Effect of Rainfall and some soil Properties on some Vegetation Indices

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Abstract:

Sixteen sites with study transect across all physiographic region in Iraq were selected for this study representing the variation of climatic conditions. Mean annual precipitation ranges from more than 600 mm in northern sites to less than 150 mm in southern sites, with mean annual air temperature ranges from less than 20°C in northern sites to more than 25°C in southern sites. Seven images for Landsat-7 for 2012 covering all the selected sites were used in this study to determine the maximum values for NDVI and SAVI indices. Soil samples were taken from each selected site to determine some soil properties including soil salinity, soil texture, organic matter content and mineralogical composition. The results indicated that there is great effect of climatic conditions on the values of NDVI and SAVI and there is some correlation between soil properties and these indices.

Introduction:

The vegetation indexes are very significant to reflect more information of vegetation. Among them, the normalized difference vegetation index (NDVI, NDVI=(NIR–Red) / (NIR+Red)) NIR denoted the reflection of near infrared, red denoted the reflection of red light from visible light) is widely used, and it is the perfect indicator of growth status, spatial density distribution (Sun et al., 1998; Purevdorj et al., 1998; Liu et al., 1999) and phenology of plant (Defnies et al., 1994; Derrein et al., 1992).

NDVI was first used in 1973 by Rouse et al. from the Remote Sensing Centre of Texas A&M University. Generally, healthy vegetation will absorb most of the visible light that falls on it, and reflects a large portion of the near-infrared light. Theoretically, NDVI values are represented as a ratio ranging in value from -1 to 1 but in practice extreme negative values represent water, values around zero represent bare soil and values over 6 represent dense green vegetation.

The soil-adjusted vegetation index was developed as a modification of the Normalized Difference Vegetation Index to correct for the influence of soil brightness when vegetative cover is low. In areas where vegetative cover is low (i.e., < 40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values. This is especially problematic when comparisons are being made across different soil types that may reflect different amounts of light in the red and near infrared wavelengths (i.e., soils with different brightness values) Huete (1988) proposed the Soil-Adjusted Vegetation Index (SAVI) to based on NDVI and versus observations to eliminate the effect from background soils. The SAVI is structured similar to the NDVI but with the addition of a “soil brightness correction factor:

$$ SAVI = \frac{NIR - RED}{(NIR + RED + L)} \cdot (1 + L) $$

where NIR is the reflectance value of the near infrared band, RED is reflectance of the red band, and L is the soil brightness correction factor. The value of L varies by the amount or cover of green vegetation: in very high vegetation regions, L=0; and in areas with no green vegetation, L=1. Generally, an L=0.5 works well in most situations and is the default value used. When L=0, then SAVI = NDVI. This study was conducted to show the relationship between vegetation indices and some soil properties and rainfall in some Iraqi rejoin.

Materials and Methods

Sixteen sites with study transect across all physiographic region in Iraq were selected for this study representing the variation of climatic conditions (Figure 1). The study sites located...
under different climatic conditions. Mean annual precipitation ranges from more than 600 mm in northern sites to less than 150 mm in southern sites, with mean annual air temperature ranges from less than 20°C in northern sites to more than 25°C in southern sites (Figure 2). Seven images for Landsat-7 for 2012 covering all the selected sites were used in this study to determine the maximum values for NDVI and SAVI indices. Soil samples were taken from each selected site to determine some soil properties including soil salinity, soil texture, organic matter content and mineralogical composition for very fine sand fraction using general laboratory procedures as mentioned by Richards, 1954; Jackson, 1958 and Milner, 1962. Simple static correlation between each of NDVI, SAVI and precipitation, temperature and each soil properties were done.

Figure 1: Location of the study Sites

Figure 2: Physiographic regions in Iraq

Table 1 Some properties of the studies soils

<table>
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<tr>
<th></th>
<th>Gravimetric</th>
<th>Organic</th>
<th>Salinity</th>
<th>Texture</th>
<th>gravel</th>
<th>silt</th>
<th>clay</th>
<th>sand</th>
<th>organic</th>
<th>Carbon</th>
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<td>4</td>
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<td>0.3</td>
<td>85</td>
<td>15</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>0.4</td>
<td>0.3</td>
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<td>1.0</td>
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<td>90</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>1</td>
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Table 2 Reflectance values for different Bands and some indices for the studies sites

The values for NDVI and SAVI for all sites of the northern sites ranges from 0.13 to 0.31 and from 0.29 to 0.81 respectively. While, their values in southern site ranging between – 0.10 to 0.27 and – 0.104 to 0.38 for NDVI and SAVI respectively. These differences in the values for NDVI and SAVI are mainly, due to the effect of climatic conditions which have great effect on soil composition and vegetation cover (type and density). Soils of the northern sites show higher degree of development represent by deeper soil profile and higher content of organic matter (for the surface horizons) with dense forest vegetation cover causing higher values for both indices. While, southern sites have undeveloped soils with high salt content and very dispersed vegetation cover and most land are bare with out vegetation causing lower values for both
indices. The results (figures 3 and 4) indicated positive correlation between NDVI and SAVI indices and the mean annual precipitation in the study area.

Figure 3: The relation between NDVI and mean annual precipitation

Figure 4: The relation of SAVI and mean annual precipitation

While the results (Figures 5 and 6) indicated the negative relationship between values of NDVI and SAVI indices in the study area.

Theses results indicated that there is indirect effect of mean annual temperature on the selected indices as the increase of air temperature will have a negative effect on the soil moisture, soil organic matter and type and density of natural vegetation causing lower values for both indices. Also, the increase of temperature will have great effect of soil salinity.

The results (Figures 7, 8 and 9) indicated that there is a good correlation between some soil properties and NDVI and SAVI indices.

Figure 7 shows that as soil salinity increase NDVI decrease due to the effect of salinity on other soil properties which have great effects on plant growth. Salinity have some effects on water and nutrients availability for plant. While, on other side, as the content of organic matter increase the value of NDVI will increase as many other soil properties will improve including nutrient and water availability, soil aeration and soil structure.

For that reasons, the studied sites in northern part from Iraq show higher values for both indices in comparison to the sites in southern part (Table 2).
Conclusion:

The results indicated the effects of climatic condition on the values of NDVI and SAVI indices. In general, soils of northern Iraq show higher values for both indices in comparison to the soils of southern part due to the effects of some properties of the studied soils which have great effects on the vegetation growth. Soils of the northern part of Iraq have, in general, good properties suitable for plant growth, while the soils of the southern part are seafaring from salt accumulation due to dry climate and bad management.

References:


