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Vegetation Indices for Optimizing Crop Monitoring

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ABSTRACT
Remote Sensing application is important in farming practices. Vegetation indices are very necessary in crop monitoring, healthiness and yield estimation, vegetation indices are expressive formulas. This paper makes use of soil-adjusted vegetation index (SAVI) for crop monitoring by making use of relevant software, in addition to field work. A particular crop was monitored from planting to harvest stage.

Keywords: Remote Sensing; Soil Adjusted Vegetation Index **(**SAVI**)**; Crop Monitoring.

INTRODUCTION

Depending on the vegetation index, information on various aspects of plant growth and development can be monitored, such as chlorophyll content, leaf area, canopy structure, and water status. Vegetation indices have a crucial role in precision agriculture and crop monitoring by providing a straight forward and reliable assessment of the condition and health of crops Dorijan et al. (2023). In precision agriculture, it is possible to use satellite monitoring of fields. Satellite monitoring systems allow you to get free images with a resolution of up to 10 per pixel, which is sufficient to determine the state of vegetation of plants on such indicators as the normalized vegetation index NDVI.

Soil-adjusted vegetation index, is used for this purpose Andrii et al. (2023). Jiaguo et al 1994 explained that soil-adjusted vegetation index (SAVI) was developed to minimize soil influences on canopy spectra by incorporating a soil adjustment factor L into the denominator of the normalized difference vegetation index (NDVI) equation. For optimal adjustment of the soil effect, however, the L factor should vary inversely with the amount of vegetation present. Forecasting the future yield of crops is an important component of sustainable and profitable agricultural production. One way to predict is to identify possible plant problems early. To identify these problems, you need to conduct a timely inspection of crops. This work is possible with the involvement of employees of the agronomic service, who will inspect the fields with the use of drones, or by means of satellite monitoring systems (Sagan et al., 2020). Taking into cognizance of the results of earlier studies, there is actual possibility of monitoring and detecting on time problems on crops with the use of satellite monitoring systems. For this research, the SAVI adjusted vegetation index was used.

Study Area

The study area is Northern Taraba in Nigeria basically Lau and Donga. It has wet and dry season. The wet season lasts for majorly 7 months which is from April to October while the dry seasons last for about 5 months from November to March. Lau and Donga has all the types of soil ranging from sandy, loamy and clay soil but the loamy soil was discovered to be more during field visit. The people of Donga and Lau are predominantly farmers.

Materials and Method

Satellite sensors in space measure the wavelengths of light absorbed and reflected by green plants Nitin et al 2025

The spectrometric data for this paper was from remote sensing satellites. The following methods was basically used for the research on the analysis of the use of SAVI for monitoring changes in crop.

1. Data Acquisition: Landsat Time series Satellite Imagery moderate resolution.
2. Pre-processing: Image Correction, Geometric Correction.
3. Band Selection, Calculation of SAVI using the Raster tool bar of ERDAS.

4. Change Detection: Thresholding, Supervised or unsupervised methods for Classification in vegetation cover.

There are so many vegetation indices for crop monitoring but the focus is on SAVI. Therefore, SAVI is a modified form of NDVI that includes a soil-adjustment factor L to account for effects from a variable soil background. In a near-infrared versus red scatterplot, the L factor shifts the origin of the plot so that the soil line and all lines of equal index value pass through the origin. The L factor can be specified as an estimate of the percentage of bare soil in the scene. Use the *Bare Soil %* parameter field to set this value. The default value is 50%. Inputs should have reflectance values between 0 and 1.

SAVI = (1 + L) * (NIR - RED) / (NIR + RED + L)

Reference: Huete (1988).

In this paper after the above numbered processes, the Raster Calculator of the Map Algebra Tools of ArcGIS Spatial Analyst Tools which was used to calculate the SAVI for optimizing crop monitoring. Then Zonal Statistics as Table Tool in ArcGIS Toolbox was used to summarize the values of the SAVI - Soil Adjusted Vegetation Index within each sugarcane plots and reports the mean vegetation index was reported.

