ANALYSIS OF 1982-2006 SUDANO-SAHELIAN VEGETATION DYNAMICS USING NOAA-AVHRR NDVI DATA AND NORMALIZED RAIN-USE EFFICIENCY

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ABSTRACT

Africa is one of the regions in the world most vulnerable to climate change. This vulnerability and the limitations of poor countries to adapt to climate change challenges were highlighted in Climate Change 2007 (IPCC). With the population outburst in the 20th century, the weight of the human factor in the environmental equation increased, and human activity has become one of the main causes of change in an environment already affected by climate change. The Sudano-Sahelian area, a rainfed agriculture dependent zone, appears as a particularly vulnerable environment, subjected to major evolutions due to climate and man-induced changes.

The objective of the RESSAC project is to determine the combined effects of climatic and environmental changes on water resources on the Bani catchment (130 000 km²) in Mali, and to elaborate climatic, environmental and socio-economic scenarios on the medium-term (2050). Conditions of streaming and drainage being very dependent on land cover, it was considered necessary to improve the hydrological models, taking into account the land cover dynamics [1]. Remote sensing appears to be a very good tool to characterize land cover on large territories. In particular, the NOAA-AVHRR images have been widely used for global studies of the Sahelian environment [2] due to their archive size (26 years), low cost, suitable wavebands and high temporal resolution. However, the land cover characterization still needs the development of methods for the monitoring of land cover at large scale by remote sensing.

This study is based on two premises: 1) NDVI is highly correlated with rainfall in the Sahel region [e.g. 3] and 2) a unique relation exists between rainfall and a land cover type, i.e. a land cover change can be detected thanks to a change of the rainfall-NDVI relation. To study this relation, the annual Rain Use Efficiency (RUE) was used [4]:

$$RUE = \frac{\sum_{January}^{December} NDVI}{\sum_{January}^{December} RainFall} \times 100$$

It was calculated for seven sub-basins of the Bani catchment, using the radiometrically (cloud screen) corrected NDVI AVHRR time series (LAC data, 1982 to 2006 at 8 km spatial

resolution, 15-days synthesis), and monthly rainfall data from 65 weather stations, over the same period.
The RUE is dependent on NDVI, which is, in turn, dependent on rainfall and land cover. In order to free the RUE from rainfall and exclusively characterize land cover dynamics due to anthropogenic pressure, the relation between annual efficiency and rainfall was modelled for each sub-basin. Then, this linear model was then used to normalize the evolution of the RUE through time. Finally, we produced a map of annual trends of "normalized RUE" in the sub-basins.

The study indicates that the analysis of the relations rainfall-NDVI is adapted to the monitoring of land use dynamics at the regional scale. It reveals that the normalized RUE, dependent on land cover and consequently on human activities, is stable or in light increase from 1982 to 2006 for six of the seven elementary watersheds. These results may be explained by a change in land cover from forest to crop [4]. A validation based on Landsat images is being processed.

REFERENCES

[1] Ruelland, D., Dezetter, A., Puech, C., Ardoin-Bardin, S. (2008). Long-term monitoring of land cover changes based on Landsat imagery to improve hydrological modeling in West Africa. *International Journal of Remote Sensing*, 29(12), 3533-3551.

[2] Tottrup, C., and Rasmussen, M. S. (2004). Mapping long-term changes in savannah crop productivity in Senegal through trend analysis of time series of remote sensing data. *Agriculture, Ecosystems and Environment* 103, 545-560.

[3] Li, J., Lewis, J., Rowland, J., Tappan, G., and Tieszen, L. L. (2004). Evaluation of land performance in Senegal using multi-temporal NDVI and rainfall series. *Journal of Arid Environments* 59, 463-480.

[4] Prince, S. D., Brown De Colstoun, E., and Kravitz, L. L. (1998). Evidence from rain-use efficiencies does not indicate extensive Sahelian desertification. *Global Change Biology* 4, 359-374.