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Research Article

Monitoring of Sugarcane Plantation Conditions Using Vegetation Indices and Remote Sensing Technologies at Some Fadama Lands in Taraba State

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ABSTRACT

The study investigated the use of Raster Calculator in the Map Algebra Tools of ArcGIS Spatial Analyst Tools in calculating Ratio Vegetation and Atmospherically Resistant vegetation indices. The results from these calculations will now be used to monitor sugarcane conditions for certain periods. After map designs and calculations it was realized that the green colors from the maps depicts sugarcane healthiness of these sugarcane farms, while red indicates bad health. Furthermore, after appropriate analysis it was now discovered that these broad band indices when prepared in maps can be used to monitor the development of sugarcane in these regions.

Keywords: Ratio Vegetation Index, Atmospherical Vegetation Index.

INTRODUCTION

Soils Selection of vegetation indices in plant mapping is needed to provide the best information of plant conditions. [3] Vegetation indices are employed to enhance the vegetation conditions and they represent a single value for converting the reflectance spectrum for measuring vegetation characteristics [4]

In the f ie ld of Remote Sensing applications, scientists have developed vegetation indices (VI) for qualitatively and quantitatively evaluating vegetative covers using spectral measurements. The spectral response of vegetated areas presents a com-plex mixture of vegetation, soil brightness, environmental effects, shadow, soil color and moisture. Moreover, the VI is affected by spatial-temporal variations of the atmosphere. [5] was 2219, 2805, 2481 and 2197 tons, respectively. This becomes a major concern that ought to be addressed given that majority of citizens depend on it [3].

The different Sugarcane development stages was looked into, two different vegetation indices was used for monitoring which are RVI and ARVI. Vegetation indices analysis was done which enabled assessing sugarcane healthiness and productivity.

Sugarcane monitoring was researched on extensively. When Remote Sensing technology is applied in sugarcane monitoring it will assist in appropriate sugarcane identification and proper placing of estimated sugarcane regions. A reasonable amount of various multi-temporal data was be combined to become one image which will have to be collected at a particular time frame i.e. 15 years at 3 years interval for this particular research.

Furthermore, making adequate use of a definite Remote Sensing method, accurate information which will enable monitoring of production processes of sugarcane was extracted.

MATERIAL AND METHODS

The study region is in Taraba State Nigeria, the data sets used were field data acquisition and satellite imageries at resolution of 30x30m for Landsat and 0.7x0.7m for Quickbird.

The study area

The study areas are precisely Lau and Donga in Taraba state North- Eastern Nigeria.

Methodology

Ratio Vegetation and Atmospherically Resistant broad band greenness indices was used to monitor sugar cane conditions from planting to harvesting.

The Raster Calculator in the Map Algebra Tools of ArcGIS Spatial Analyst Tools was applied to a wide range of vegetation indices in the study area to enable monitoring. The appropriate

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formulas of each indices and there values was inputted in the ArcGis platform through the raster calculator.

Vegetation indices are used as measures of vegetation condition so that higher index values indicate higher amounts/strength of green vegetation.

Two indices were used in this research namely Atmospherically Resistant and Ratio Vegetation indices as follows:

(a) RVI

RVI - Ratio Vegetation Index

RVI = NIR / RED

The RVI captures in simplest form the contrast in near-infrared and red values for areas of healthy green vegetation. For fully vegetated areas the red values may approach zero and the ratio value then increases without bound. The RVI is thus a non-linear measure of vegetation that is very sensitive to variations in areas with high vegetative cover but much less sensitive in areas with sparse cover. [1]

(b) Atmospheric Resistant: ARVI

ARVI - Atmospherically Resistant Vegetation Index

ARVI = (NIR - 2*RED - BLUE) / (NIR + 2*RED - BLUE)

This index can be used with imagery that incorporates a blue spectral band, which is the visible band most sensitive to atmospheric effects. ARVI is a modified form of NDVI that attempts to minimize atmospheric effects on the red band by using the blue band to correct the red values. [2]

Vegetation Indices Statistics for Plots

The Zonal Statistics as Table Tool in ArcGIS Toolbox was used to summarize the values of the vegetation indices within each sugarcane plots and the mean vegetation index was reported.

RESULTS & DISCUSSION

ArcGIS 10.3 Spatial Analyst Tools had been used to calculate two broad band greenness indices for the Sugar Cane Plantation in Donga and Lau starting from December 2017 when sugarcane was planted on the site, to the mid-season of sugarcane development in February 2018 and the near harvesting period in April 2018. It should be noted that images of the time of harvest in June was not processed as it contained cloud cover because of the rainy season.

