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Depletion of Stem Water of Sclerocarya birrea Agroforestry Tree Precedes Start of Rainy Season in West African Sudanian Zone

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Understanding water use by agroforestry trees in dry-land ecosystems is essential for improving water management. Agroforestry trees are valued and promoted for many of their ecologic and economic benefits but are often criticized as competing for valuable water resources. In order to understand the seasonal patterns of source water used by agroforestry trees, samples from rain, ground, and surface water were collected weekly in the subcatchment of the Singou watershed that is part of the Volta Basin. Soil and vegetation samples were collected from and under a Sclerocarya birrea agroforstry trees located in this catchment in sealed vials, extracted, and analyzed with a Picarro L2130-i CRDS to obtain both δO18 and δDH fractions. Meteorological measurements were taken with a network of wireless, autonomous stations that communicate through the GSM network (Sensorscope) and two complete eddy-covariance energy balance stations, in addition to intense monitoring of sub-canopy solar radiation, throughfall, stemflow, and soil moisture.

Examination of the time series of δO18 concentrations confirm that values in soil and xylem water are coupled, both becoming enriched during the dry season and depleted during the rainy season. Xylem water δO18 levels drops to groundwater δO18 levels in early March when trees access groundwater for leafing out, however soil water does not reach this level until soil moisture increases in mid-June. The relationship between the δDH and δO18 concentrations of water extracted from soil and tree samples do not fall along the global meteoric water line. In order to explore whether this was a seasonally driven, we grouped samples into an “evaporated” group or a “meteoric” group based on the smaller residual to the respective lines. Although more soil samples were found along the m-line during the rainy season than tree samples or dry season soil samples, there was no significant difference in days since rain for any group This suggests that xylem water is always under stress from evapotranspiration and soil water underwent evaporation soon after a rain event. Visual observation of tree confirms conclusion that trees access deep ground water in March and April, before rain begins and before soil is connected to groundwater. Results from the research are being integrated into a local outreach project to improve use of agroforestry.