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Using Remote Sensing to Determine of Relationship between Vegetation Indices and Vegetation Percentage (Case Study: Darab Plain in Fars Province, Iran)

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Abstract

Vegetation Indices (VIs) obtained from remote sensing (RS) based canopies are quite simple and effective algorithms for quantitative and qualitative evaluations of vegetation cover, vigor, and growth dynamics, among other applications. In the study for modeling and estimated of density and percentage vegetation value of Artemisia Herba alba was used Green Difference Vegetation Index (GDVI), Normalized Difference Vegetation Index (NDVI), Optimized Soil Adjusted Vegetation Index (OSAVI), Soil Adjusted Vegetation Index (SAVI) by Landsat 8 ETM+ bands vegetation in the Fathabad of Darab plain, Iran in 2015. By software ENVI preprocessing, processing, geometric and atmospheric corrections were performed, and then vegetation index for the study area was calculated. Also, ArcGIS 10.2 software for mapping of area vegetation was applied. Then the relationship between Vegetation Indices, density and vegetation value of Artemisia herba alba was determined. The results show that with increasing of percentage and density of vegetation, the value of vegetation indices increases. Finally, in order to determination of suitable elevation of growing of Artemisia herba alba was determined relationship between elevation and percentage of vegetation. The results show that the best elevation for growing of Artemisia herba alba was 1767 to 1782.

Keywords: Vegetation Indices (VIs), Remote sensing (RS), Artemisia herba alba.

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1. Introduction

Remote sensing (RS) for vegetation studies use data by satellite sensors that measure wavelengths of light absorbed and reflected by green plants. RS of vegetation is mainly performed by obtaining the electromagnetic wave reflectance information from canopies using passive sensors. The reflectance from vegetation to the electromagnetic spectrum is determined by chemical and morphological characteristics of surface of leaves (Zhang and Kovacs, 2012).

Vegetation Indices (VIs) extracted from light spectra range can be attributed to a range of characteristics beyond growth and vigor quantification of plants related to yield (Foley et al., 1998; Batten, 1998). Therefore, Vegetation Indices obtained from the spectra range can be used as a proxy to assess stomata dynamics that regulates transpiration rate of plants. However, the applicability of remote sensing and its different VIs extracted from these techniques usually relies heavily on the instruments and platforms to determine which solution is best to get a particular issue (Xue and Su, 2017).

According to the importance of the Vegetation Indices, the present study is an attempt to determine the relationship between percent and density of the vegetation and Vegetation Indices (VI) for Artemisia herba alba.The Artemisia herba alba or A. sieberi is a medicinal plant that some pharmacological effects of A. sieberi plant such as spasmolytic, vermicidal (1), insecticidal (2), anticandidal (3) and asexual reproduction inhibition of some filamentous fungi (4) were confirmed (Mahboubi and Farzin, 2009).

A study on A.herba-alba species collected from Sinai and Israel desert showed that Siniol, Thujone, Borneol, and Pinene were the main groups of combinations found in the plant; so that their concentration was a factor of their habitat (Feuerstein et al., 1988). The Pasture Technical Office started to collect and code plants in the pasture and commented on the capacity of Artemisia and A. sieberi in particular in 1991 (Rabie et al., 2007). confirmed the title A. sieberi after phytochemical studies on 34 species of Artemisia in Iran and Artemisia herba alba from Spain and A. siberi from Palestine (Rabie et al., 2007). Mirza et al. (1998) extracted and studied essence of species of Artemisia genus and A. sieberi in particular from quantitative and qualitative viewpoint (Mirza et al., 1998). Also, Mozafarian (1996) was determined the habitats of Artemisia herba-alba in Iran.

In order to Determine the relationship between percentage and density of vegetation was used vegetation indices. Many studies on the use of remote sensing techniques and vegetation indices in agriculture and natural resources are done (Arzani et al., 2009). using indicators SAVI (Soil-adjusted Vegetation Index), MSAVI (Modified Soil Adjusted Vegetation Index) and PVI have proposed to estimate the crown of Vegetation. In northern China, Bao et al (2009) predicted winter wheat biomass and Ren et al (2008) monitored winter wheat yield using data from Modis, and Koppe et al (2012) estimated estimated winter wheat biomass using Hyperion data. Vegetation index NDVI (Normalized Difference Vegetation Index), NDVI-RE (Red Edg NDVI), msR-RE (Modified Red Edge Simple Ratio) and Curvature demonstrated that the spatial and temporal variations in leaf area index (LAI) as well can be estimate (Tillack et al., 2014). Ren et al (2011) showed that the linear model based on NDVI (862, 693 nm) relative to the index, SAVI is composed of 887 and 685 nm bands had a better estimates of green biomass of the desert steppe. Baihua and Burgher (2015) stated that the vegetation index NDVI is a good indicator to identify and assess long-term changes in the areas of vegetation.

