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The Efficiency of Remote Sensing Data's Assessment in Salt Marsh monitoring (Case Study: Kashan, Iran)

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Abstract

Because of large-scale dry regions, salt marsh monitoring is necessary using of remote sensing data's. The aim of this study is to monitor salt Kashan using of satellite data's processing. Therefore, the satellite images of LISSIII sensor were used. Initially, the technique of color composite images ENVI4.8 software was used to clearly distinguish salt. Then, principal component analysis (PCA), Normalized Difference Vegetation Index (NDVI) and composite spectral satellite images techniques were used to monitor the salt marsh. The spectral composite images techniques according to characteristics LISSIII sensor characteristics were defined Ratio Salt Index (RSI) and salt Normalized Difference Salt Index (NDSI). To assess the resolution of principal component analysis (PCA), NDVI index and RSI and NDSI indicators, salt and non-salt distribution of pixels in a two-dimensional plot was investigated. In the final stage to ensure the resolution, the threshold in the range of values were used between zero and 255. Finally based of the error matrix and overall accuracy, it became clear that RSI and NDSI indicators in comparison with the first and second components and NDVI data show the best resolution with high accuracy with 82 and 89 respectively. The results showed that RSI and NDSI indicators for monitoring salt marsh of Kashan using multi-spectral satellite data are effective in regional scale.

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INTRODUCTION

It has always been difficult access to arid regions due to special circumstances. In this case, monitoring of such areas can be considered as an important issue in the management of natural resources (Lilisand & Keifer, 2006). In recent decades, the use of remote sensing technology has increased dramatically (Fatemi, 2006). Salt marsh monitoring of arid regions is an important parameter in sustainable development and environmental protection and the need to extract and thematic maps at different times (Fathi & et al, 2013). Remote sensing technology seems to be an effective method to obtain the required data's. This is not the usual limitations of time and place (Alavipanah, 2006).

Researches on arid countries have done using remote sensing technology that to some of them pointed out. Esfaniari & et al (2016), Salt marsh monitoring of dry areas in Iran (Case Study: Damghan) were study using satellite data's processing. The results have showed that RSI and NDSI indicators for monitoring salt marsh of dry areas using multi-spectral satellite data are effective in regional scale. Fathi et al. (2013), in a study evaluate composite band and thresholding techniques in Damghan of salt marsh across the desert using ASTER and LISSIII satellite data's. They were able to separate salt marsh using spectral reflectance properties of salt and thresholding. Ferifteh and et al (2008), six spectral ranges in salinity and alkalinity of soils exposed to are different, the introduction of which consists of bands of the visible, near-infrared and mid-infrared respectively. Results have shown that in low humidity conditions, salts of more reflected in the visible spectral show, especially water. Low-reflective mineral salts in the presence of water or high humidity in fresh salt occurs in the mid-infrared bands. The type and arrangement of crystals of salt and its construction is also effective in the reflection.

In total main objective of this study was to investigate the possibility of salt marsh monitoring with satellite images in the space of dry areas. Given the above and the importance salt marsh arid regions Kashan salt marsh monitoring using sensor images LISSIII examined in this study.

MATERIALS AND METHODS

Study area studied in this research is salt marsh of Kashan in central Iran and between 35 degrees 30 minutes west to 34 degrees 17 minutes' north latitude and 51 degrees 30 minutes 51 degrees 18 minutes east longitude is located. Figure 1 shows the location of the study area.

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Figure.1. Location of the study area

For this purpose, LISSIII images sensor have been used in the shooting date in November 2012. This sensor with equivalent bands TM2, TM3, TM4 and TM5 and 5/23 meter ground resolution of visible light and near-infrared bands and the middle and imaging width of 140 kilometers (Alavipanah, 2006). According to the study is processed the separation of Kashan salt and thematic mapping using satellite images. Therefore, like principal component analysis, vegetation index NDVI, band combined ratio and threshold techniques was used and was evaluated the accuracy of the output of error matrix. In the beginning, using ENVI4.8 attempt to cut the area under study was the entire image. The range satellite imagery used a small part of the full frame. So, the next operation was performed on the cropped area.

