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TEMPORAL AND SPATIAL ANALYSIS OF VEGETATION ON THE SOIL SURFACE WITH NDVI ANALYSIS

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Abstract. In the paper changes in vegetation and soil cover were identified by analyzing Landsat, Sentinel, Azerskay satellite images obtained in 2015-2021 on the basis of normalized vegetation differentiation index (NDVI) within the capabilities of ArcGIS program. The Vegetation Index (NDVI), calculated from satellite images, is widely used to track green vegetation on Earth. This study aims to investigate temporary changes in vegetation density, such as the distribution within the study area, the date of plant growth, and the date of reaching the highest density. This information was analyzed by ArcGIS. According to the results of the study, the vegetation activity started in the southern and north-eastern part of the study area. It is shown that vegetation changes can be successfully tracked and analyzed with NDVI data.

Keywords: *Satellite imagery, NDVI, ArcGIS, Vegetation, Remote sensing.*

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1. Introduction

Vegetation density, soil, relief and other environmental conditions such as sunbathing are greatly affected by climate change. We know that there is a positive relationship between rainfall and vegetation (Babaeva, 2005). Vegetation viability in an area with sufficient rainfall also indicates high agricultural production. Using the relationship between these two parameters, it is possible to predict the possible amount of agricultural production with remote sensing data (Bulgakov, 2002). One of the most widely used tools in remote sensing technology to track green vegetation is the Normalized Vegetation Index (NDVI). NDVI is calculated from the bands that detect the wavelength of light, near infrared (NIR) and red (RED) (Becker & Li, 1990).

What is NDVI? Technically speaking, green leafy plants absorb sunlight, which we use as a source of energy during photosynthesis (a chemical phenomenon that allows plants to produce organic food with light energy is called photosynthesis) (Ian Williamson *et al.*, 2011). For this reason, live plants look brighter in infrared (NIR) cameras. Chlorophyll in plant leaves strongly absorbs visible light (VIS) (0.4-0.7 μm) for use in photosynthesis. The special cellular structure of the leaves is strongly reflected in the near-infrared light (0.7 - 1.1 μm). As a result, the more leaves a plant has, the more it is affected by the wavelengths of light.

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2. Materials and methods

NDVI values theoretically range from (-1) to (+1). In areas with high green vegetation, the index value is close to +1, clouds, water and snow have low (negative) NDVI index values. In the case of bare soil and poor vegetation, it shows an NDVI value close to zero. When agricultural-intensive areas are observed on the NDVI map, areas with low NDVI values show areas with poor plant growth due to various causes such as drought, excessive moisture, diseases and pests. On the other hand, high NDVI values indicate areas where plant growth is healthy (Pobedinsky & Erukov, 2004).

As shown in the following mathematical equation, NDVI, generated by mathematical modeling of these two wavelengths, is taken as the main indicator of plant biomass quantity and leaf area index value and is used to monitor plant growth and evaluate yield (Rasouli *et al*., 2021).

$$NDVI = \frac{NIR-RED}{NIR+RED} \quad (1)$$

where: NIR - reflection in the near-infrared spectrum; RED is a reflection in the red spectrum. According to this formula, the density of vegetation is equal to the ratio of the difference of the intensity of light reflection in the red and infrared ranges at a certain point in the image.

According to the results of the formula, you can analyze the condition of the plant as follows:

Table 1. Condition of vegetation

Other	Condition of vegetation
<0	Road, building, concrete, etc.
0- > 0,33	Weak vegetation (sparse)
0,33->0,66	Healthy vegetation (medium)
->0,66	Very healthy vegetation (dense)

3. Results and discussion

The Jalilabad cadastral district selected as the object of research covers an area of 1,440 km. In addition to the study on the basis of spatial images, land sections were placed in characteristic places, field observations were made, and the state of productivity depending on soil-climatic conditions and cultivation was studied. Spatial images of July 2015 and 2021 Image analysis conducted in the ArcGIS program allowed to determine the direction of changes in soil vegetation. An electronic map of vegetation was compiled, based on the results taken from the attribute table, changes in soil and vegetation in Jalilabad cadastral region during 2015-2021 were identified: forest cover - 0.20%, shrubs - 0.09%, pastures 0, 60%, arable lands decreased by 0.20%, swamps - by 0.51%, inland waters decreased by 0.30% (Fig. 1-2).

