also, due to the low expressive power of this factor and the elimination of the chance factor, the kappa coefficient was calculated. The kappa coefficient describes the degree of agreement between the classification results and the ground reality, given that random coincidences are excluded from the considerations.

Vegetation indices were used to study vegetation changes in the study period. This index was proposed by Tucker in 1989 based on the plant's nature in reflecting the solar electromagnetic spectrum in the visible and infrared range and was defined according to Equation 3:

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad (3)$$

In this regard, NIR is the reflection of light in the infrared bands and RED is the reflection of light in the red band.

Table 1. Percentage of area allocated to salinity classes

Land use	Year	First floor	Second floor	Third floor	Fourth floor
Agriculture	1987	29.7	9.7	14.1	46.4
	1990	35.5	4.7	18.8	40.8
	2000	28.6	26.4	21.1	23.7
	2002	27.1	15.6	25.7	31.6
	2009	26.2	5.8	30.0	37.8
	2010	40.8	16.9	9.7	32.4
	2011	16.8	6.9	32.1	44.0
	2014	53.8	3.8	5.2	37.0
Grassland	1987	0.7	42.3	12.1	44.7
	1990	3.1	15.0	16.1	65.6
	2000	1.1	68.8	7.5	22.3
	2002	0.96	27.94	28.76	42.17
	2009	0.7	17.9	24.6	56.5
	2010	1.9	47.1	6.1	44.5
	2011	1.4	29.6	19.6	49.1
	2014	6.1	24.4	17.2	52.0
Whole area	1987	12.7	28.8	12.9	45.4
	1990	16.5	10.7	17.2	55.3
	2000	12.5	51.3	13.1	22.9
	2002	11.8	22.9	27.5	37.8
	2009	11.2	12.9	26.8	48.8
	2010	18.0	34.7	7.6	39.5
	2011	7.8	20.2	24.8	47.0
	2014	25.8	15.9	12.2	45.8

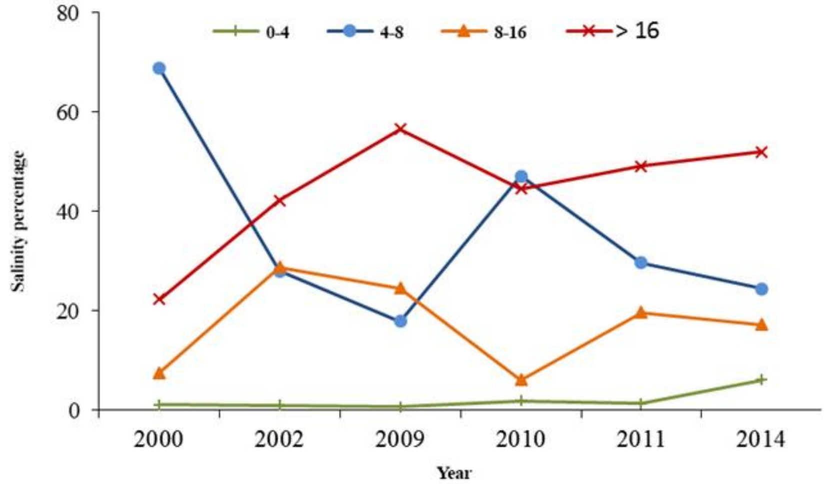


Figure 4. Percentage of area allocated to salinity classes in rangelands

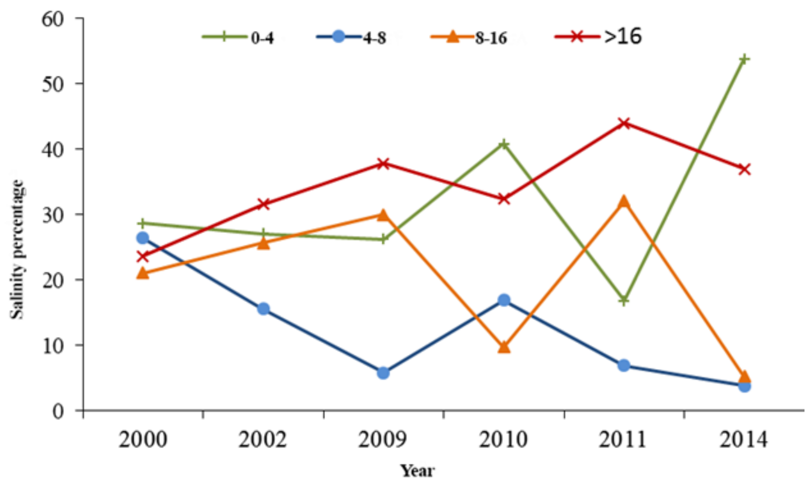


Figure 5. Percentage of area allocated to salinity classes in agriculture

As shown in Figure (4), in all years (except 2000) the salinity class of more than 16 dS / m has the highest salinity percentage among the classes. And the lowest salinity percentage is assigned to low salinity class (less than 4 dS / m).