RESULTS AND DISCUSSION

Data processing was performed is as follows:

A. Spectral enhancement images. At this point of the histogram was used to evaluate the reflection spectral phenomena. Expanding the range of brightness values of image to a broader range of spectral is named enhancement or contrast (Lilisand & Keifer, 2006). In order to improve contrast images, histogram linear modulation technique has been used.

B. Band combination with the optimum index factor (OIF). Optimum index factor (OIF) including the selection of bands based on statistical criteria used in making color images. A combination of three different bands and assign each color of the three primary colors red, green and blue (RGB) in each band is constructed a color image. In false color image is attributed to infrared band in red, green, blue to red band and green band (Nazmfar et al 2014). By combining different bands used sensor, a large number of false-color image shows that the best color combinations (Figure 2).

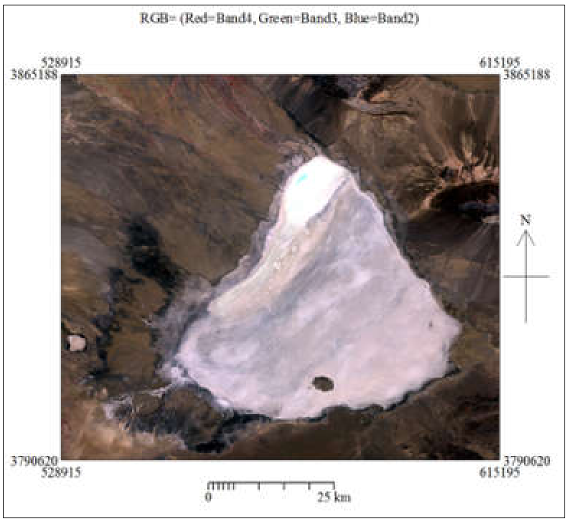
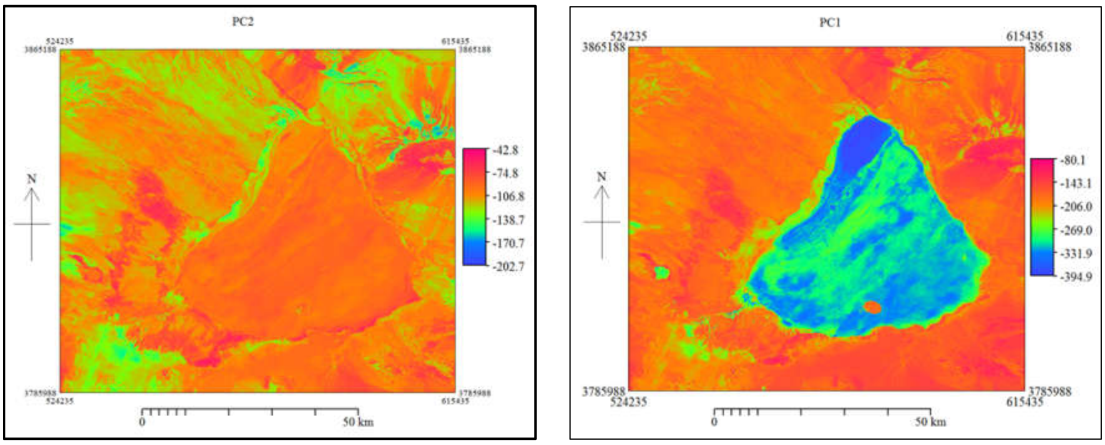


Figure 2: False color image of Kashan salt Marsh (RGB 234)

C. The use of principal component analysis technique (PCA). Principal component analysis in the interpretation of remote sensing digital data is of utmost importance. The most important benefits is phenomena information collected in different bands in number or less component bands. In other words, this technique is widely used to remove redundant information on satellite data's. The ability to reduce the size of the cut data and the gangs that decompose to produce usable results, in terms of time and possibly cost is important (Alavipanah et al, 2004). Percent of the variance of the principal components of the study area show that more than 90 percent of data after compression is focused in the first and second components. So, first and second components respectively 93.9% and 5.6% containing useful information can be extracted from salt marsh, which is in the form of visual and digital. Figure 3 shows images of the components LISSIII the first and second sensors.