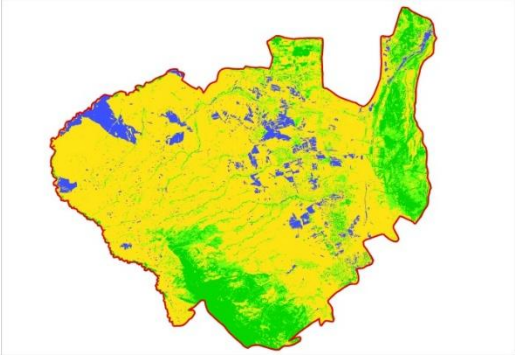

Fig.1. Vegetation of Jalilabad cadastral region, 2015

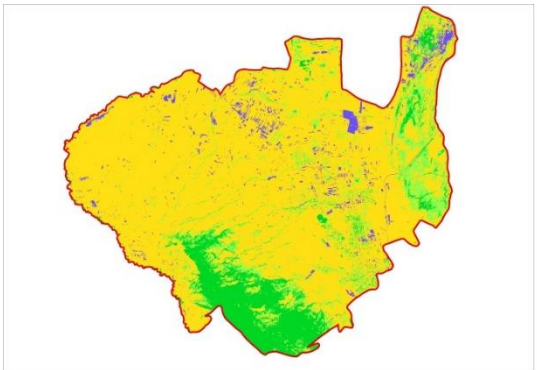

Fig.2. Vegetation of Jalilabad cadastral region, 2021

The following images show Jalilabad cadastral district, Uchtapa village, 48 ° 28 '33,524 "E 39 ° 20' 1,243" N, Tazakend village, 48 ° 29 '42,019 "E 39 ° 19' 34,408" N and Alar village 48 ° 31 '22,918 " E 39 ° 18 '36,955 "N satellite coordinates of the area and maps compiled on the basis of NDVI analysis and locations of land sections determined by coordinates via CPS are shown on the satellite image (Fig. 3).

Fig. 3. Location of plots and an example of NDVI analysis

NDVI data have been used successfully by many scientists in different parts of the world, especially in the study of vegetation in large areas. The NDVI method is more useful than traditional methods due to both the rapid acquisition of vegetation change data and the lower cost of large-scale research. In particular, plant index values obtained from daily satellite data provide significant advantages in tracking biological activities.

In the research conducted in Jalilabad cadastral region, using Landsat NDVI data, the change of the main plant groups in Jalilabad cadastral region during the year was investigated. He also studied the seasonal variation of pasture vegetation with NDVI data. With this information, the leaf area index (LAI), biomass and soil cover ratio can be determined depending on the season. It was stated that these parameters are mainly related to soil fertility, soil moisture, sowing time and plant density.

In this study, multi-temporal NDVI data were analyzed with maps obtained by the ArcGIS program and mapped to investigate temporary and spatial changes in vegetation in the Jalilabad cadastral area.

The NDVI index for the territory of Jalilabad cadastral region was determined on the basis of ArcGIS-Image Analysis function, Landsat 5 and 8 satellite images and spatial analysis.

Note that the short-infrared rays in Landsat 5 range from 0.76 to 0.90 microns, and in Landsat 8 from 0.851 to 0.879 microns. The red rays range from 0.63 to 0.69 microns and 0.636 to 0.673 microns, respectively. The program performs all calculations on a pixel basis and generates the results in the form of a raster map (McBratney *et al.,* 2003).

Although the value of NDVI is low due to the lack of snow or vegetation at the beginning of the year, over time the plant begins to revive and peaks in a certain period. Then the process is completed when the vegetation begins to turn yellow. ArcGIS cannot provide data for these regions because NDVI values do not generate a year-round bell-like distribution in the water surface, in continuous snow cover, or in bare areas deprived of vegetation. Similarly, the beginnings and dates of vegetation reach their peak. This program can also provide information in areas that are not as severe due to agricultural practices (growing two crops per year) (Mammadov *et al*., 1998, 2003, 2018).

NDVI is related to biological activity parameters such as photosynthetic activity of vegetation, amount of greenery and maturity. Work such as drought analysis and grazing use planning can be done by tracking the initial and peak values of vegetation with long-term satellite data. ArcGIS outputs from different years can be used to evaluate the yield of widely grown crops such as cereals (https://www.usgs.gov).

Thanks to NDVI technology, you can find out the condition of the crops on your land (field, soil, etc.), the vegetables you grow, or the viability of the plants in the area or whether the plant is diseased by analyzing NDVI images.

4. Conclusions

In the selected field of experiment, NDVI-normalized different vegetation index was found to be in the range of 0.7-0.05. The ArcGIS program has developed a vegetation intensity map (NDVI) for Jalilabad cadastral district for 2015 and 2021. Analysis of satellite images in the territory of Jalilabad cadastral region allowed to identify the following changes in soil and vegetation cover in 2015-2021: forest cover - 0.20%, shrubs - 0.09%, pastures 0.60%, sown areas 0, 20%, swamps - 0.51%, inland waters - 0.30%. Determining the normalized different vegetation index of vegetation is an invaluable tool for farmers, tax and property workers in studying the agronomic condition of soils, determining fertilizer and irrigation norms, other agro-technical, agro-ameliorative measures, reducing land cultivation costs.

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