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Analysis of Spatial Variability in Vegetation Cover Using NDVI and dSAVI Indices With Climatic Conditions Taken Into Account

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SUMMARY

The study examines the spatial variability of vegetation cover based on the NDVI and dSAVI vegetation indices, taking climatic conditions into account. Climatic conditions were analyzed for the years 2020–2023, while the comparison of vegetation indices was performed for 2023. For detailed analysis, the year 2023 was selected, for which a comparison of results was conducted for two time periods of satellite imaging. Climatograms of average monthly air temperature and precipitation were constructed, average values of vegetation indices were determined, and their spatial distribution was compared. Between May 29 and June 16, 2023, the average monthly air temperature rose from 14.70 to 19.57 °C, the amount of precipitation increased from 10.40 to 62.25 mm, the average NDVI rose from 0.157 to 0.220, and the dSAVI from 0.099 to 0.621. Spatial analysis showed that at the initial stages of vegetation development, the dSAVI index more accurately reflects the heterogeneity of the vegetation cover, while the NDVI characterizes its general condition. The results obtained confirm the feasibility of using climate indicators and vegetation indices in the analysis of spatial variability of crops.

Keywords: Sentinel-2; NDVI; dSAVI; Vegetation cover; Spatial variability; Climatic conditions; Precision agriculture.

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Introduction

The development of vegetation cover depends on a combination of climatic conditions, soil properties, and biological characteristics of crops. Temperature regime and atmospheric moisture determine the intensity of growth processes throughout the growing season, which is reflected in the spectral characteristics of vegetation and can be estimated using remote sensing data (Funk et al., 2015).

Sentinel-2 satellite data are widely used for monitoring vegetation cover due to their high imaging frequency, multispectrality, and spatial resolution of 10, 20, and 60 m (Drusch et al., 2012). Based on these data, vegetation indices are calculated and used to assess the condition of crops, as well as analyzing seasonal dynamics and spatial heterogeneity of agricultural lands (Bannari et al., 1995).

The most common indicator of vegetation condition in precision agriculture technologies is the NDVI index (Rouse et al., 1974), which is widely used to assess crop condition, analyze spatial variability of vegetation cover, construct heterogeneity maps, and support decision-making on differentiated crop management in precision agriculture technologies. However, in the early stages of crop development, NDVI values are largely dependent on the influence of bare soil, which can complicate the assessment of spatial heterogeneity in vegetation cover. To reduce this influence, an adaptive dSAVI index has been proposed, in which the value of the soil correction coefficient is determined depending on the current state of vegetation cover (Zatserkovnyi et al., 2026).

The use of dSAVI makes it possible to account for changes in the ratio between vegetation and bare soil within a field, which is of particular importance at the initial stages of crop development. Comparing the results obtained from the NDVI and dSAVI indices allows for assessing the specific features of their application for the analysis of spatial heterogeneity in crops under the same climatic conditions (Zatserkovnyi et al., 2025).

The aim of the work is to assess the spatial variability of vegetation cover using the NDVI and dSAVI vegetation indices, taking climatic conditions into account, based on Sentinel-2 data.

Methods

The analysis was performed using Sentinel-2 Level-2A satellite data and climate data obtained using EarthExplorer (U.S. Geological Survey, 2025). At the first stage, the average monthly air temperature and precipitation for 2020–2023 were analyzed to characterize the climatic conditions of the study area.

Further analysis was performed for 2023 using satellite images from May 29 and June 16. Material processing, calculation of vegetation indices and construction of thematic maps were carried out in the ArcGIS software environment (Esri, 2025). To assess the state of vegetation cover, the NDVI (Rouse et al., 1974) and dSAVI (Zatserkovnyi et al., 2026) indices were used.

Spatial variability was assessed by comparing NDVI and dSAVI cartographic models constructed for two periods of satellite imaging. For each index, the average values were determined and their comparison with the average monthly air temperature and precipitation was performed.

The study was carried out on an agricultural field with an area of 309.6 hectares, located near the village of Berizka, Varvynska territorial community, Pryluky district, Chernihiv region (Fig. 1). The territory is represented mainly by typical low-humus and degraded light loamy chernozems. The relief is slightly undulating with a height difference of about 20 m and a maximum slope steepness of up to 4°. Such natural conditions cause spatial heterogeneity of moisture and create rerequisites for the formation of differences in the state of vegetation cover.