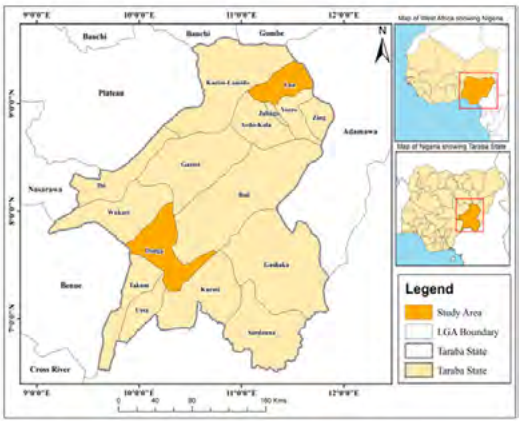

Figure 1: Map of Taraba Showing the study areas

Figure 2 shows the map of the vegetation indices for the Planting season, December 2017, February, 2018 and April, 2018.

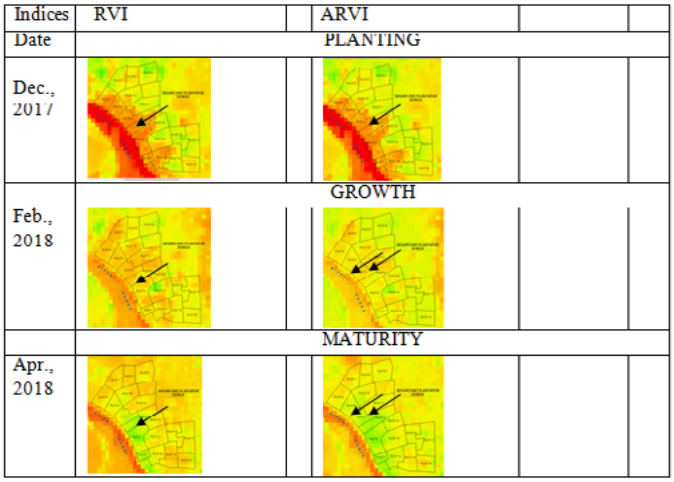

Figure 2(a): Broadband Indices Map for Donga Sugar Cane Plantation Dec 2017, Feb 2018 and Apr 2018

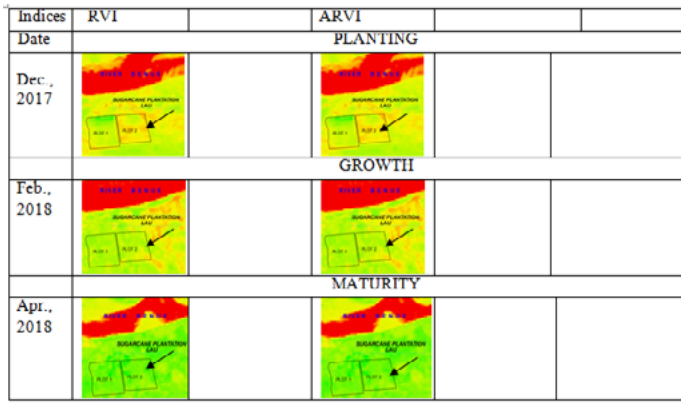

Figure 2(b): Broadband Indices Map for Lau Sugar Cane Plantation Dec 2017, Feb 2018 and Apr 2018

The healthiness of sugarcane is from red to orange to green, with red indicating bad health and green indicating good health. It will be noticed that there is a gradual change in the health of the sugarcane from December 2017 during the time which the sugarcane was planted from bad to good in April 2018, at about the time the sugar cane is to be harvested. This shows that these broad band indices when prepared in maps can be used to monitor the development of sugarcane 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 two broad band indices and the subsequent generation of the mean value of the indices over each farm plot, Tables 1 was computed. Table 1shows the value of the two broadband indices in December 2017 February, 2018 and April, 2018. A selection of four plots in Donga and two plots from Lau in which sugarcane was planted and confirmed from ground truth data was selected for comparison.