Allbed et al., 2014 determined relationship between soil salinity and vegetation indices derived from IKONOS high-spatial resolution imageries. The results show that among the investigated indices, the Soil-Adjusted Vegetation Index (SAVI), Normalized Differential Salinity Index (NDSI) and Salinity Index (SI-T) yielded the best results for assessing the soil salinity of cultivated lands with dense and uniform vegetation.

Modeling vegetation was used Yospin et al. (2015) parameterized Fire BGCv2 to identify the effects of different levels of ignition suppression on landscape-level patterns of vegetation and successional dynamics in sub-alpine Tasmania. The results show that because the distribution of vegetation types was unstable temporally and across stochastic replicates, present distributions may be a legacy of previous climate, Aboriginal fire management, or both.

The study area aim is modeling and understanding the behavior of Vegetation Indices for Artemisia herba alba in the Fathabad Darab plain in Fars province, Iran. For determination of relationship between vegetation indices and Artemisia herba alba was used GDVI, NDVI, OSAVI, SAVI based on Landsat 8 ETM+ in 2015 years.

2. Material and Methods

2.1. Case study

The case areas was located in east of Darab plain, Fars province, Iran. The locations of the case areas are shown in Figure 1. In the study for determination of relationship between vegetation indices and density of Artemisia herba alba fifty points were used that are shown in Figure 2. According to Figure 2 distribution of points were quite randomly.

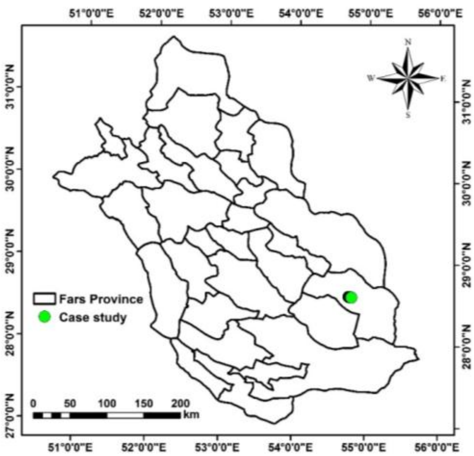

Figure 1. Position of the study area

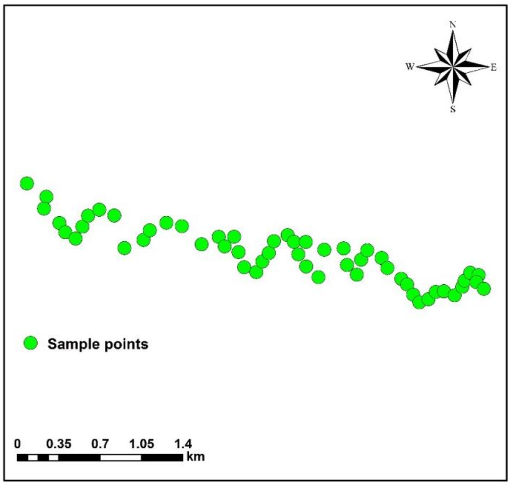

Figure 2. Position of sample points in the study area

2.2. Methods

In this study to calculate the Generalized Difference Vegetation Index (GDVI), Normalized Difference Vegetation Index (NDVI), optimized soil adjusted vegetation index (OSAVI), soil adjusted index (SAVI) have been used that the equations of each indices are in the following:

Green Difference Vegetation Index (GDVI)

This index was originally designed with color-infrared photography to predict nitrogren requirements for corn (Sripada, et al., 2006).

$$GDVI = NIR - Green \tag{1}$$

Normalized Difference Vegetation Index (NDVI)

This index is a measure of healthy, green vegetation. The combination of its normalized difference formulation and use of the highest absorption and reflectance regions of chlorophyll make it robust over a wide range of conditions. It can, however, saturate in dense vegetation conditions when LAI becomes high (Rouse et al., 1973).

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)} \tag{2}$$

The value of this index ranges from -1 to 1. The common range for green vegetation is 0.2 to 0.8.