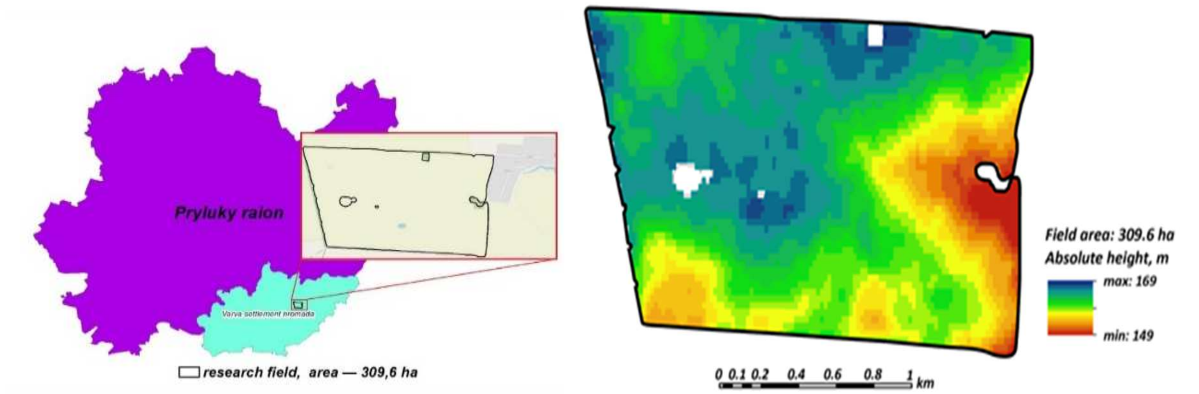

Figure 1. *Location of the studied field and digital terrain model (field area — 309.6 hectares)*

Results

The climatic conditions of the study area in 2020–2023 are shown in Fig. 2. The climatograms reflect the seasonal variation in average monthly air temperature and precipitation. In all years, the highest temperatures occur in the summer months, while the distribution of precipitation is characterized by pronounced interannual variability. The largest differences are observed in May and June, when there is active development of vegetation cover.

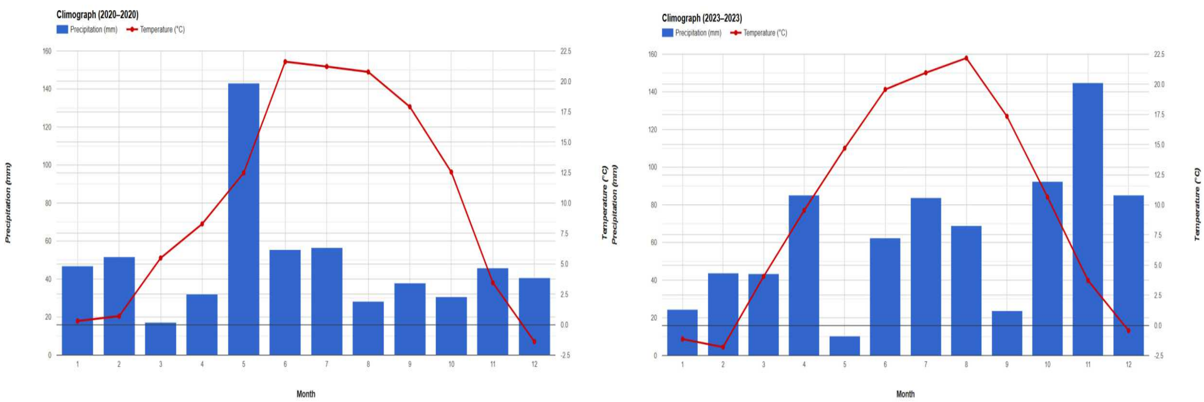

Figure 2. *Climatograms of average monthly air temperature and precipitation for 2020 and 2023*

For a detailed analysis of the spatial variability of vegetation cover, the year 2023 was selected, for which a comparison of the vegetation indices NDVI and dSAVI was performed for two periods of satellite imaging - 05/29/2023 and 06/16/2023. Table 1 shows the average monthly air temperature, the amount of atmospheric precipitation and the average values of the vegetation indices for the corresponding periods of observation. During the studied period, the average monthly air temperature increased from 14.70 to 19.57 °C, and the amount of atmospheric precipitation – from 10.40 to 62.25 mm. At the same time, the average value of NDVI increased from 0.157 to 0.220, while the dSAVI rose from 0.099 to 0.621. The increase in the values of both indices occurred simultaneously with changes in temperature and atmospheric humidity. At the same time, dSAVI was characterized by a greater amplitude of change in average values compared to NDVI.

The spatial distribution of indices also underwent changes: the areas of plots with high values increased, while the areas with low values decreased. The most pronounced changes are observed in the central and eastern parts of the studied field, where the intensity of vegetation development was higher compared to other areas. The features of the spatial distribution of NDVI and dSAVI are illustrated by the cartographic models (Fig. 3, 4).

Table 1. Climatic indicators and average values of NDVI and dSAVI vegetation indices for the satellite imaging periods in 2023

Satellite image date	Average monthly temperature, °C	Amount of precipitation, mm	Vegetation indices (average)	
			NDVI	dSAVI
29.05.2023	14.70	10.40	0.157	0.099
16.06.2023	19.57	62.25	0.220	0.621

The spatial distribution of the NDVI index is shown in Fig. 3. The image dated May 29 is dominated by areas with low and medium index values, which corresponds to the initial stages of vegetation development. In the image dated June 16, 2023, the area of zones with high NDVI values increases noticeably, while the area of zones with low values decreases. The most intense changes are observed in the central and eastern parts of the studied field.