	Name	RVI	ARVI
	PLANTING		
Dec-17	PLOT 1 (Donga)	1.62	-0.26
	PLOT 2(Donga)	1.56	-0.29
	PLOT 3(Donga)	1.68	-0.25
	PLOT 4(Donga)	1.58	-0.28
	PLOT 1 (Lau)	1.65	-0.27
	PLOT 2 (Lau)	1.56	-0.32
	MID-SEASON		
Feb-18	PLOT 1 (Donga)	1.66	-0.26
	PLOT 2(Donga)	1.64	-0.27
	PLOT 3(Donga)	1.58	-0.29
	PLOT 4(Donga)	1.53	-0.31
	PLOT 1 (Lau)	1.61	-0.33
	PLOT 2 (Lau)	1.62	-0.32
	MATURITY		
Apr-18	PLOT 1 (Donga)	1.99	-0.16
	PLOT 2(Donga)	1.96	-0.17
	PLOT 3(Donga)	1.84	-0.22
	PLOT 4(Donga)	1.82	-0.22
	PLOT 1 (Lau)	1.77	-0.28
	PLOT 2 (Lau)	1.62	-0.35

Table 1: Shows the value of the two indices in December 2017 February, 2018 and April, 2018.

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. Figure 2.2(a) and (b) shows the condition of 6 plots from planting to harvesting for RVI, and ARVI respectively. It will be noted that there is a gradual rise in the values of the five broad band vegetation indices from planting in December, 2017 to harvest in April 2018. More noticeable rise was experiences between February, 2018 and April 2018. This confirms that these broad band vegetation indices can be used to monitor sugarcane conditions in the study area.

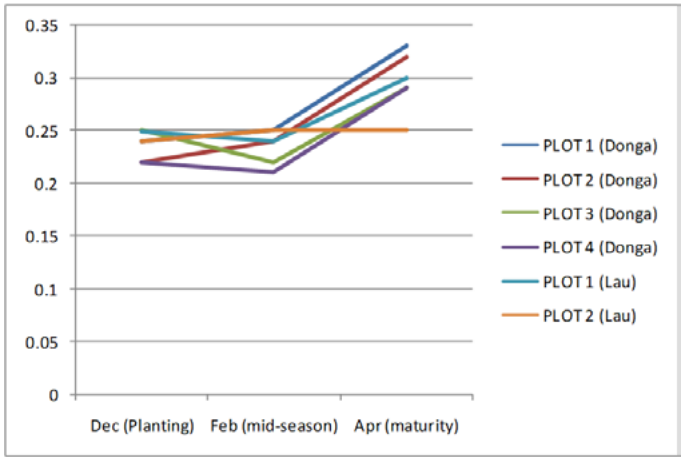

Figure 2.2(a): RVI indicative of sugar cane condition from planting to harvesting

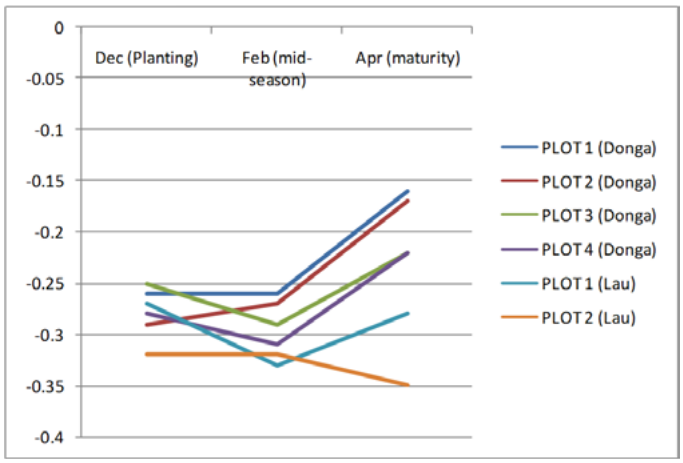

Figure 2.2 (b): ARVI Index indicative of sugar cane condition from planting to harvesting

Vegetation indices generated from the maps shows healthiness all through the years except for a gradual change in the health of the sugarcane from December 2017 during the time which the sugarcane was planted from bad to good in April 2018, at about the time the sugarcane is to be harvested. It was observed 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 noticeable rise was experienced between February 2018 and April 2018. This shows that the two broad band indices when prepared in maps can be used to monitor the development of sugarcane in the region

Sugarcane farming has all the potentials available to be more diverse as knowledge of geospatial methods in sugarcane farms increases. If proper monitoring, mapping and yield is estimated more frequently, then were there are lapses over the years it can be quickly corrected and in situations where yield is not very much the factors that caused it can be checked and corrected on time.

CONCLUSION

In view of this research, it was discovered that sugarcane farms can actually be analyzed using geospatial technology. Vegetation indices too can actually be used for monitoring the healthiness of a lot of crops and yield estimated.

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