RESULT AND DISCUSSION:

ArcGIS 10.3 Spatial Analyst Tools had been used to calculate broad band greenness indices for the Plantation in the study area Figure 1 shows the map of the soil adjusted vegetation indices for the Planting season, December 2017, February, 2018 and April, 2018. This shows that the SAVI broad band indices when prepared in maps can be used to monitor the development of crop condition in the region. Plantation areas affected by pests or plant diseases can be sighted from maps.

Following the overlay of the sugarcane farm plots on the broad band indices and the subsequent generation of the mean value of the indices over each farm plot, table 1 were computed. Table 1 shows the value of the broadband indices in December 2017 February, 2018 and April, 2018. A selection two plots from Lau in which sugarcane was planted and confirmed from ground truth data was selected for comparison.

Table 1 shows the value of the 5 indices in December 2017 February, 2018 and April, 2018.

	Name					SAVI
	PLANTING					
Dec 2017	PLOT 1 (Donga)					0.16
	PLOT 2 (Donga)					0.14
	PLOT 3 (Donga)					0.17
	PLOT 4 (Donga)					0.15
	PLOT 1 (Lau)					0.18
	PLOT 2 (Lau)					0.15
	MID-SEASON					
Feb 2018	PLOT 1 (Donga)					0.14
	PLOT 2 (Donga)					0.13
	PLOT 3 (Donga)					0.12
	PLOT 4 (Donga)					0.12
	PLOT 1 (Lau)					0.15
	PLOT 2 (Lau)					0.15
	MATURITY					
April 2018	PLOT 1 (Donga)					0.23
	PLOT 2 (Donga)					0.22
	PLOT 3 (Donga)					0.19
	PLOT 4 (Donga)					0.20
	PLOT 1 (Lau)					0.21
	PLOT 2 (Lau)					0.17

Using Microsoft Excel, the Graph of Broadband Vegetation Indices Values from Planting to Harvest was composed in order to show the trend of the increase/decrease in the condition of the crops. It will be noted that there is gradual rise in the values of the broad band vegetation indices from planting in December, 2017 to harvest in April 2018. More visible increase was seen between February, 2018 and April 2018. This shows that the broad band vegetation indices can be used to monitor sugarcane conditions in the study area.

Conclusion

Satellites imageries can be used to monitor the variations in vegetation. Vegetation indices makes plants to be different from other image features. SAVI maps can be useful for land applications such as agriculture, pest invasion, natural resource management and early signals. Using the standard index of plant healthiness review from different literatures, the following range of vegetation indices from planting to harvesting were obtained: for soil adjusted vegetation index ((SAVI) 0.12 -0.23. This result shows that there is a gradual rise in the values of the broad band vegetation indices from planting to harvest, thereby confirming that the SAVI broad band indices were used to monitor the development of sugarcane in these regions. In view of this research it was discovered that crops can actually be analysed using SAVI and I also recommend that further research can be done using other vegetation indices which was not used in this research. In view of this research it was discovered that crops can actually be monitored using vegetation indices.