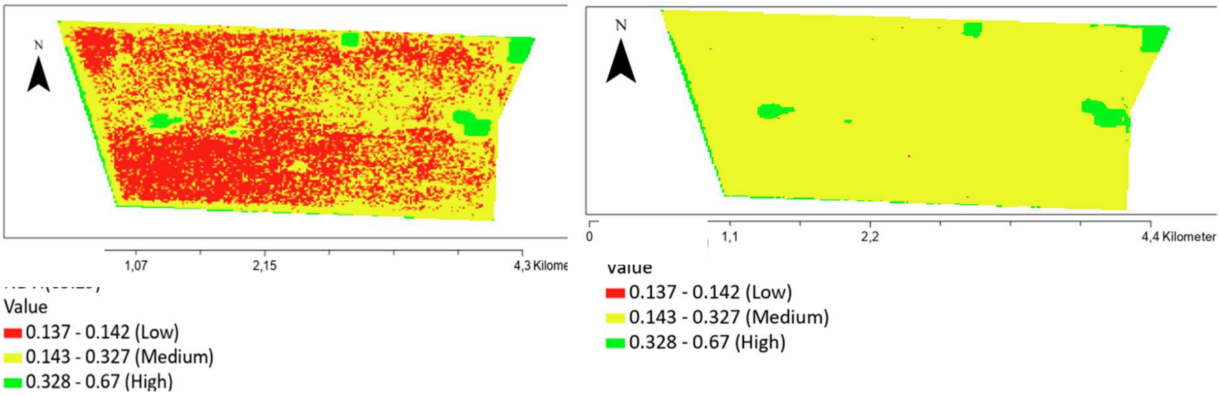

***Figure 3.** Spatial distribution of the NDVI index according to Sentinel-2 data 05/29/2023 and 06/16/2023*

The spatial distribution of the dSAVI index is shown in Fig. 4. In the image dated May 29, the index more clearly reflects the heterogeneity of the vegetation cover and the boundaries of individual plots within the field. In the image dated June 16, 2023, the area of plots with high dSAVI values increases, and the spatial distribution of the index becomes more uniform. Compared to NDVI, local features of the vegetation cover stand out in more contrast. This is most noticeable in areas with low vegetation density.

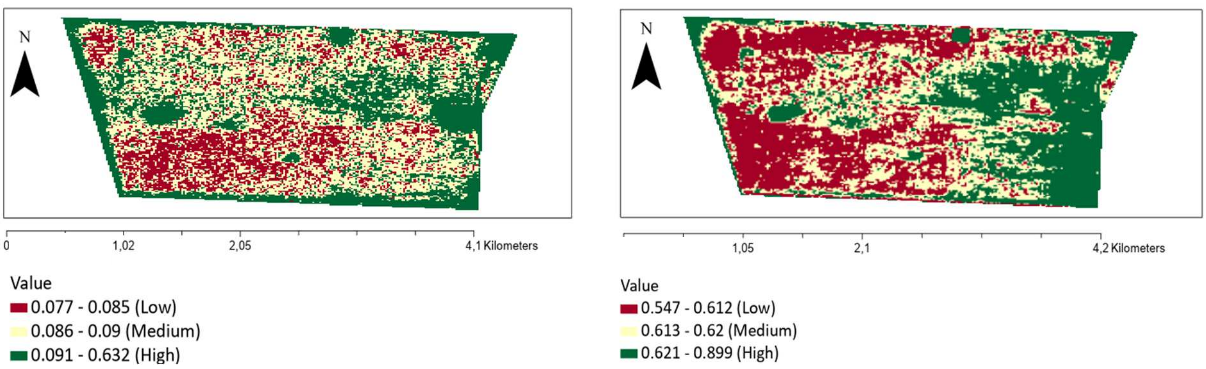

***Figure 4.** Spatial distribution of the dSAVI index according to Sentinel-2 data 29.05.2023 and 16.06.2023*

Comparison of the results showed that changes in the average values of NDVI and dSAVI between the periods of satellite imaging occurred simultaneously with changes in temperature and atmospheric humidity. At the initial stage of vegetation development, the dSAVI index reflects the spatial heterogeneity of crops in more detail, while NDVI characterizes the overall change in the state of vegetation cover.

Conclusions

The climatic conditions of the study area for 2020–2023 were analyzed. The year 2023 was selected for a detailed analysis of the spatial variability of vegetation cover.

For the satellite imaging dates of 05/29/2023 and 06/16/2023, the average monthly air temperature increased from 14.70 to 19.57 °C, and the amount of atmospheric precipitation rose from 10.40 to 62.25 mm. During the same period, the average NDVI value changed from 0.157 to 0.220, and dSAVI from 0.099 to 0.621.

A comparison of the NDVI and dSAVI cartographic models showed differences in the spatial distribution of vegetation cover between the satellite imaging periods. At the initial stage of crop development, the dSAVI index reflects the spatial heterogeneity of crops in more detail, while NDVI tends to show the general condition of vegetation.

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