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Analysis of NDVI and RFE time series to monitor vegetated ecosystem dynamics in Sahel

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Recent studies on Sahel have shown an overall greening which demonstrates the recovery of these areas with respect to the strong drought of the '60s. However, the implication on the ground of the greening detected by satellite observation are not yet interpreted. Despite a recovery of the vegetation compound in those areas, several humanitarian crises, which are related to natural resources, have been reported in the region during the last decade. Further studies are needed to address different aspect of ecosystem dynamics in order to highlight anomalous changes that might cause possible critical situations. The present research aims to contribute to the understanding of climate/human impact on the status of pasture vegetation and agriculture in the Sahelian region from the late 90s to current days.

The dynamics of vegetated ecosystems in the region have been analyzed using time series of SPOT VGT 1 Km NDVI data and FEWS 8 km satellite RFE (Rainfall Estimate) in order to detect anomalous hot spots. Ancillary information and high resolution Landsat TM data have been used to interpret the results. For each year, we calculated the pixel cumulated rainfall and the maximum NDVI to derive annual synthesis that are considered as proxy of the production of plant biomass. Each dataset has been processed to derive "anomalies relative to mean" in order to make comparable the trends of the two different variables (rainfall and proxy of vegetation production). Correlation analysis has been conducted to map areas where climate variable cannot fully explain the vegetation dynamics. To identify trends in each variable, we calculated the slope of the regression line between time (year) and annual value of the variable. The map of the slopes highlight those pixels which are characterized by positive (slope >0.1), negative (slope<-0.1) or stable (slope in $\pm$ 0.1) trends of the variable. Statistical test was performed to determine whether the regression slope was statistically significant. Finally a combined analysis of rainfall and production trends was conducted to identify those areas where vegetation (i.e. NDVI) follows the trend of rainfall (climate-driven plant development) and areas where the two variables have opposite trends (anomalous situations). Results show a general positive trend in vegetation (re-greening) as a consequence of rainfall increase. Anomalous increases of vegetation productivity, which are not explained by rainfall trends, are often related to expansion of cropping system and/or agricultural practice improvement, as in the area of Lake Chad and in the province Katsina (Nigeria) close to some artificial basins. Finally, some critical hot spots are present in northern latitude areas where cropping system and pasture activity are likely to conflict such as in region Tillabéry (Niger) and Batha (Chad). In those chronic situations, where ecosystems carry capacity is endangered, humanitarian crisis events are often reported. Maps of critical hot spot in the Sahel are provided and interpretation of possible causes are discussed.