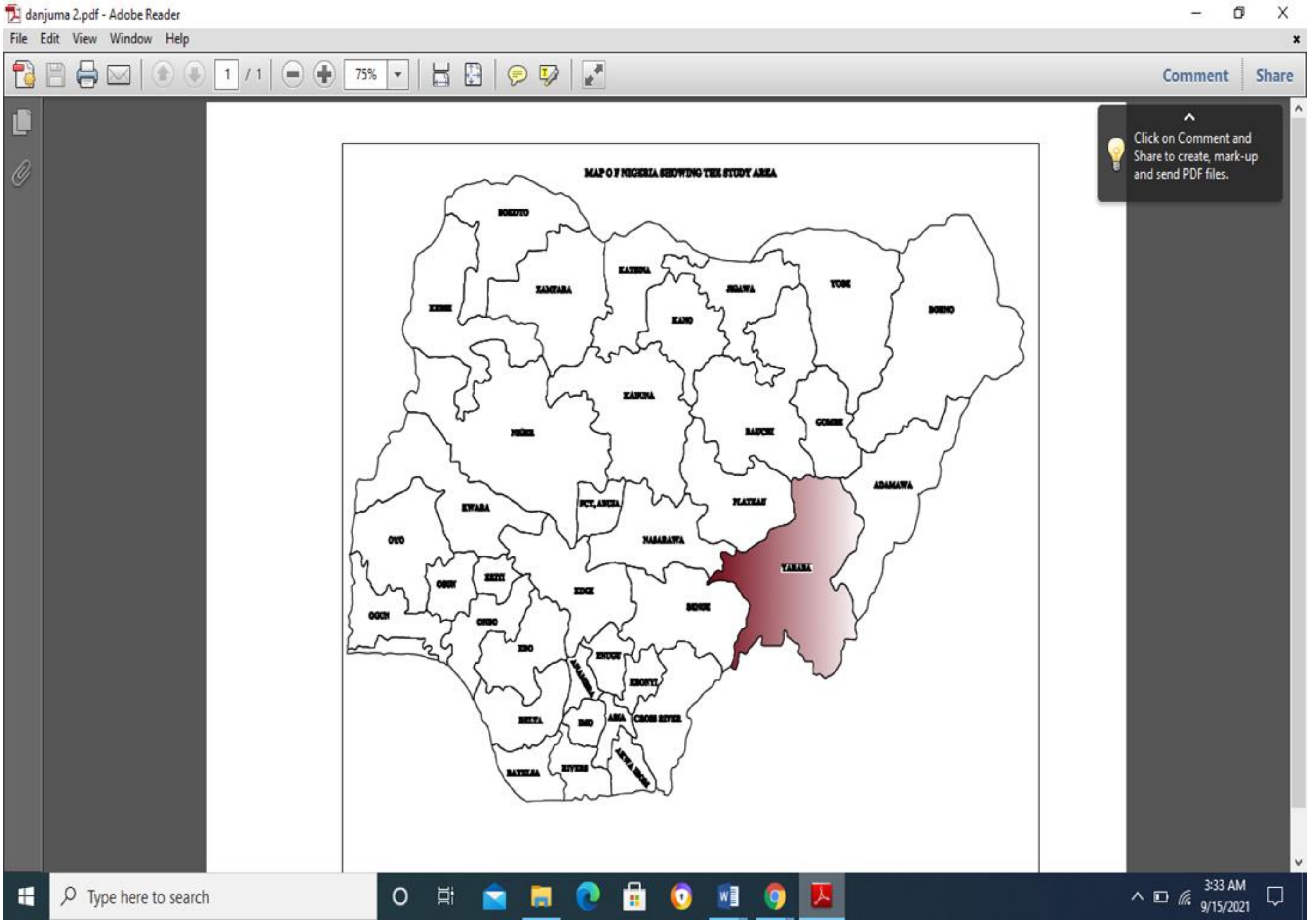


Fig. 1: Map showing the study area within the geographic and political map of the Federal Republic of Nigeria.

