2010 International Conference on Nanotechnology and Biosensors
IPCBEE vol.2 (2011) © (2011) IACSIT Press, Singapore

Determination of the Onset and Cessation of Growing Season in South West Nigeria

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***Abstract*— This study used precipitation amount and Normalised Difference Vegetation Index (NDVI) to determine the onset and the end of the rainfall and growing seasons in six stations within the Guinea Savannah zone of Nigeria for the period 1981 – 2001. The onsets and cessations of the rainfall and growing season for these stations were determined from the mean dekadal analysis of NDVI and rainfall data. This was used to determine the lag difference between the period when the rainfall season begins and when active vegetative growth is actually noticed.**

The results obtained were able to establish the fact that growth does not commence immediately after rainfall. The lag difference for the onsets of rainfall and growing season was between the range of 1-4 dekads (within a month) while their cessations was between the range of 2-5 dekads (about a month). This work was also able to determine the difference between the lengths of the rainfall and the growing season.

It is therefore recommended that using this method, adequate information on the vegetation and agricultural status of various locations can be monitored effectively by agencies, NGOs and policy makers.

Keywords: Agriculture, Greenness, NDVI, Rainfall

I. INTRODUCTION

Satellites have been invaluable sources of information for operational analysts and forecasters and they also provide data over a large area especially in data sparse and developing areas.

The relationship of the Normalised Difference Vegetation Index, NDVI (otherwise known as greenness), to rainfall is used as a basis for employing NDVI as an indicator of the onset and cessation of the growing season. The onset of suitable moisture conditions for vegetation causes the emergence and growth of plants. The resulting increase in the amount of vegetation and in the photosynthetic activity leads to a consistent increase in the NDVI. When these conditions cease, the resulting moisture stress will reduce biophysical rates (photosynthetic rate and transpiration) which will result in a substantial fall in the NDVI (Bonifacio et al., 1993a).

The NDVI measures the changes in chlorophyll content (via absorption of visible red radiation) and in spongy mesophyll (via reflected NIR radiation) within the vegetation canopy. As a result, higher NDVI values usually represent greater vigor and photosynthetic capacity (or greenness) of vegetation canopy (Tucker, C.J., 1979).

NDVI has been extensively and qualitatively used to infer changes in vegetation response to rainfall in seasonally arid regions (Lambing et al, 1993). Malo and Nicholson (1990) studied the relationship between NDVI and rainfall in the semi-arid Sahel region of Mali and Niger. In an area like the Guinea Savannah region of Nigeria which is limited in acquiring in situ data, the NDVI estimates and analysis can be used to identify areas prone to drought related crop failure and poor pasture conditions. Satellite observations are routinely used by developed countries where agriculture and pastorals is the primary livelihood. This method is yet to be utilized to the maximum in developing and third world countries By monitoring environmental and social conditions in these areas, governments may able to respond rapidly to vegetation (food) and drought crises (Aweda et al, 2009).

II. DATA AND METHODOLOGY

Daily rainfall data was collected from the climate and investigation department of the Nigerian Meteorological Agency (NIMET), Lagos which covers the time period of January, 1981 to December, 2001 for some stations in the south western region of Nigeria.

This was analysed and used to determine the onset and cessation of rainfall. In the determination of the onset and cessation of rainfall, the Ilesanmi's (1972) method was preferred. He identified the onset and retreat of monsoon in Nigeria using prescribed percentiles of the cumulated rainfall. The onset occurs when the cumulated rainfall reaches 8% of the total rainfall and retreat when the cumulated rainfall reaches 90% of the total.

The NDVI data was extracted from the PAL Global 8km, 10-day composite Normalized Difference Vegetation Index (NDVI) product archived at the Goddard Earth Sciences, Distributed Active Centre (GES-DAAC). The data also covers the time period from January 1981 through December, 2001. The rainfall and NDVI parameters were analysed into dekads (10 – day intervals) from which the onsets, cessations, and lengths of the growing season of the stations under study were determined and their lag differences were calculated.

The method used to determine the onset and cessation of the growing season in this study was developed by Kogan

(1995). The equation used to determine the onset and cessation uses the value of NDVI.

$$\text{NDVI ratio} = \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \quad \text{(i)}$$

Where NDVI ratio is the output ratio, ranging from 0 to 1, NDVI is the daily NDVI, NDVImax is the annual maximum NDVI while NDVImin is the annual minimum NDVI.

Onset is observed at the dekad when NDVI ratio exceeds 0.5, cessation is observed when

III. Results And Discussion

The results obtained are shown in figure 2a-f. The onsets of rainfall and growing season in Ondo is shown in figure 2a to be at the 8th and 9th dekad respectively while their respective cessations were at the 28th and 35th dekad.

Figure 2b gives the onsets of rainfall and growing season in Abeokuta to be at the 7th and 9th dekad respectively and cessations of the rainfall and growing season to be at the 29th and 35th dekad respectively.