(b) (a)

Figure 3: (a) The first components, (b) The second components

D. The use of Normalized Difference Vegetation Index (NDVI) of the most popular and easiest to identify and separate the salt marsh vegetation indices. The index is based on two red and near infrared bands defined as follows:

$$NDVI = (NIR-R) / (NIR + R) \quad (1)$$

The index values between -1 and +1 are normal that easily enables search and display NDVI data values in addition to simple calculation (Richards, 2004). Figure 4 shows the resulting image of NDVI data.

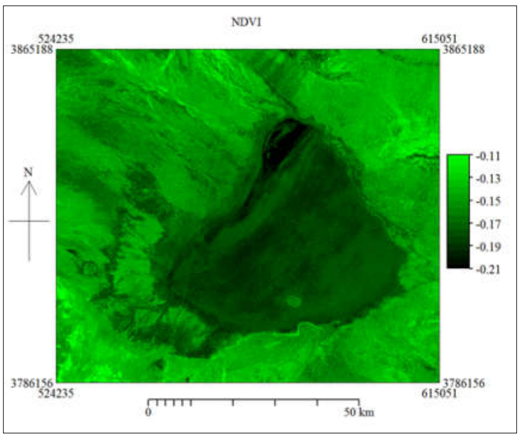


Figure 4: NDVI Image of Kashan salt marsh

E. Since salt marsh monitoring with satellite images have pure pixels salt separated from the other pixels, so images feature different bands were used for this resolution. In low humidity conditions, reflects the value of the land affected by salt water more in the range of the visible spectrum and is especially low reflection occurs in the mid-infrared bands. Given that most of the other bands in the visible bands salt marsh are influenced by the characteristics do not look very good for separation of pure salt pixels. But since mid-infrared bands to limit salt more sensitive to moisture and rapidly absorbed by water molecules in salt, less than visible bands are influenced by the surface properties of salt in dry areas (Esfaniari et al, 2015). The spectral behavior of salt is not available due to lack of access to accurate spectral radiometer; you can use the histogram or the values of image pixels. By drawing the values of pixels in image brightness, spectral reflection curves obtained salt the formula and parameters to be extracted from it (Esfandiari et al, 2016). In order to reduce the unwanted effects of salt on information and increase their details, they can incorporate at least two bands from the sensor to create a mixed formula. The mathematical conversion formulas are based on different sensor bands defined and are designed to detect phenomena in multi-spectral satellite observations (Fathi et al, 2014).

The present paper attempts to provide some indicators that increase information about the salt marsh. The importance of these measures depends on the type of data used and the percentage level of salt coating. Figure 5 shows the spectral reflectance curve of Kashan salt marsh in the visible, near-infrared and mid-infrared bands of LISSIII sensor that the average values of the brightness are extracted of image pixels.

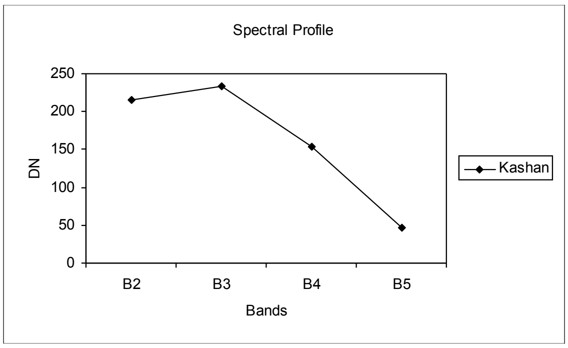


Figure 5: Spectral reflectance curve of Kashan salt marsh

According to the analysis of figure 5 can be inferred that the highest salt spectral reflectance in the visible region and the lowest is reflected in the mid-infrared range. The difference between the amount of salt in parts of the visible and mid-infrared spectral reflection is very high and the ratio of these bands can be a good indicator for identifying them. In this study, two of the indicators were tested according to the characteristics of the sensor LISSIII offer:

- Relative Salt Index (RSI). This index is defined as follows:

$$RSI = LISSIII5 / LISSIII3 \quad (2)$$

Figure 6 shows image of the RSI index of Kashan salt marsh.

