Use remote sensing techniques to estimation of vegetation factor (C) for selected areas in Diyala Governorate

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Abstract. This study was conducted on the floor coverings of Diyala Governorate, central Iraq, between latitudes 44° 27'31.99'' -45º 25'11.78'', and 33º 30' 8.66 ''-34º36'48.18'', with an area of 10,336,399 km². Using the two satellite images of the Landsat 8 satellite OLI_TIRS (rod 36, 37 and path168) captured on 29/4/2018. For the purpose of the NDVI calculation and then a mathematical equation was applied to calculate the values of factor C, the study determined the classification of NDVI values and C factor values to 4 categories. The low values of the C factor were concentrated in the presence of forests and orchards with dense vegetation cover (0 - 0.04731), whereas the average values were concentrated in areas with medium density vegetation cover and agricultural areas cultivated with different crops ranged from (0.04732 -0.09462) The high values of the vegetation factor were concentrated in the areas of water, mountain ranges and building areas where there is no vegetation cover and ranged between (0.09463 - 0.18925).

Keywords: vegetation factor (C), vegetation index, NDVI, remote sensing, soil erosion.

Introduction

Water erosion is one of the most important factors leading to soil degradation and low production. It is affected by soil properties, rainfall intensity and vegetation. Estimating the risk of soil erosion and spatial distribution of this risk is one of the main elements of the successful assessment of soil erosion. Develop successful policies to reduce soil loss, taking into account the diverse geographical conditions of the studied area (Panagopoulos and Ferreira, 2010). To achieve this, many international models that achieved good results were used to predict the seriousness of the drift and determine its spatial distribution. The accuracy of these models differed in determining the risk of drift by the type of indicators that make up the model (Wambua et al., 2009).

The Global Soil Loss Equation (USLE) is the most important model designed to predict the amount of soil lost by surface runoff in crop areas, subject to specific management applications. This equation was based on factors whose local values are measured, such as the ability of rainfall to cause erosion, soil susceptibility to erosion, topography and vegetation, given as follows (Wischmeier and Smith, 1978):

\[ A = R \times K \times LS \times C \times P \]
As:

\[ A = \text{Annual rate of lost soil (ton / ha / year)} \]
\[ R = \text{Rain intensity factor} \]
\[ K = \text{Soil erosion factor (ton / ha)} \]
\[ LS = \text{slope length factor and gradient (in degrees)} \]
\[ C = \text{vegetation factor.} \]
\[ P = \text{Soil maintenance factor.} \]

Because of the difficulty of estimating the drift factors involved in this equation, especially in the wide and different areas of the elevations and slopes, and because the values of factor C in the global soil loss equation were considered only for the crops, the global equation for soil loss (USLE) Taking into account forests, pastures and untreated soil, as well as adjusting the slope and regression method using modern technologies, thus setting the revised global equation for soil erosion (RUSLE), which enabled the prediction of the amount of soil drifting in the case of various non-agricultural conditions (Shinde et al. 2010). Because vegetation factor C is an important indicator of the amount of soil lost when applying both USLE and RUSLE because of its high impact on soil erosion (Bonilla et al., 2010), it is difficult to estimate the traditional methods, especially in the wide and diverse areas covered In this context, it was possible to find more rapid and accurate methods for estimating the values of this factor. This was demonstrated by the use of remote sensing techniques and spatial image analysis. The analysis of spatial images can determine the value of the Normalized Difference Vegetation Index (NDVI).

The NDVI (Normalized Difference Vegetation Index) is one of the most proven spectral vegetation evidence used in the field of vegetation studies. It has been used extensively in the study of temporal and spatial dynamics of vegetation (Lukasova et al., 2014), as well as its use in growth estimates, biomass, Productivity and biodiversity, Mohamed (2015). The NDVI index is based on the spectral characteristics of vegetation, compared to vegetation-free areas. Green plants absorb red color strongly, and reflect nearby infrared radiation. This is caused by chlorophyll in the green leaves, so the areas with dense vegetation differ in their spectral characteristics in the infrared and infrared ranges compared to areas with less dense or plant-free vegetation, and the NDVI index is calculated using the difference in the amount of reflected radiation in the red channels and infrared divided by the sum of the reflection in the two channels. The value of the NDVI index is between (-1 and + 1), the value of which is close to 1 (0.8-0.3) when there is dense vegetation, about 0.1 in the case of bare soil, and(0.2 - 0.3) with the presence of shrubs and herbs, and the negative values of the guide is recorded in the case of clouds and snow-covered areas (Ilene and Wael, 2016).

After determining the NDVI values, it is possible to calculate the C values of the inverse correlation between them. A number of studies on soil erosion have been based on estimating the C values of this method and have produced results. Mona et al 2014 have conducted a study to estimate the vegetation factor using the NDVI for the Upper and Lower Basin region of the Northern Kabir River in the governorate of Latakia / Syria. The results showed that the low values of factor C were concentrated in parts of the eastern and northern regions where forests predominate, while the high values of factor C were concentrated in the western regions, ranging between (0.8-1), the areas of Amran and buildings where there is no Where the cover is And the average values of factor C were concentrated in parts of the central and eastern regions, where citrus and olive cultivation, which provide moderate protection, are valued with a factor of 0.4-0.8.
In a study by Okore et al. 2017 for estimating factor C in Imo state in Nigeria using remote sensing techniques, the study reached NDVI values ranging from -0.1035 to 0.836 while the values of factor C ranged from 0.33 to 1.34. Degen et al.2017 their study of vegetation factor C in northern China shows that the different values of the worker vary according to the distribution of vegetation, especially forests. The C value depends on the type of vegetation cover and the growth stage. The higher values of the C factor do not affect the cover and soil loss compared to the barren land, while the low C value implies a very strong cover effect resulting in non-erosion (Yuan et al 2016).