Optimized Soil Adjusted Vegetation Index (OSAVI)

This index is based on the Soil Adjusted Vegetation Index (SAVI). It uses a standard value of 0.16 for the canopy background adjustment factor. Rondeaux (1996) determined that this value provides greater soil variation than SAVI for low vegetation cover, while demonstrating increased sensitivity to vegetation cover greater than 50%. This index is best used in areas with relatively sparse vegetation where soil is visible through the canopy.

$$OSAVI = \frac{1.5 * (NIR - Red)}{(NIR + Red + 0.16)} \quad (3)$$

Soil Adjusted Vegetation Index (SAVI)

This index is similar to NDVI, but it suppresses the effects of soil pixels. It uses a canopy background adjustment factor, L, which is a function of vegetation density and often requires prior knowledge of vegetation amounts. Huete (1988) suggests an optimal value of L=0.5 to account for first-order soil background variations. This index is best used in areas with relatively sparse vegetation where soil is visible through the canopy.

$$SAVI = \frac{1.5 * (NIR - Red)}{(NIR + Red + 0.5)} \quad (4)$$

For preparing each of indices was used bands 1, 2, 3, 4, 5 and 7 Landsat 8 ETM + sensor, 2015 years. Spectral characteristics of ETM + bands are shown in Table 1:

Table 1. Spectral characteristics of Landsat 8 ETM +

Spectral Band	Wavelength	Resolution
Band 1 - Coastal / Aerosol	0.433 - 0.453 µm	30 m
Band 2 - Blue	0.450 - 0.515 µm	30 m
Band 3 - Green	0.525 - 0.600 µm	30 m
Band 4 - Red	0.630 - 0.680 µm	30 m
Band 5 - Near Infrared	0.845 - 0.885 µm	30 m
Band 6 - Short Wavelength Infrared	1.560 - 1.660 µm	30 m
Band 7 - Short Wavelength Infrared	2.100 - 2.300 µm	30 m
Band 8 - Panchromatic	0.500 - 0.680 µm	15 m
Band 9 - Cirrus	1.360 - 1.390 µm	30 m

First, using ENVI v.5 preprocessing like geometric and atmospheric corrections were performed, and then vegetation indices for the study area was calculated. ArcGIS10.2 software for mapping of area vegetation was used. Then indexes compared with land use map in order to determine best index for estimate vegetation in study area.

3. Results and Discussion

The results of the vegetation indices maps (GDVI, NDVI, OSAVI and SAVI) in the study area show in the Figure 3. According to Figure 3, value of indices were high in the agriculture field for NDVI and low for OSAVI, SAVI and GDVI indices. Vegetation is low in the salt land. So salt land seen white color in satellite images (Prost, 2013). The OSAVI was between -0.43 to 0.89, SAVI was between -0.18 to 0.5, GDVI was between -0.06 to 0.2 and NDVI was -1 to + 1.

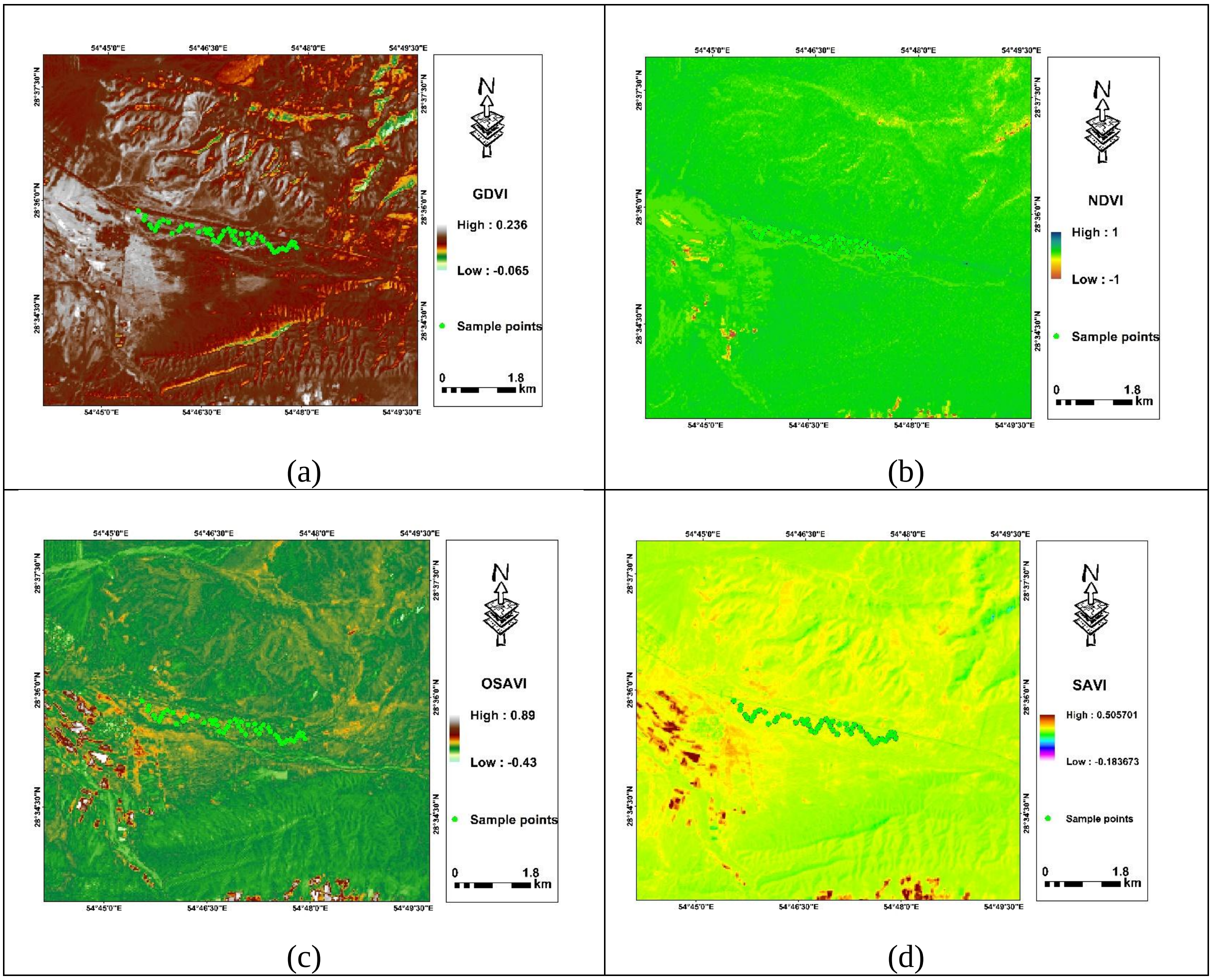

Figure 3. Vegetation indices of the study area. (a): GDVI, (b): NDVI, (c): OSAVI, (d):SAVI

In order to determine the relationship between vegetation index, density and percentage of vegetation indices 15 sample points were used that are shown in Figure 4 and Figure 5, respectively.