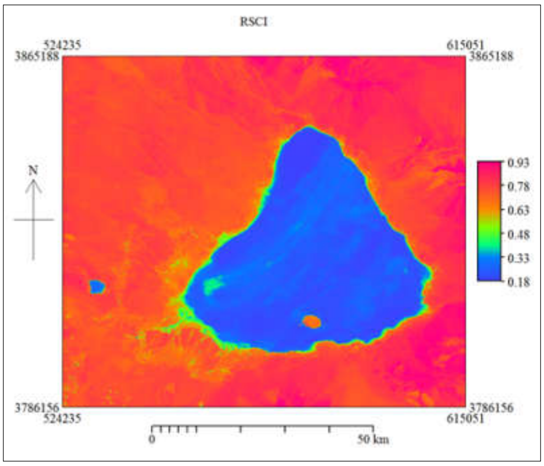


Figure 5: The RSI index image of Kashan salt marsh

- Normalized Different Salt Index (NDSI). This index is defined as follows:

NDSI = (LISSIII3-LISSIII5) / (LISSIII3 + LISSIII5) (3)

Figure 7 shows NDSI index image of Kashan salt marsh.

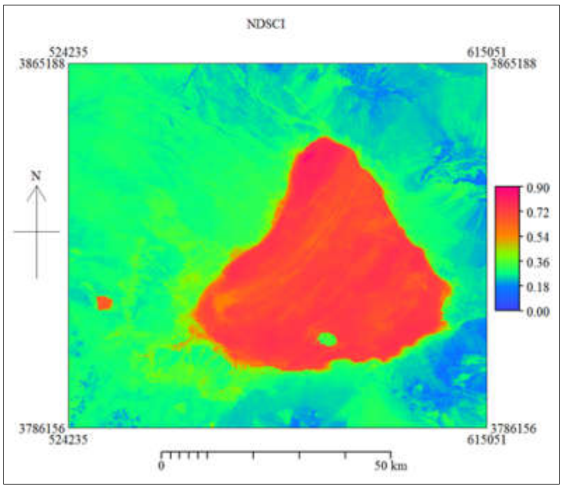


Figure 6: The NDSI index image of Kashan salt marsh

F. Thresholding technique in the final stage is used. The simplest way to interpret the results is the threshold. The threshold below which the boundary for spectrum space for pixel unlikely to enter an imaginary class there and pixels are unknown assigned to the class. If the distance range for pixel X is greater than or equal to the threshold introduced, pixel X is classified in class introduced; otherwise, remains unknown (Lilisand & Keifer, 2006). It is critical thresholds based on class type and amount of spectral overlap; they are usually done by trial and error. Threshold values for the user domains that should be given to regional conditions based of adverse information and knowledge and experience to determine and impose them (Esfaniari et al, 2016).

In this study, to evaluate the ability of resolution the first and second components, NDVI data and RSI and NDSI indicators in detection of salt marsh; were used of thresholding techniques. First, images of ENVI software put on a band set to produce false color images. Based on visual interpretation on false color image, salt and non-salt identify classes and was conducted at the same time on the screen by displaying two-dimensional graph of salt and non-salt pixel selection and sampling. After selecting a sample classes to control the resolution were evaluated two-dimensional chart of distribution of pixel values statistically. After repeated two-dimensional diagrams investigations showed that the RSI and NDSI indexes show the best resolution for salt and non-salt (Figure 8). So, in the final stage to ensure the resolution RSI and NDSI indicators were used the threshold ranges between zero and 255 (lines drawn perpendicular to each other markers in Figure 8 show the threshold resolution). The threshold in this method was chosen so to all the other pixels salt distinguished. The Salt zero pixels and a pixel non-salt number attributed to the production of a map. But mixed pixel or salt pixels to be trust them, was introduced salt pixels in ENVI software as the following algorithm which Gi(x) show pixel values I of the image:

IFF [$G_i(x) < 100$ and $G_i(x) > 148$, salt crust, non-salt crust]

With the algorithm implementation of this software, thematic maps including salt marsh and non-salt marsh was produced where salt is quite clear (Figure 9).