For the Akure station, the onsets of the rainfall and the growing seasons were at the 10th and 12th dekad while the cessations were at the 28th and 35th dekad respectively (figure 2c).

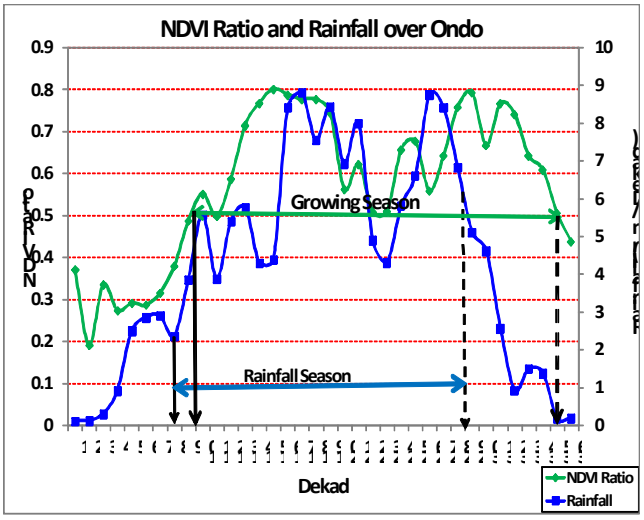
For Osogbo, it is shown in figure 1d that the onsets of the rainfall and growing season were at the 9th and 11th dekad while the respective cessations were at the 29th and 34th dekad.

Figure 2e shows the onsets of the rainfall season in Ibadan to be at the 7th dekad while the onset of the growing season was at the 10th dekad. The cessation of rainfall over this station was 29th dekad while that of the growing season was at the 35th dekad.

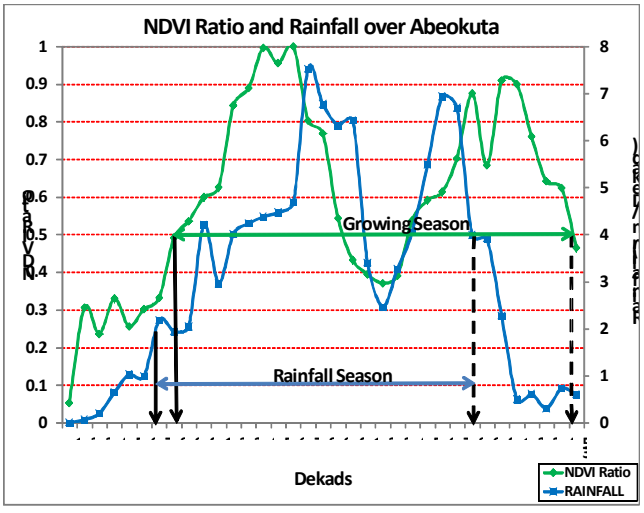
Lastly, the onsets of the rainfall and growing season in Saki was shown to take place at the 10th and 14th dekad respectively while the respective cessations of rainfall and its growing season was at the 27th and 33rd dekad.

Figures 3 and 4 show the onset and cessation dekad for the rainfall and growing season in the stations. Taking a general observation for these stations, it could be noticed that there was a general similarity in the difference between the onset of rainfall and that of greenness for these stations. This means that for this region, the onset of rainfall begins earlier than the onset of greenness thereby highlighting the fact that some amount of rainfall will be needed before the onset of greenness can take place. Something similar also happens at the cessations. It is interesting to note that it takes some time for photosynthetic activities to stop even when the rainfall season has ended.

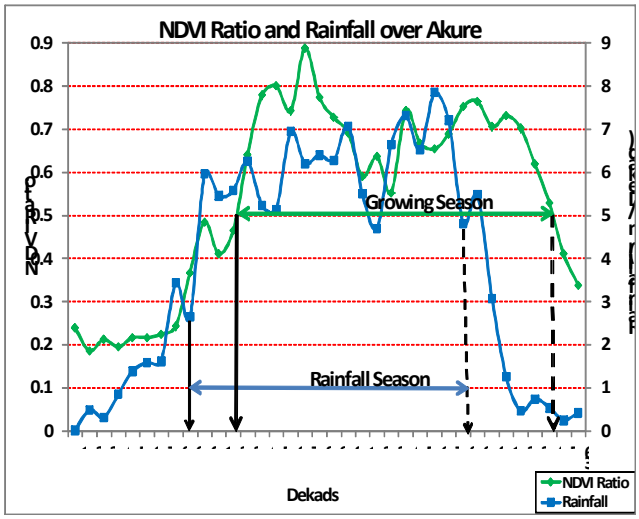
Figure 5 shows the comparison between the length of rainfall and the length of greenness among the stations that were studied. As it could be noted, all the stations had a longer length of greenness (NDVI) than that of rainfall. Taking a closer look, it could be noticed that difference between the lengths was quite slight for the stations Abuja and Ilorin. On the other hand, it could be observed that a station like Lokoja had a substantial difference in the length of greenness and that of rainfall. This means that this area will have a considerable period of growing season which is not conclusively dependable because of the very sharp contrast it has with other stations which may be due to some other factors such as soil water retentive capacity amongst others. Table 1 also gives a summary of the results obtained which include the lag differences in the onsets and cessations of the rainfall and growing seasons in addition to the differences in the lengths of the different seasons.