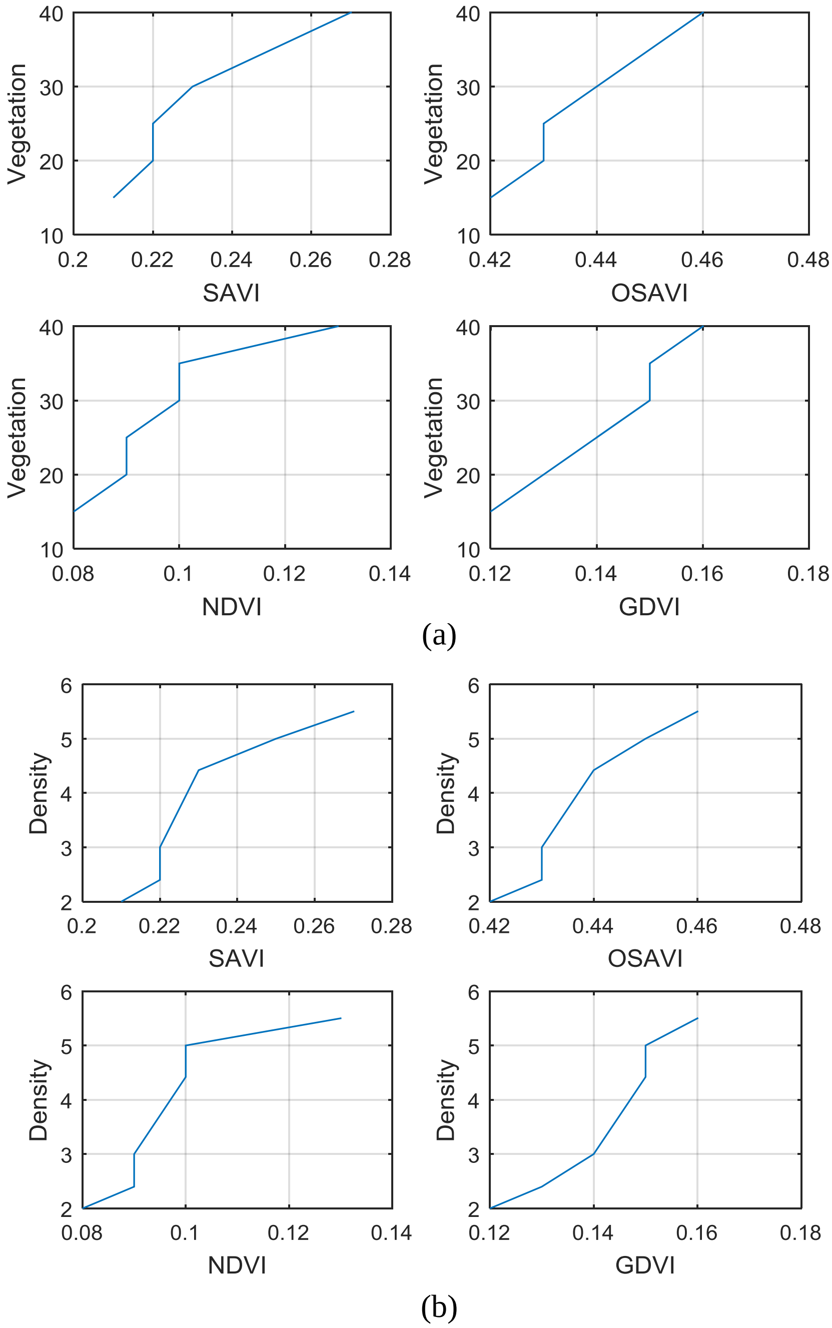

Figure 4. The comparison of vegetation indices in the study area and sample points plotted versus for the vegetation value (a) and value of the density (b).

The results of two Figures show that with increasing of percentage and density of vegetation, the value of vegetation indices increase. Finally, in order to determination of suitable elevation of growing of Artemisia herba alba was determined relationship between elevation and percentage of vegetation. According to Figure 5, the best elevation for growing of Artemisia herba alba was 1767 to 1782.

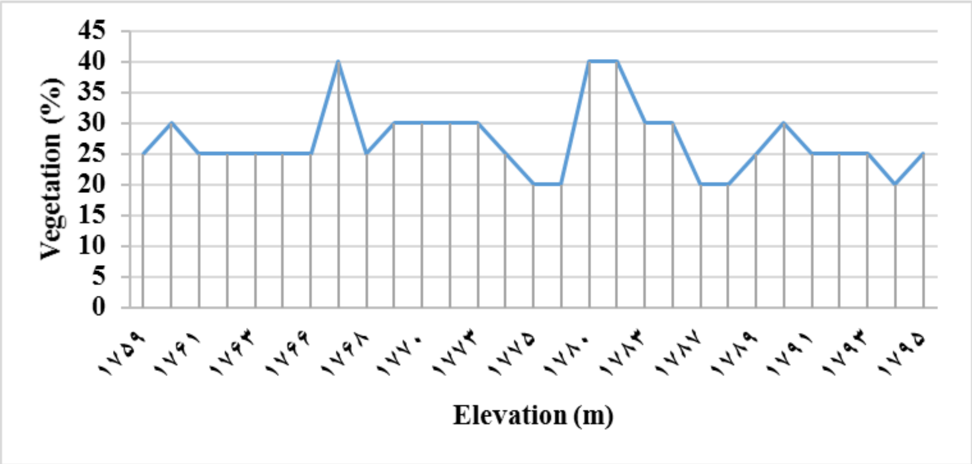

Figure 5. Relationship between elevation and percentage of vegetation for *Artemisia herba alba*

4. Conclusions

Remote sensing is the advanced tool for surveying. It provides the synoptic view of the area. Remote sensing satellites provide data with different spatial, spectral, radiometric and temporal resolutions. In the present study, the relationship between vegetation Indices, density and vegetation value of Artemisia herba alba were determined. Due to the importance of Artemisia herba alba in medical especially in traditional medicine, the study aimed to investigate this plant. Using remote sensing techniques in the study of vegetation has resulted in a low volume having access to a host of information with a high accuracy. In the study area, the relationship between indices GDVI, NDVI, OSAVI, SAVI and density and percentage of Artemisia herba alba were determined. With the increase of the percentage and density of vegetation, the value of vegetation indices increased. Finally, in order to determination of suitable elevation of growing of Artemisia herba alba was determined relationship between elevation and percentage of vegetation. Also, the best elevation for growing of Artemisia herba alba was 1767 to 1782. Generally, the results of the study showed that vegetation index compared with measured vegetation has benefits including reduced time, frequency of data and saving the cost and labor.

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