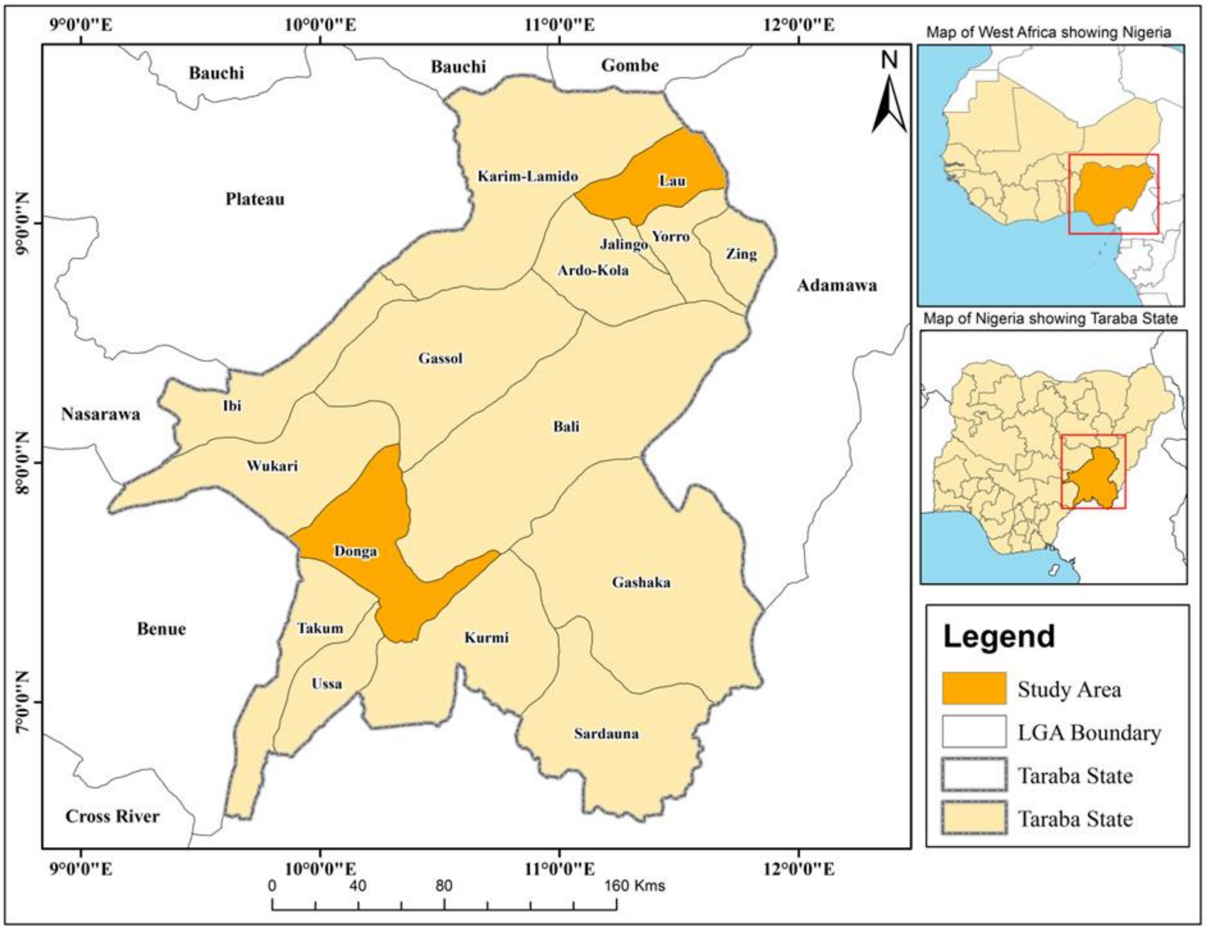


Fig. 2: Map of the study area

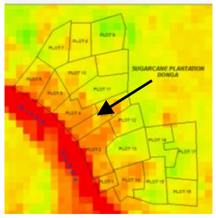
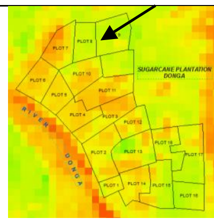
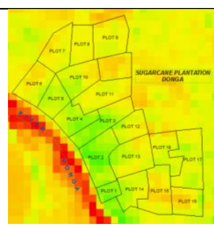
Indices					SAVI
Date					PLANTING
Dec., 2017					
					GROWTH
Feb., 2018					
					MATURITY
Apr., 2018					

Fig. 3: Broadband Indices Map for Donga Sugar Cane Plantation Dec 2017, Feb 2018 and Apr 2018

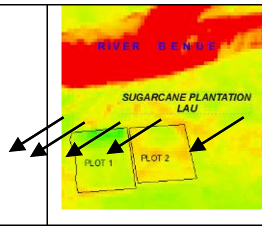
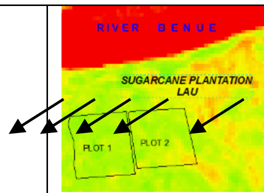
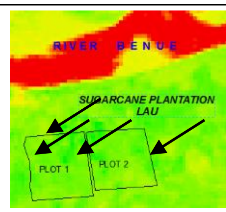
Indices					
Date	PLANTING				
Dec., 2017					
	GROWTH				
Feb., 2018					
	MATURITY				
Apr., 2018					

