Vegetation cover changes analysis at the Cameroonian shores of Lake Chad and its hinterland (2000-2018)

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Land use changes: Trends and projections

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Vegetation dynamics: Re-greening

Since the great droughts of the 1970s, the monitoring of vegetation cover in arid regions is a major environmental challenge. Satellite images played an important role in the study of these droughts. In 90s, images of NOAA (1981) and MODIS (2000) sensors have been coupled with weather data to study the "regreening" of Sahel started with the improvement of climatic conditions. However, observations carried out at local scales show trends of evolution sometimes different from the results obtained in the Sahel. This study explores the quantification of changes in vegetation cover at the Cameroonian shores of Lake Chad and its hinterland. Its two complementary goals are the mapping of vegetation cover; and the statistical changes analysis to assess the degree of correlation between visual, quantified trends, and environmental parameters.

Area and Remote Sensing Data

The data used are the MODIS NDVI MOD13Q1 reference images corresponding to a bi-weekly summary of the best records in terms of data quality. The LP DAAC operator in charge of the MODIS sensor propose them. 434 granules of 250 meters of spatial resolution and covering the period from 2000 to 2018 are used. The map of soils potentialities and agricultural lands, of the far north Cameroon (IRD Cameroon) is also used for spatial correlations.

Experimental site

This space is marked by a strong spatial and spectral variation of the vegetation cover between the dry and the rainy season.

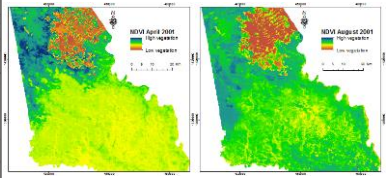
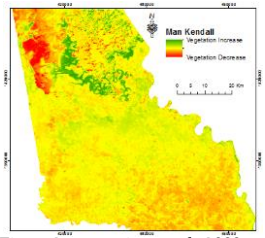


Figure 1 : vegetation state in dry and rainy season

A. Man Kendall Correlation



The significance test measuring non-zero changes is applied by the probability measure p <0.001. The progression means the transformation of water or bare soils spaces into vegetation. The opposite refers to regression.

- Positive trends: 13. 29%
- Negative trends: 21. 61%
- Stability: 65. 08 %

Strongest evolutions trends in the lake part. Regression and stability dominate in the hinterland where trends are weak.

Figure 2: vegetation trends 2000 to 2018

The landscape of Makari well-drained, is dominated by stable and progressive trends (83.1%). The landscape units of Bodo Kouda and Lake Chad poorly drained, are dominated by stable and regressive trends (87.47% and 93.3% respectively). The landscape of Dana witch is also poorly drained is dominated by stable and progressive trends 78.43 %.

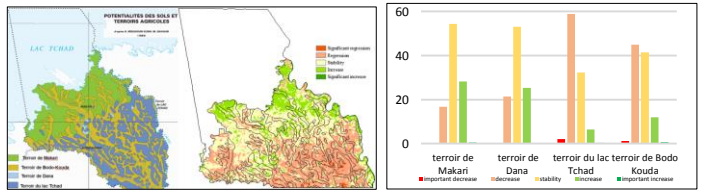


Figure 3 : spatial correlation between vegetation trends and soils characteristics

B. Principals Components Analysis

The principal component analysis applied to the 434 images summarizes the information of these images into 8 principal components of 5 classes each. The first component concentrates 82.66% of the information, the second 3.15%, the third 2.2%, the fourth 1.44%, the fifth 0.9%, and the sixth 0.46%.