3.3. Soil Salinity Changes

As shown in Figure (4), in all years (except 2000) the salinity class of more than 16 dS / m has the highest salinity percentage among the classes. And the lowest salinity percentage is assigned to low salinity class (less than 4 dS / m).

Soil salinity changes.

In agricultural areas, there is no specific situation to determine the high and low salinity class, because salinity is a function of farm management, especially irrigation, and studies cannot be done without considering this important. Therefore, agricultural areas were separated from other areas. Therefore, the map of soil salinity classes in 2014 is without considering agricultural areas and can be presented in Figure (6).

In order to study the salinity changes with respect to rainfall, rainfall values were calculated in 3-time scales. The amount of rainfall in spring, which is the total rainfall in April, May, and June, the amount of annual rainfall, which is the total rainfall from October to September of that year, and the amount of rainfall in the growing season, which is the total rainfall in March, April, May, and June.

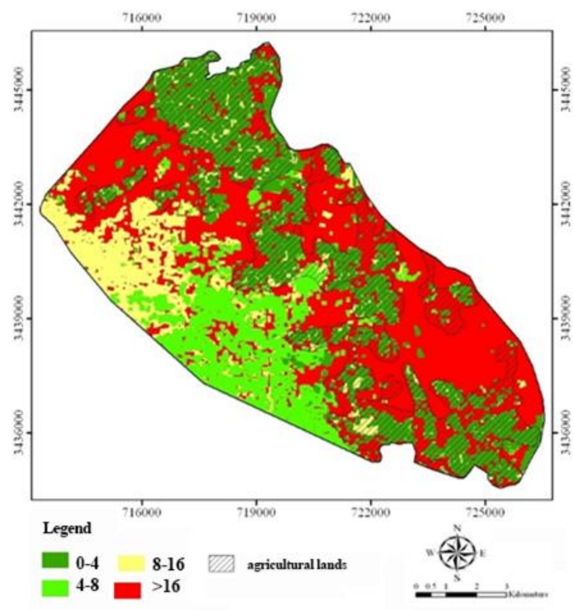
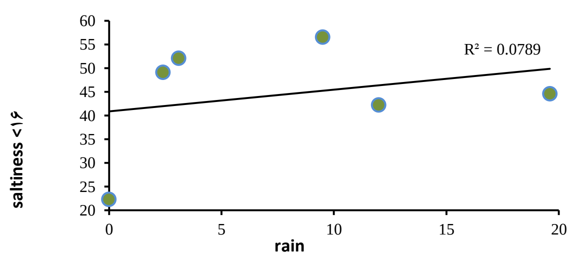


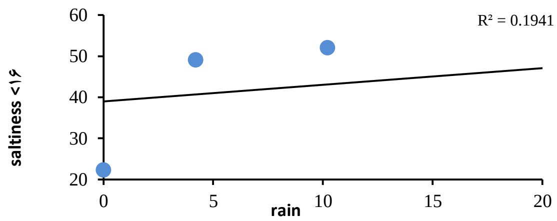
Figure 6. Map of salinity classes in Abarkooh-Mehrabad region related to 2014

3.4. Relationship between Soil Salinity and Rainfall

The relationship between precipitation and salinity class of more than 16 dS / m in the rangelands of Abarkooh-Mehrabad region is shown in Figure (6) (Nouri et al. 2018).



