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The 25 years long drought in Sahel and its impacts on ecosystems: Long term vegetation monitoring from the sky and on the ground

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The Sahel region is known to be very sensitive to climatic fluctuations. Precipitation interannual variability has immediate and strong consequences on water resources, vegetation production, all affecting human populations. All along its history, Sahel had to face extreme climatic events. In the recent past, a 25 years period of persistent drought jeopardized the ecosystems equilibrium. Indeed, from the 1970's to the mid 1990's, precipitations were strongly and repeatedly below average. A debate has grown for years in the scientific community about the evolving trend of ecosystem in Sahel: is there desertification, or rehabilitation indicated by a "re-greening" taking place since the 1980's, as observed on satellite data by many scientists?
To answer these questions, NDVI (Normalized Difference Vegetation Index) time series derived from NOAA/AVHRR are analyzed and compared to field measurements of the herbaceous aboveground mass, tree inventory and crop phytomass collected in Mali and Niger, from 1984 to 2011 and 1994 to 2011 respectively.

The GIMMS-3g NDVI trends analysis from 1981 to 2011 show positive and significant slope values over almost every part of the Sahel, except for western Niger and central Sudan, thus reinforcing the "re-greening" hypothesis.
Field observations are in good agreement with satellite data. A positive trend is observed over the Gourma in Mali, particularly for periods beginning in the 1980's, showing the ecosystem resilience to drought. A similar recovery is observed in western Niger, but only up to the mid 1990's, then the trend turns negative without being explained by rainfall. While the Gourma is mainly a pastoral land, western Niger is an agro-pastoral region in which cropped surfaces expanded widely over the last decades. For both regions, the re-greening trends are mainly observed on sandy soils, while erosion processes have been observed on shallow soil surfaces, inducing increased run-off and decrease in vegetation cover to the benefit of vegetation in clayed depressions receiving run-on water. Thus, even if an overall re-greening trend is observed, contrasted changes may have occurred in the landscape. The woody cover shows the same general behavior: a strong resilience on sandy soils but a decreasing trend over shallow surfaces and more complex variations in the cultivated Fakara.
Finally, decreasing trends in Rain Use Efficiency are found for both regions. RUE values are particularly high after the drought, but show smaller and constant values ever since.

This study suggests that Sahelian ecosystems are resilient to extreme climatic events such as the 1970-1980's drought, relying on remarkable plant traits (annual type, strong photosynthesis at leaf and canopy level, rapid growth, large seed production and dissemination), but that other causative factors can prevent from a total recovery of vegetation, that induce changes in terrestrial ecosystems.