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Surface response to monsoon : a Sahelian ecohydrology case study

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The Sahel, in particular its southern cultivated part, is a good example of a system subjected to both high rainfall variability and a strong anthropogenic pressure. Indeed, this semiarid region is in fast population increase with a strong pressure on the environment, especially due to the extension of crops and the uncontrolled fuel wood extraction. Furthermore, over the last decades, the monsoon-dominated climate has been marked by wet periods (e.g. 1950s- 1960s) and very dry periods (e.g. 1970s-1980s). Since the 1990s, a return to more average conditions can be observed, but with a strong interannual and intraseasonal variability. Rainfall variability and anthropogenic pressure have large consequences for the eco-hydrologic cycle.

Our study aims at the understanding of relationships between vegetation, climate and hydrological processes in the Wankama pilot watershed, a Sahelian site in Niger; West Africa. The Wankama watershed is an intensive measurement site of the AMMA program (http://www.amma-international.org/). It is an endoreic catchment of 1.9 km^2, typical of the region, which mainly consists of a sandy hillslope with slopes below 2%. Since 2005, the surface response to the rainfall variability is continuously monitored through a vegetation survey and the recording of energy and water cycles by eddy correlation and soil moisture stations. Results point to the dominant role of water in the energy cycle variability, be it seasonal, interannual, or between land cover types. Rainfall is responsible for nearly as much seasonal variations of most energy-related variables as solar forcing. The rainfall distribution has an impact on soil functioning. As observed in other semiarid environments, when the rain season starts, the shallow soil response displays a pulse. After each early rain event, a quick response is observed in evaporation and carbon fluxes. The rainfall distribution also has an impact on the development of vegetation and thus on evapotranspiration and carbon uptake with a clear difference between the "natural" vegetation (fallow) and the crop vegetation. Vegetation development in the fallow was found to depend more on rainfall distribution along the season than on its starting date. A quite opposite behaviour was observed for the crop vegetation: the date of first rain appears as a principal factor of millet growth. Carbon flux exchanges are well correlated to vegetation development. Rain-season evapotranspiration is nearly always lower at the crop site. Higher soil moisture at this site suggests that this difference arises from lower vegetation requirements rather than from lower infiltration / higher runoff.