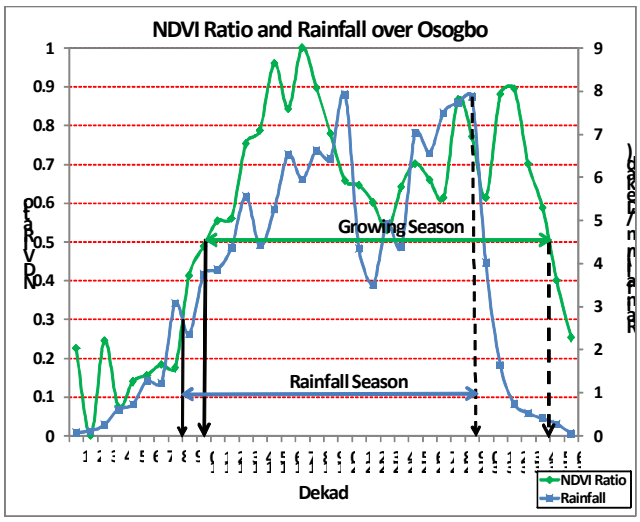
(a)



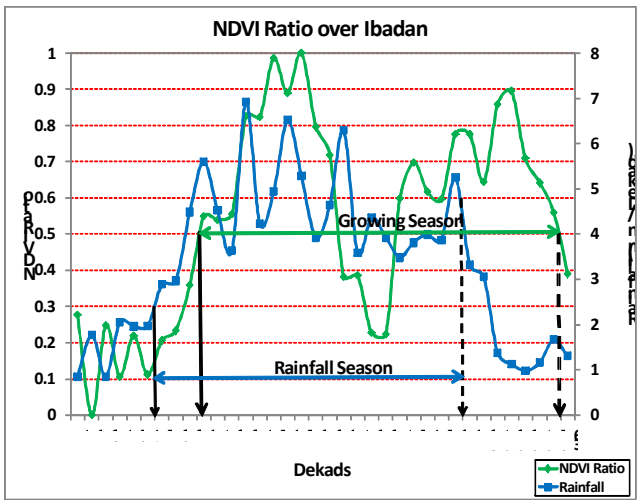
(b)



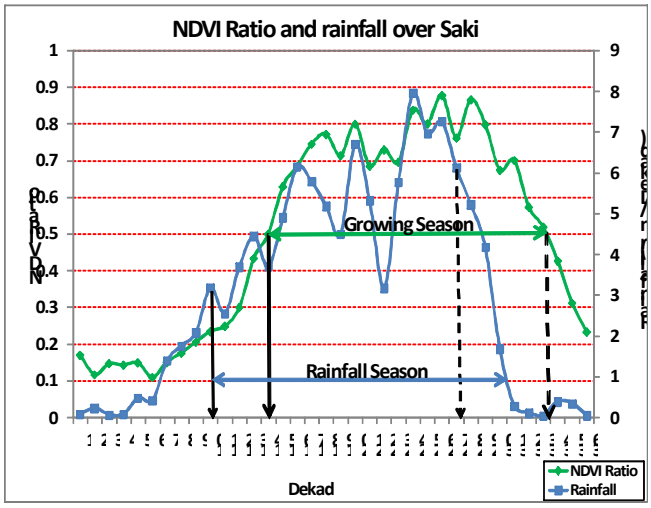
(c)



(d)



(e)



(f)

Figure 2. Graphical representation of the onset and cessation of rainfall and growing season over the various stations in south-west Nigeria

IV. CONCLUSION

The Normalised Difference Vegetation Index is a tool that can give the picture of the vegetation status of a particular location on a regular basis. The use of this tool in this study has been able to highlight the differences in the onset and cessation periods of the rainfall and greenness period for the various stations within this region.

The integration of satellite-derived information with other layers including climate, soil type, hydrology and socioeconomic condition of people would be the next requirement. This multidisciplinary information can be effectively and accurately handled with GIS. Spatial analysis in GIS can lead to a decision support system for the concerned government departments, NGO's and others to help drought vulnerable people and others living in potential drought areas.

It is necessary to take note of the fact that vegetation growth cannot take place without the presence of rainfall. Therefore, the onset of the growing season is dependent on the onset of the rainfall season. Nevertheless, the beginning of the rainfall season does not indicate that the planting season starts immediately. There is always a time lag between these periods and timely information about this difference is very important so as to have the maximum farming efficiency and output required.

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