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Research Article

NDVI Sensibility to Rainfall Spatial Distribution in ADJOHOUN (Benin, West Africa)

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Abstract

Linear regression analysis confirms a strong sensitivity between East NDVI and East-Center rainfall in Adjohoun with a threshold of 0.54%. Indeed, the reduction in 1236.25 units of rain in Central East induced decrease of one unit of East NDVI. Similarly, in the threshold of the 0.1%, there is a strong link between East rainfall and East-Center NDVI and West-Center NDVI. East-Center rain is strongly related to East rain in 0.1% threshold. Indeed, one unit increasing of East rain in the East causes an increase of 4.99 units of NDVI in East-Center and decreasing of 3.8 units of NDVI in East-Center. As for rainfall, increasing of one unit of rain in the East causes increased 0.38 unit of rain in East-Center.

Keywords: *NDVI, Rainfall, Adjohoun, reduction, increasing , decreasing.*

Introduction

Climate change is intensifying rainfall variability over West Africa causing extreme events, such as droughts and floods (IPCC, 2007) This may have consequences on land surface vegetation in this zone since climate plays a key role in vegetation condition. Therefore, it is essential to assess and quantify the response of vegetation to rainfall variability. Remotely sensing derived NDVI data have been successfully used for monitoring of vegetation activity and environmental changes at regional and global scales (Tucker et *al*., 2001 ; Kowabata et *al*., 2001 ; Xiao et Moody, 2004), detection of droughts (Kogan, 1997), desertification and land degradation studies (Kogant, 1997 ; Wessels et *al*.,2004 ; Tham, 2002).

The Normalized Difference Vegetation Index (NDVI) is a satellite-based vegetation index, which is commonly used and based on the differential reflection of green vegetation in the visible and infrared portions of the magnetic spectrum (Moulin et *al*., 1997 ; Azzali et Menenti, 2000 ; Diouf et Lambin, 2001 ; Kawabata et al., 2001 ; Loveland et *al*., 1995). NDVI has become a good indicator of various vegetation parameters, such as green leaf area index, biomass, percent green cover, green biomass production and the fraction of absorbed photosynthetically active radiation (Anyamba and Tucker, 2005). It is widely agreed that the energy exchanges at the land-atmosphere interface largely determine the climate and its variations (Chahine, 1992). The bio-geophysical feedback mechanism postulated by Charney (1975 , 1977), in which lack of rainfall leads to maintenance of aridity, may be linked to vegetation in the sensethat a change in the vegetation density is associated with a change in albedo. Xue and Shukla (1993) showed that the desiccation of the land surface over West Africa resulted in a significant reduction of local precipitation. Vegetation influences the energy balance, climate, hydrologic and biogeochemical cycles and can serve as a sensitive indicator of climatic and anthropogenic influences on the environment (Zhang, 1999). Our work aims to explore the relationship between NDVI and rainfall by various vegetation types in Adjohoun.

Materials and methods

The material used consists of global positioning system (GPS), Landsat satellite image, rainfall data of ASECNA and software (Arcgis 10.1 Envi 4.8, Excel, SPSS IBM 21). The first step was the acquision Landsat images on the site of the United States Gelological Survey (www.earthexplorer.usgs.gov).

The satellite imagery was exploited during the entire process. Indeed, a radiometric preprocessing has been applied to the Landsat image, and subsequently image mathematical revealed NDVI. The relief and surface altimetry has been materialized through exploration of the image SRTM radar in the environment of global mapping software simultaneously with Arcgis. Spatialization by radial basis function allowed the interpolation of rainfall data, the changes detection technic and image differentiation has contributed to a better revelation of rainfall changes, including worsening and rainfall increase.