spring season



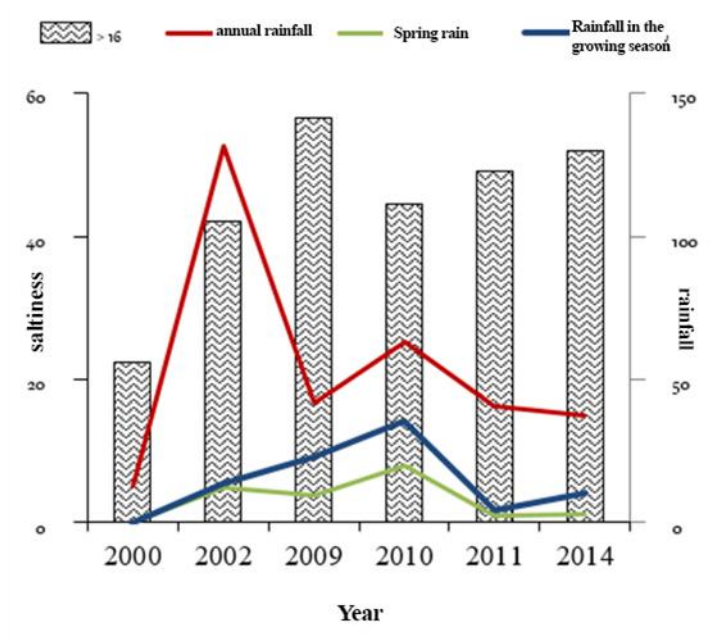
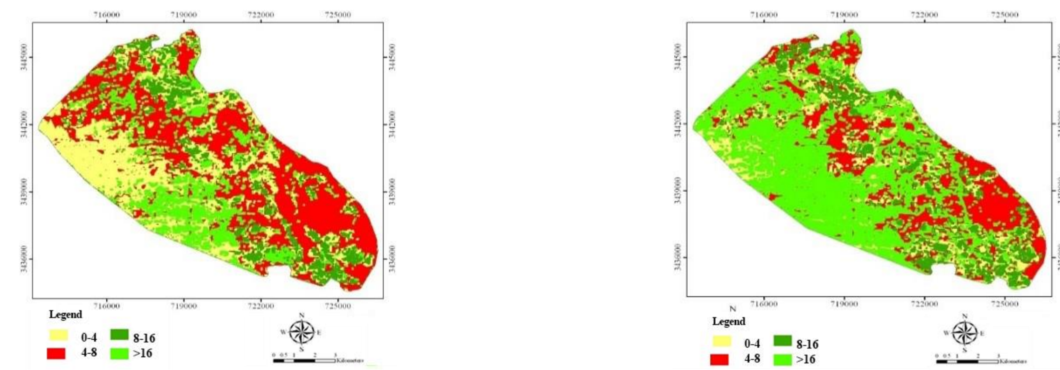


Figure 7. The relationship between precipitation and salinity class <16 in the rangelands of the study area

Rainfall fluctuations are inversely related to salinity values, so that with increasing rainfall, the salinity decreases (2002 and 2010) and in the year of low rainfall, the salinity increases. The effect of spring and growing seasons on soil salinity in this area is not significant, which due to low rainfall in arid areas, to investigate this effect should be investigated immediately after rainfall.



Year 2002 Year 2000

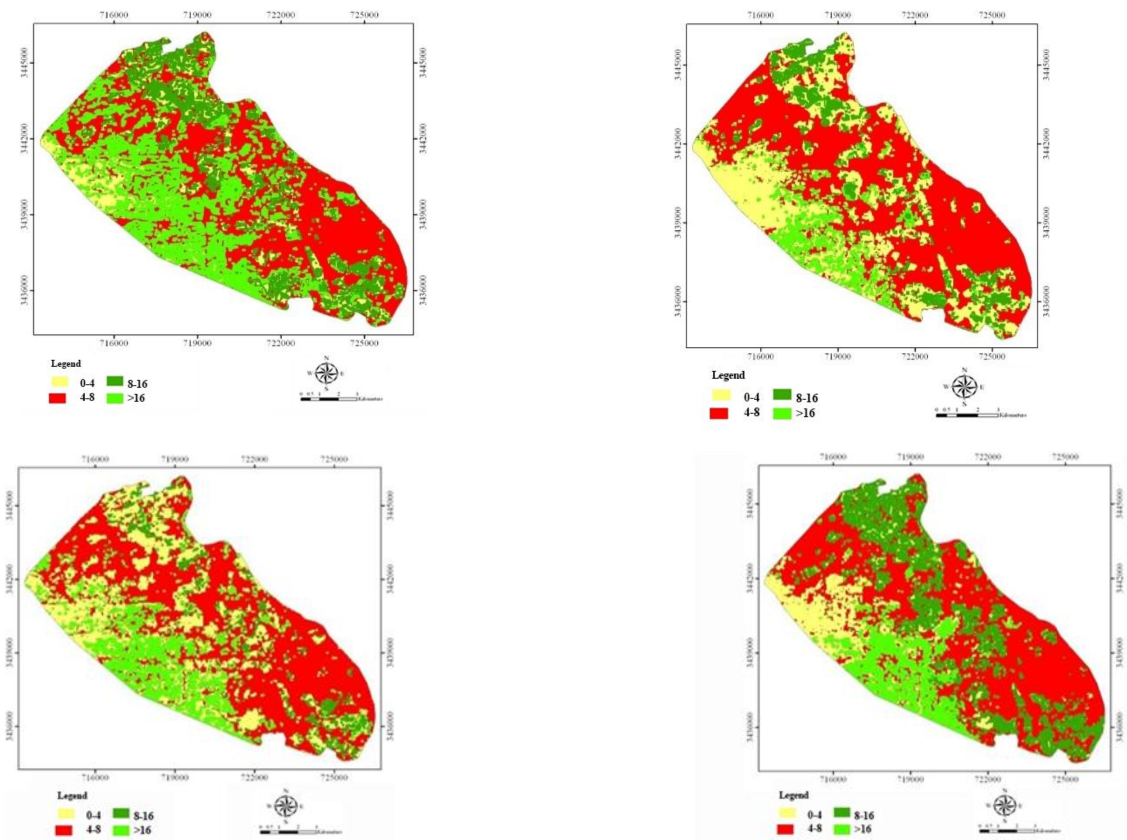


Figure 8. Map of salinity classes in different years in the study area

Despite the high correlation coefficients, there was a lot of error when the model was applied to the images of the region in other years. The results show that if a relation for calculating soil salinity is obtained using digital image information, this relation cannot be used at other times. The reason for this is the relativity of digital data related to bands in different images.

Figure (8) shows the salinity maps obtained from the monitored classification method in 2000, 2002, 2009, 2010, 2011 and 2014 and shows the percentage of area related to different salinity classes (classified map).

4. Conclusion

According to the extracted results, it can be said that the effective elements in vegetation and soil salinity of the region are the amount of seasonal rainfall, land use (agriculture, etc.), irrigation and fertilization methods to agricultural areas. The most important factors can be summarized in the amount of annual rainfall and land use. So, precipitation fluctuations have an inverse relationship with salinity values, that with increasing rainfall, the salinity decreases (2002 and 2010) and in the low rainfall year, the salinity has increased.

The effect of spring and growing seasons on soil salinity in this area is not significant, which due to low rainfall in arid areas, to investigate this effect should be investigated immediately after rainfall. Therefore, this hypothesis has spread over time over residential and agricultural land use in the region and the level of saline lands has increased. One of the notable points in the present study is that agricultural areas and rangelands are separated from each other and soil salinity classification is done only for rangelands. It is inferred that in agricultural lands, soil salinity is a function of farm management, especially irrigation, and it is not possible to determine and model soil salinity without considering this important. Therefore, the soil salinity classification map in this study can be cited in rangeland areas

Table 2. Salinity indices used

Relation	Reference	Salinity index
(R-NIR)/(R+NIR)	Majer et al. (1990)	NDSI
$\sqrt{R+G}$	Khan et al. (2005)	SI
$\sqrt{R^2+G^2}$	Khan et al. (2005)	BI
(R-B)/(R+B)	Dashtakian et al. (2008)	YSI
R/NIR	Khan et al. (2001)	Ratio1
$\sqrt{R^2+NIR^2}$	Fernandez et al. (2006)	IB
(R-NIR)/(G+NIR)	Danny and Lunis (2012)	SR
2×G-5(R+NIR)	Danny and Lunis (2012)	VSSI

In this study, we tried to define a new indicator for determining soil salinity by telemetry data by studying numerical values in different bands with the collected samples and examining the degree of correlation between them. But these models were associated with a large error in the digital information of images from other years. A review of sources and studies shows that most readers determine the study of soil salinity using terrestrial educational samples and finally the classification of images with the help of terrestrial data. Therefore, in this study, in the supervised study of changes in the region, after selecting educational samples using all bands and indices NDVI, NDSI and BI, the region was classified in terms of salinity (Tran et al., 2002).