The objective of this study is to find the values of factor C based on the values of the NDVI index in a vital and environmentally important region where the vegetation cover (forests, crops, citrus, palm trees and other fruit trees) is different and with different terrain.

Materials and Methods

Study area:

The study area was determined by field visits using the GPS Test program and downloaded on the Galaxy J7 and compared to the coordinates taken with the Global Positioning System (GPS) 100% of the readings corresponded, the study area within the administrative boundaries of Diyala Governorate. Coordinates between between latitudes 44° 27'31.99'' - 45° 25'11.78'', and 33° 30' 8.66 "-34°36'48.18", with an area of 10,336,399 km².

Satellite images:

In this study, two satellite images were used for Landsat 8, the OLI_TIRS sensor (rows 36, 37 and path 168), captured on 29/4/2018 as shown in Figure 1.

![Figure 1. Study area in Diyala Governorate](image)

Processing of satellite images:

Using the Erdas Imagine 2014 program, we have integrated Mosaic for the two satellite images because the study area is located in the two images and then we cut and map the study area as shown in Figure 2.
Figure 2. Map of the study area

Set up an NDVI map

Using the Erdas Imagine 2014 program, the NDVI map was prepared as shown in figure (3). To calculate the NDVI values from the satellite data of the study area, use Erdas Imagine V.14 and apply the following equation (Ahmed, 2018):

$$ N = \frac{\text{Band}(\text{NIR}) - B}{\text{Band}(\text{NIR}) + B} $$

As:

NIR = Near Infrared Ray

RED = red Ray
Calculation of vegetation factor C

After obtaining the NDVI values for the study area, the values of factor C were calculated using an arithmetic relationship that allows the estimation of the vegetation cover factor in terms of NDVI (Karaburun, 2010) as follows:

\[ C \text{ factor} = 1.02 - 1.21 \times \text{NDVI} \]

Which confirmed the inverse correlation relationship (R) between both C values and NDVI values as shown in Figure 4.
Figure 4. Linear relationship between NDVI and vegetation factor values C

This relationship has been used to calculate factor C values in many drifting studies and is currently one of the most important, easiest, and most accurate methods for calculating this factor (Alatorre and Beguería, 2010).

Results and discussion

NDVI Study Area

The NDVI index represents the ratio between spectral reflections at infrared wavelength and red wavelength on the total of these reflections at the wavelengths (Anejionu et al., 2013). The higher the NDVI values approached (+1), the greater the vegetation cover. If the values of NDVI are reduced to (-1), this refers to the soils or rock discoveries (Aghasi et al., 2011). Using ARC GIS V.10.3 and Erdas Imagine V.14 the NDVI map was developed as in Figure (5).
Figure 5. Map of NDVI values for the study area.

In Figure 5, we note that NDVI values ranged from -0.743 to 0.975, with an average of 0.115174 and a standard deviation of 0.49845, we can classify the NDVI values into 4 categories (Ehsan and Kazem, 2013). They are low (0.7431-0.0983) and include water such as Lake Hamrin, Diyala River and other areas of water, as well as the barren land and the series of hills free of vegetation, medium (0.1050-0.2935) includes agricultural land cultivated with various crops scattered in most parts of Diyala province and grasslands and jungles, high (0.3002-0.5964) and includes vegetation cover of citrus orchards, grapes, pomegranates, other fruit species and scattered trees here and there and are located in the areas of Muqdadiya, Baquba and Khalis and very high (more than 0.6032) and includes various fruit orchards of high density and palm groves spread along the outskirts of the Diyala River and the forests located in the areas of Canaan and Baldrose.

Calculation the value of vegetation factor C

The values of factor C were calculated based on NDVI values, ranging from (0-0.18925), with an average of (0.17305) and a standard deviation of (0.0529), using ARC GIS V.10.3 and Erdas Imagine V.14. The NDVI map was prepared as in Fig. 6.
From Figure 6, we note that the high values of the vegetation factor were concentrated in the areas of water availability, mountain ranges and building areas where there is no vegetation cover, ranging from (0.09463- 0.18925). The medium values were concentrated in areas with medium density vegetation cover and agricultural areas cultivated with different crops ranged from (0.04732-0.09462), While the low values were concentrated in the areas of the presence of forests and orchards with dense vegetation cover ranged from (0 - 0.04731). What has been obtained is consistent with the results of many researchers (Estoque and Murayama, 2011; Mona et al., 2014) who confirmed the inverse relationship between C and vegetation values, where C values were lower in places with good vegetation cover.

CONCLUSIONS

The study on the estimation of vegetation factor C using NDVI for selected areas in Diyala governorate showed the following:

1- The low values of factor C were concentrated in the presence of forests and orchards with dense vegetation cover (0-0.04731), whereas the average values were concentrated in areas with medium density vegetation and agricultural areas cultivated with different crops, ranged from 0.04732-0.09462. Vegetation was concentrated in the areas of water availability, mountain ranges, and buildings, where there is no vegetation cover and ranged between (0.09463- 0.18925).

2- Calculation of Factor C values using this technique refers to dense vegetation cover areas and vegetation-free areas, thus drawing attention to the need for change in the agricultural system in places where the values of factor C are high to ensure the necessary coverage.

3. The use of remote sensing technology in the calculation of the values of factor C, which is the most important indicator on which to determine the risk of drift, is an easy and quick way, where in a short period of time can calculate the values of factor C for large areas.

Recommendations

Due to the importance of this factor in that it gives an idea of the distribution of vegetation cover and its role in soil protection from erosion, we recommend the adoption of the method used in this study to estimate the factor of vegetation in studies that address the problem of erosion or water erosion of soil in other areas of Diyala.

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