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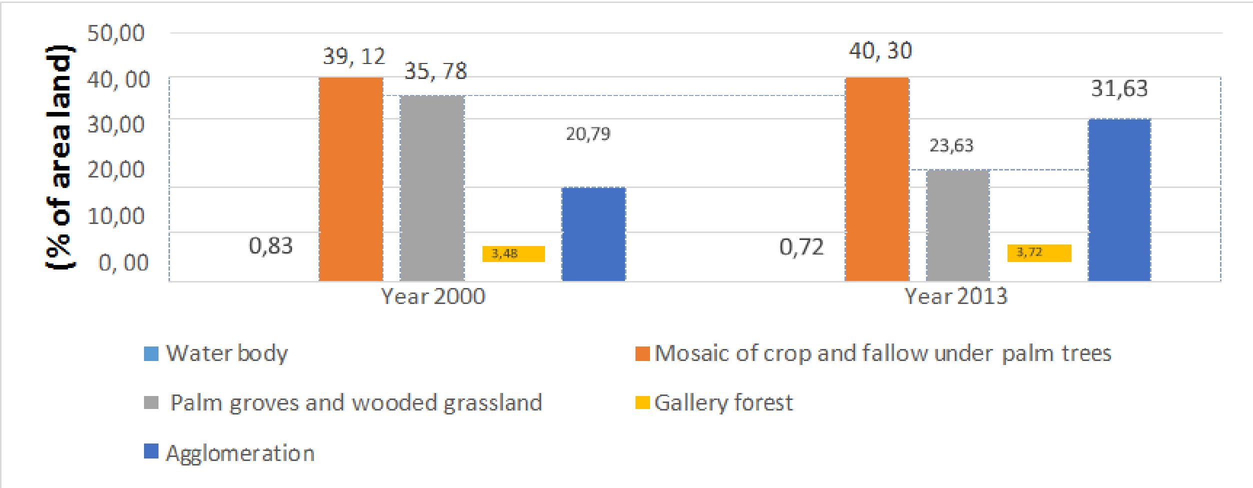