The salinity maps from the supervised classification method in 2000, 2002, 2009, 2010, 2011 and 2014 are shown in Figure 8. The percentage of area allocated to salinity classes in rangelands and agriculture was 0.96 and the kappa coefficient was 0.95 obtained from the supervised classification using the maximum probability method. This percentage indicates that a high percentage of their pixels are correctly classified in terrestrial reality. Because all the classes have been selected correctly and the agricultural areas have been separated from the rest of the areas, and these results confirm the hypothesis of changing the use of barren lands and turning it into agricultural lands during the studied years has caused the expansion of saline lands in the region. Contrary to popular belief, the effect of rainfall on vegetation in this area is not significant. The vegetation index increased in 2002 due to heavy rainfall. This index has been accompanied by an increase in 2002, which although the rainfall shows less than in 2002, but the amount of rainfall in this year with 41.6 mm, has increased the vegetation index.

This index has changed slightly in 2010 and this slight change can be seen in 2011. With the decrease in rainfall, the NDVI index has also decreased. The reasons for the lack of a significant relationship between annual rainfall and annual vegetation of rangelands can be the lack of coordination of annual rainfall on vegetation in the same year and possible delays in the impact of rainfall on vegetation (due to soil moisture storage) and the role and importance of effective rainfall instead of annual rainfall. Each of which requires separate studies. Therefore, according to the above explanations and the inverse relationship of these two indicators, salinity changes in rangelands can be studied. Due to the inverse relationship between vegetation index and drought impact index, the highest IDI index is observed in 2000 and 2014 and the lowest in 2002.

Due to the above-mentioned issues answering the questions and rejecting or accepting the main hypotheses of the research in the present study, the relationship between rangeland vegetation and annual rainfall was not observed. One of the reasons for the lack of this significant relationship is the lack of coordination of annual rainfall on vegetation in the same year and possible delays in the effect of rainfall on vegetation in the study area due to soil moisture storage and the role and importance of effective rainfall instead of annual rainfall. Each of which requires separate studies. Contrary to the above, the hypothesis of the relationship between soil salinity and vegetation was reported to be significant in rangeland areas and the effect of increasing soil salinity on reducing vegetation in the years under study was evident. Comparing these results with the research of Hosseini et al. (2001) who examined the relationship between rainfall fluctuations and vegetation changes in 2008 in part of the rangelands of Yazd province. In that study, rainfall information_ period 1996 was used. The results obtained there also indicate the lack of monthly NOAA of meteorological stations and satellite images of poor correlation or association of rangeland types (shrubland, tree and shrub) with rainfall. Also, one of the results of this study is the selection of an optimal method in preparing the salinity map of the region, which led to Landsat. In comparison with Taj gardan et al. in a study for ETM+ using sensor data, presenting a model for mapping salinity values using satellite data emphasized the effectiveness of using this method for zoning and justifying changes in soil salinity in Aq Qala region of Golestan province. On the other hand, another feedback of this study is the lack of a significant relationship between soil salinity and remote sensing indicators. In the research conducted in 2006 this important point has been mentioned and confirmed, the reason for this issue will be explained in detail in the conclusion section. One of the notable points in the present study is that agricultural areas and rangelands are separated from each other and soil salinity classification is done only for rangelands. It is inferred that in agricultural lands, soil salinity is a function of farm management, especially irrigation, and it is not possible to determine and model soil salinity without considering this important. Therefore, the soil salinity classification map in this study can be cited in rangeland areas. One of the most important issues that has led to a lack of significant relationship between satellite remote sensing indicators and soil salinity of agricultural areas is the type of agricultural cover that in the study area are mainly perennial pistachio trees. Soil salinity of pistachio orchards at the time of sampling, can not immediately affect the reflections made from the tree surface and computational indicators by these reflections, and this issue creates a significant relationship between soil salinity and remote sensing indicators. this important point has been pointed out and studied. In the present study, no statistically significant relationship was found between rangeland vegetation and annual rainfall. The reasons for the lack of this significant relationship can be the lack of coordination of annual rainfall on vegetation in the same year and possible delays in the impact of rainfall on vegetation in the study area (due to soil moisture storage) and the role and importance of effective rainfall instead of annual rainfall. Each of which requires separate studies. In contrast, the relationship between soil salinity and vegetation was reported to be significant in rangeland areas and the effect of increasing soil salinity on reducing vegetation in the years under study was evident.

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