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Modelling the water budget of a cultivated hillslope under Sudanian climate: evidenced role of the riparian forest

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Rainfall amounts in West African Sudanian region are important (700 – 1400 mm/year), but unevenly distributed all along the year, causing water scarcity and droughts during the dry season. To better manage the water resources, the aim of this study is to improve our understanding of hydrological processes at the hillslope scale in North Benin. This scale is retained because all hydrologic processes and their interactions are involved and can be documented: vadose zone and groundwater storages, rainfall, evapotranspiration and seepage fluxes. The study focuses on a typical cultivated hillslope of the upper Ouémé basin under Sudanian climate in North Benin. Crops are present on the main part of the hillslope and a riparian forest can be found at low elevation. At the basin scale, the riparian forests cover only a negligible fraction of the landscape but are commonly found, bordering the second and upper order streams. A vertical 2D approach is followed using the physically-based model HYDRUS-2D to simulate the hillslope hydrodynamics.

A multi criteria approach is performed to evaluate the simulations using data from hydrological sensors deployed in the context of the AMMA-CATCH observing system (African Monsoon Multidisciplinary Analysis - Coupling the Tropical Atmosphere and the Hydrological Cycle). Since annual evapotranspiration can reach up to 83 % of the annual rainfall in this area, particular attention is paid to this term of the hydrologic cycle thanks to recent measurements of actual evapotranspiration (Large Aperture Scintillometer, Flux Tower).

Hillslope hydrodynamics is correctly modelled in regard of soil moisture, deep groundwater level and actual evapotranspiration dynamics. A virtual experiment is performed at the hillslope scale removing the riparian forest and the deep groundwater table. This virtual experiment evidences these two roles of the riparian forest transpiration on the hillslope hydrodynamics: annual fluctuation of the deep groundwater table; disconnection between deep groundwater table and river drain. The intra annual variability of the transpiration origin is explored. The riparian forest transpiration represents 37 % of the hillslope total transpiration for the simulated year and reaches 57 % during the dry season.