Figure 1: Landscape units proportion between 2000 and 2013

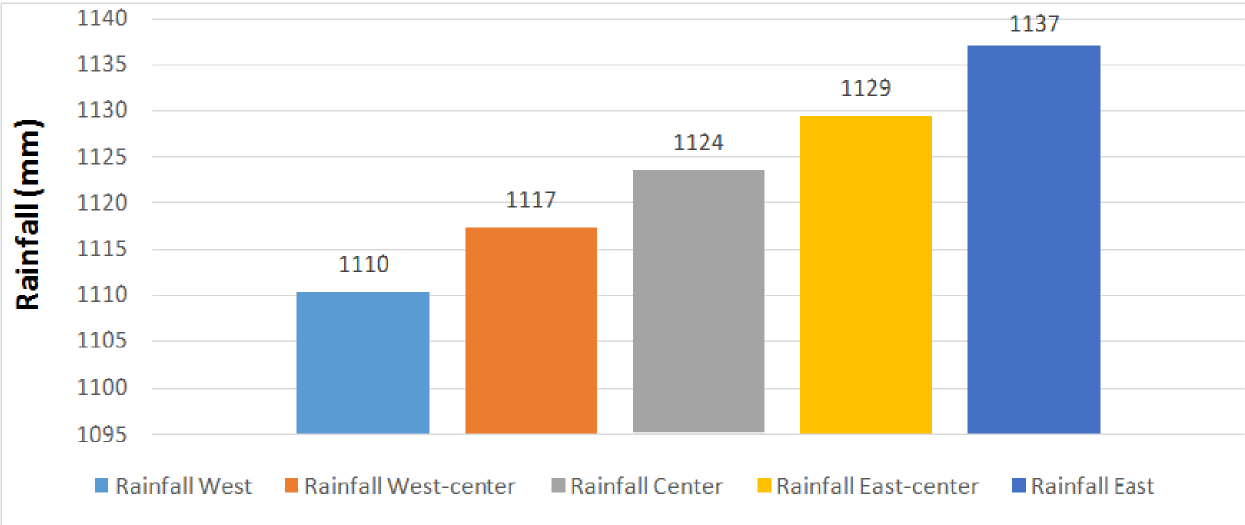

Figure 2: Rainfall distribution from West to East in Adjohoun

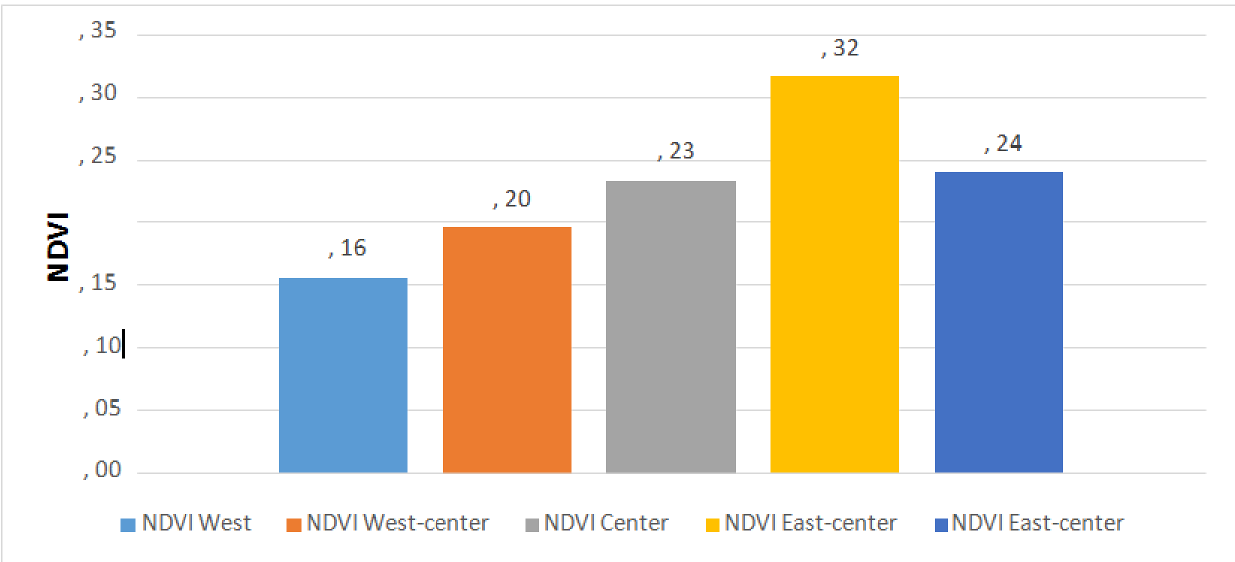

Figure 3 : NDVI distribution from West to East in Adjohoun

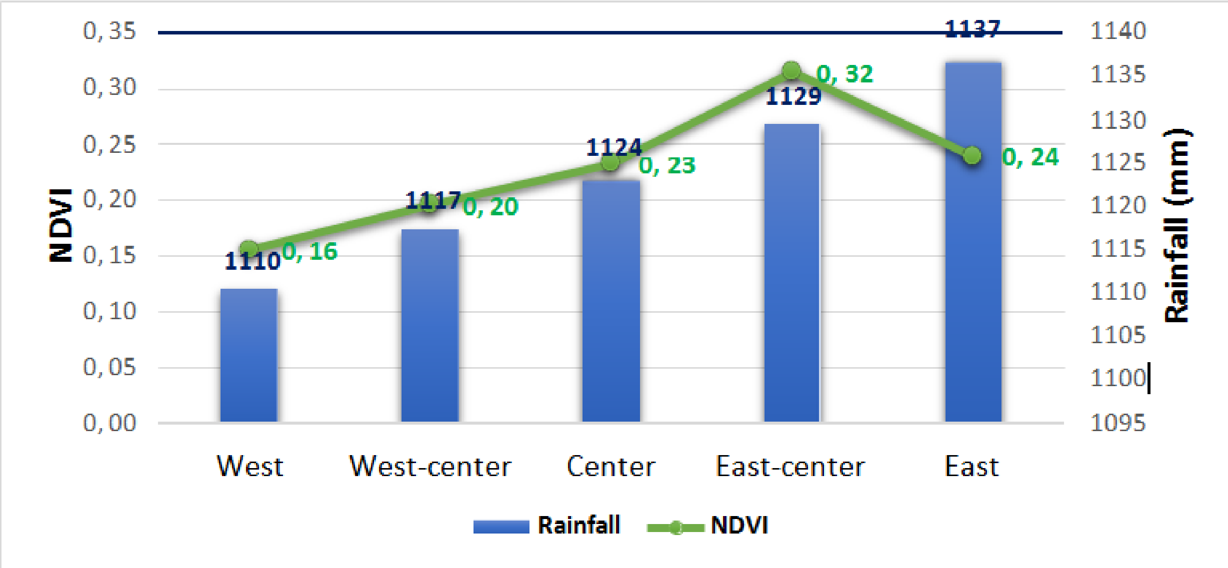

Figure 4: NDVI distribution from West to East in Adjohoun

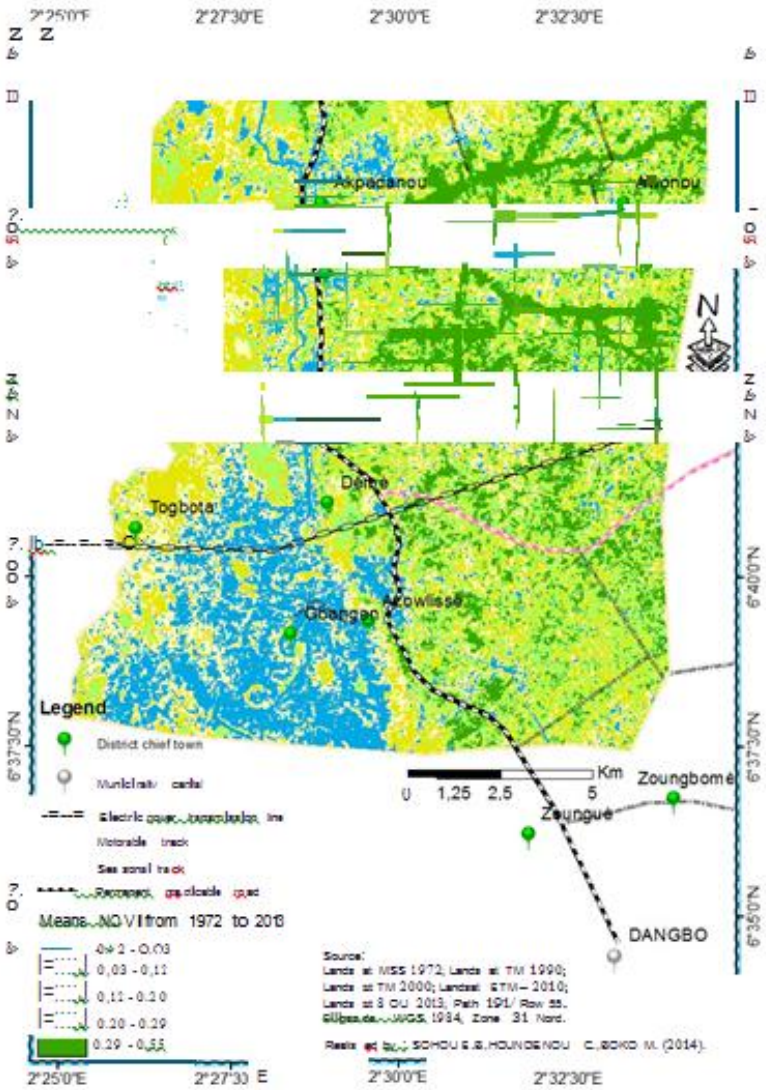

Figure 5: Spatial distribution of NDVI in Adjohoun

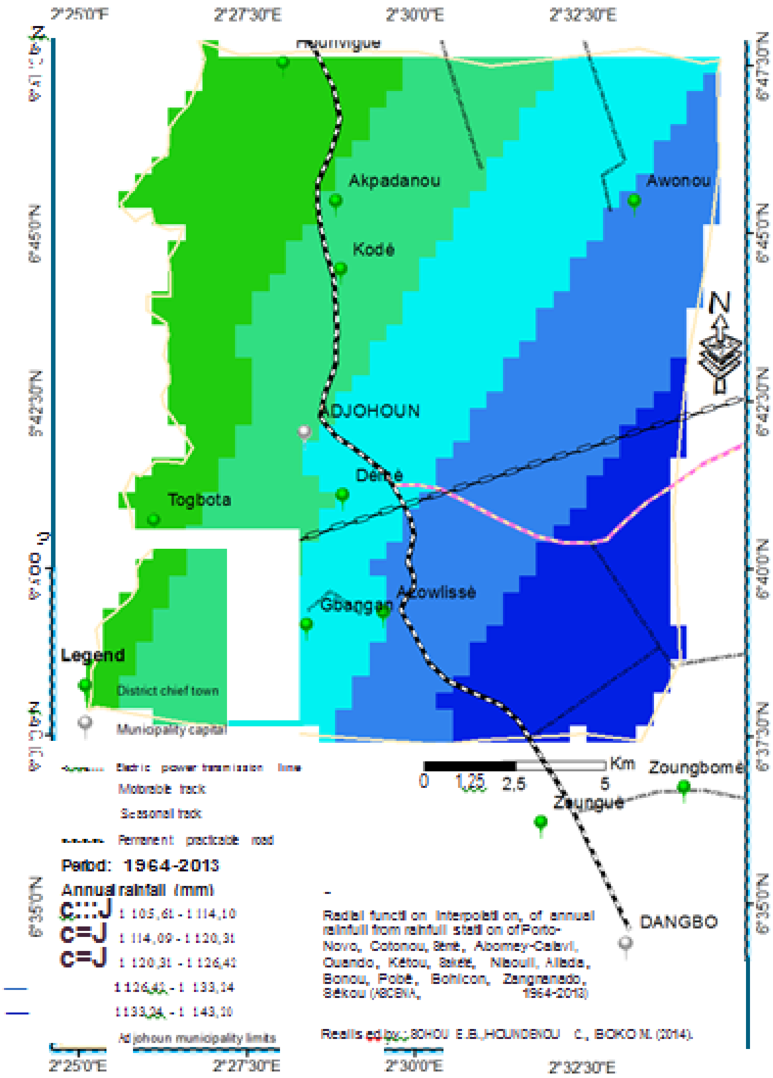

Figure 6: Spatial distribution of annual rainfall in Adjohoun

Discussions

Nightingale and Phinn (Nightingaleet Phinn, 2003) found a strong relationship between precipitation and NDVI (Normalized Difference Vegetation Index). For vegetation, higher NDVI values correspond to an increase in vegetation "greenness" or vigor, controlled by a combination of vegetation type, health, photosynthetic activity and canopy density (Bannari et *al*., 1995). Through time series analysis, interpretation of NDVI data has been extended to indicate land surface-climate interactions (Carleton et *al*., 1994 ; Carleton et *al*., 1995) , landscape change (Lambin,1996; Lambin et Ehrlich, 1996) , vegetation stress (e.g., drought) (Nicholson et *al*., 1990) and phenology (Lobo et *al*., 1997).