Fig. 3: Broadband Indices Map for Lau Sugar Cane Plantation Dec 2017, Feb 2018 and Apr 2018

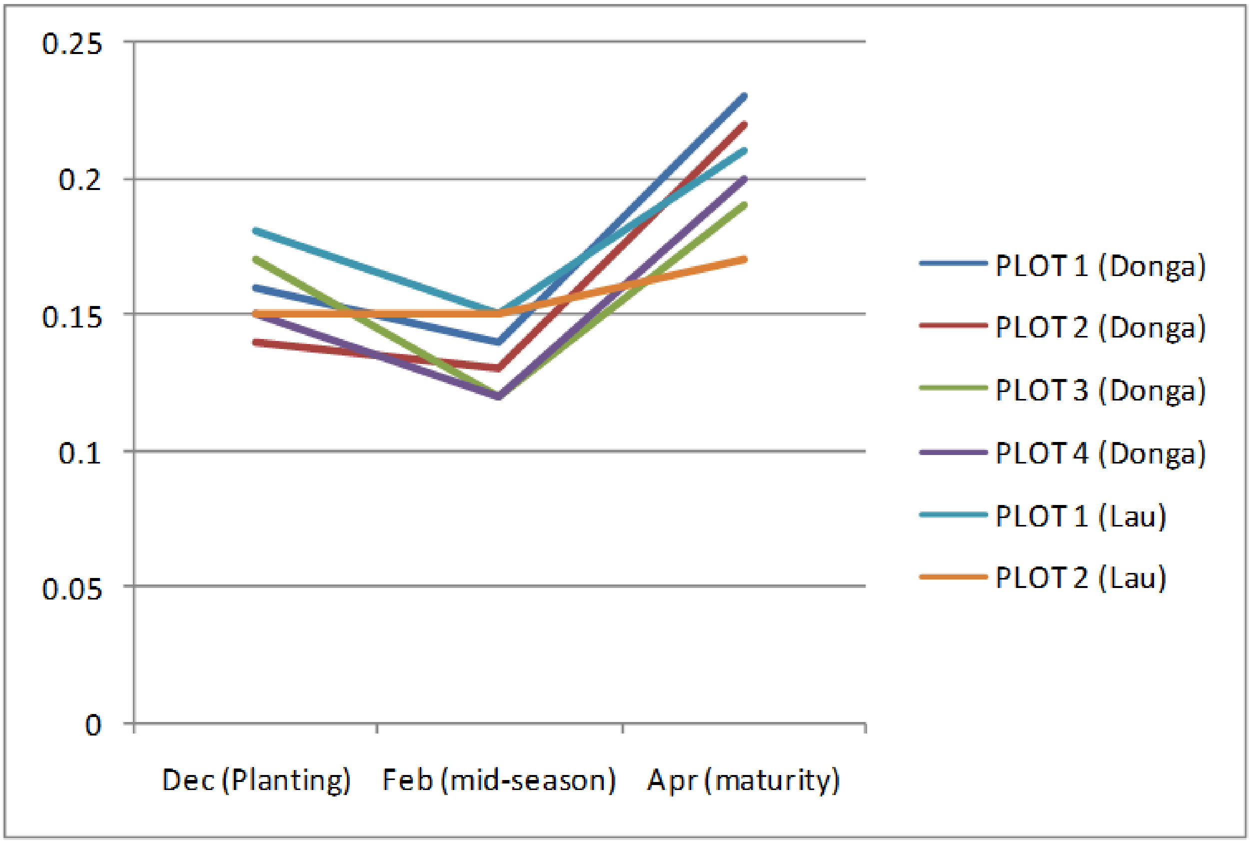


Fig. 4: SAVI Index indicative of sugar cane condition from planting to harvesting

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