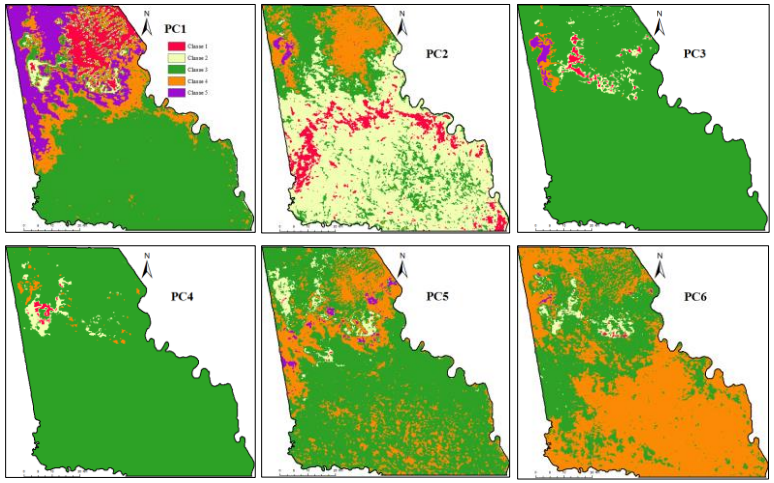
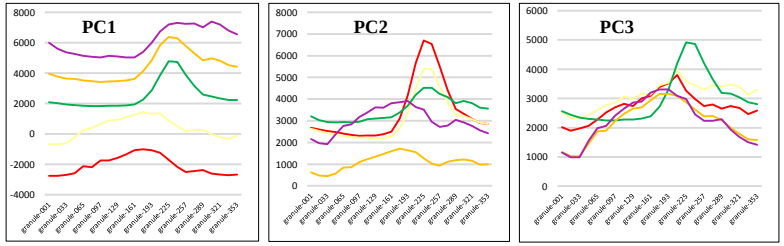


Figure 4 : principals components

C. Annuals evolutions

The profiles below represent seasonal variations in the chlorophyll activity of the 5 vegetation classes of principal component. These are results are based on the mean values of each granule over the entire observed period.



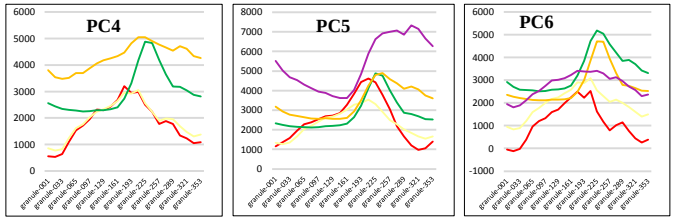


Figure 5 : variations in chlorophyll activity of vegetation classes

D. Classification of Principals' Components Analysis

The reclassification of all principal components by the unsupervised's Kmeans algorithm has helped to categorize vegetation according to their seasonal cycle and their proximity to the lake. Annual vegetation dominates the northern part of the lake, the outer shores and the hinterland. Flood and permanent vegetation are present in the rest of the lake part.

During the first half of the study period the growth of the vegetation of the hinterland reaches its maximum at the beginning of August. Between 2010 and 2018, this maximum move towards the second half of August and the floodable vegetation doubles in quantity.

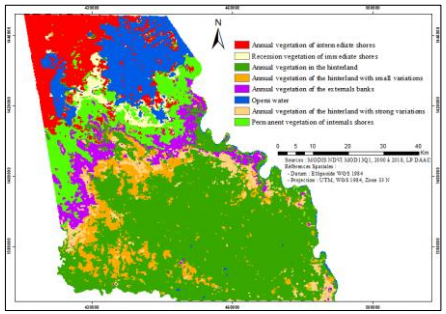


Figure 6 : differents types of vegetation

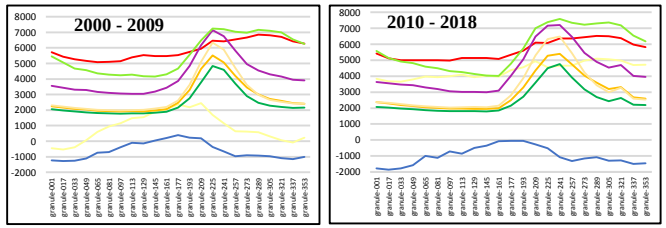


Figure 7 : variations in chlorophyll activity of differents types of vegetation

Conclusion

The three trends in vegetation cover are observed in the lake part, while the hinterland of the study area is dominated by stable and regressive trends. The vegetation trends of well drained landscape are stable and progressive unlike of the poorly drained landscape where the trends are stable and regressive. The classification of the principal components shows that the vegetation of the hinterland is essentially composed of annual vegetation while floodable and perennial vegetation is located in lake part.

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