NDVI time series data can be reliable indicators of eco-climatologic variables, such as temperature (Lobo et *al*., 1997 ; Yang et *al*.,1997) and precipitation, although these relationships are explicitly regional in nature, because of the sensitivity of vegetation to the climate. The strong relationship between natural vegetation and climatic elements has been described in wide range of research (Anyamba and Tucker, 2005; Fabricante et *al*., 2009 ; Lei and Peters 2004; Yang et *al*., 1998). Climate and climate change affect the existence and distribution of natural vegetation. On the other hand, natural vegetation can modify local, regional and global climate at diurnal, seasonal and long-term scale (Zhong et *al*., 2010). Remote sensing plays important role in and provides an effective tool for monitoring different parameters of a complex ecosystem (Zhong et *al*., 2010).

However, Barbosa (2006) stated that few studies have assessed temporal and spatial patterns in great detail and most of them have assessed seasonal and spatial variations in vegetation activity as a function of rainfall in Africa. Theoretically, NDVI can be considered as climatic recorder, mainly as a rainfall recorder. This assumption was used in various drought watching and drought early warning systems (Kogan, 1997; Song *et al*, 2004). However, the relationship is linear only in a limited range of rainfall conditions. Many studies proved a high sensitivity of NDVI to inter-annual rainfall anomalies. Thus, NDVI can be used as a good proxy for the study of inter-annual climate variability on regional and global scales or for identification of climatic signal by evaluation of land degradation (Richard & Poccard, 1998, Kuwabata *et al*, 2001; Evans & Geerken, 2004).

Conclusion

NDVI is very sensitive to spatial distribution of rainfall in Adjohoun. Adjohoun is in the Benin region (southeastern Benin), where the rainfall worsening is most important. It is characterized by a sudden fall and continues of annual rainfall the last 60 years. This causes a significant impact on crop canopy health expressed by NDVI and chlorophyll density on the landscape. It imposes an agro-rainfall planning for better conservation of plant resources and ecosystem sustainability in Adjohoun. Adaptation to climate hazards, and integration of rainfall realities in the spatial management policy remains a priority.

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