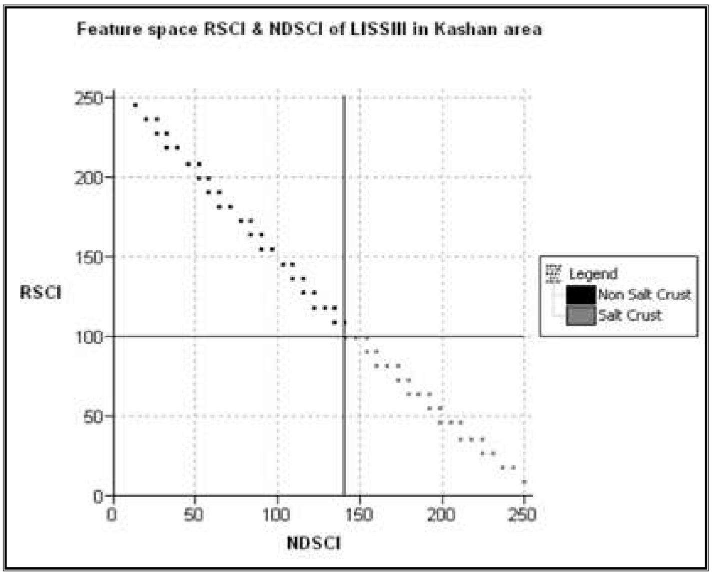


Figure 8: The RSI and NDSI indexes pixels in two-dimensional diagrams

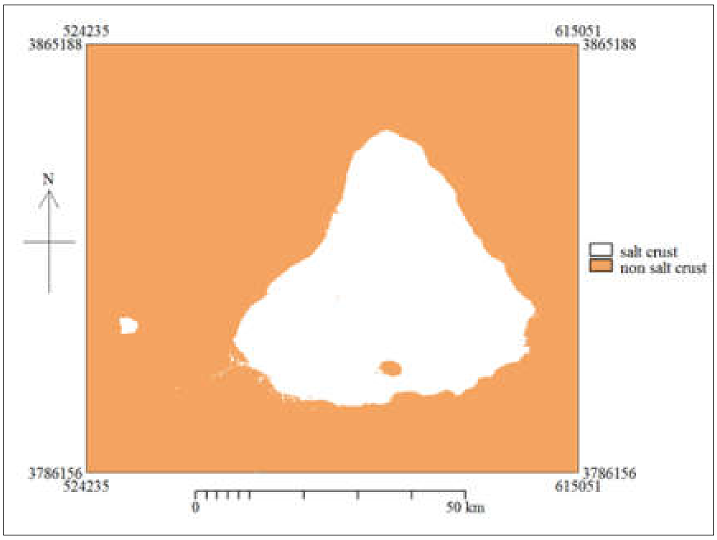


Figure 9: The image of RSI and NDSI indexes threshold

To assess the plans of threshold elements of the first and second, vegetation index NDVI, indicators of salt RSI and NDSI with the ground truth map was based on the confluence of error matrix was calculated from the results in Table 1.

Table 1: The overall accuracy of threshold map

Index	The overall accuracy (%)
RSCI	82
NDSCI	89
PC1	55
PC2	41
NDVI	46

CONCLUSION

The aim of this study is multi-spectral satellite data's processing in Kashan salt marsh monitoring. Therefore, the LISSIII sensor satellite images were used. First, the color composite images ENVI4.8 software was used to clearly distinguish salt. Then, techniques were analyzed like principal component analysis (PCA), Normalized Difference Vegetation Index (NDVI) and composite spectral for salt detecting on satellite images. The techniques range composite images according to characteristics LISSIII were defined Ratio Salt Index (RSI) and Normalized Difference Salt Index (NDSI). To assess the resolution principal component analysis, NDVI data and RSI and NDSI indicators, salt and non-salt distribution was investigated of pixels in a two-dimensional plot. In the final stage to ensure the resolution of threshold values were used in the range between zero and 255. The threshold, thematic maps include salt and non-salt classes where salt is clear. Finally, the the overall accuracy of the first and second components with 55 and 41, NDVI index with 46 and RSI and NDSI indicators with 82 and 89, respectively based of error matrix. The results showed that the RSI and NDSI indices with high accuracy compared with the first and second components and vegetation NDVI index are the best resolution. So, RSI and NDSI indicators are effective for monitoring salt marsh in dry areas using multi-spectral satellite data in regional scale.

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