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Evidence of hydraulic lift for pre-rainy season leaf out and dry-season stem water enrichment in Sclerocarya birrea, a tropical agroforestry tree

Natalie Ceperley, Theophile Mande, Andrea Rinaldo, and Marc B. Parlange
EPFL, ENAC, EFLUM, Lausanne, Switzerland (natalie.ceperley@epfl.ch, 41216932711)

We use stable isotopes of water as tracers to follow water use by five Sclerocarya birrea trees in a catchment in South Eastern Burkina Faso interspersed with millet fields, gallery forest, Sudanian savanna, and fallow fields. Isotopic ratios were determined from water extracted from stems of the trees and sub-canopy soil of two of them, while nearby ground water, precipitation, and surface water was sampled weekly. A unique configuration of sensors connected with a wireless sensor network of meteorological stations measured sub-canopy shading, the temperature and humidity in the canopy, through-fall, and soil moisture under two of the trees.

Both water extracted from sap and water extracted from soil is extremely enriched in the dry season, but drop to levels close to the ground water in February or March, which coincides with the growth of leaves. Dates of leaf out were confirmed by changes in δDH and δO18 concentrations of water, photographic documentation & pixel analysis, and analysis of sub-canopy radiation and proceeded the rise in humidity and flow that was later detected in the sub-canopy soil, the trunk of the tree (sap-flow), and atmosphere (canopy VPD). Examination of the isotopic signature suggests that size of tree plays an important role in duration and timing of this leaf-out as well as the degree of enrichment during the peak of the dry season. Further examination of the isotopic signatures of the roots suggested that the trees are performing hydraulic redistribution, or lifting the ground water and "sharing it" with the soil in the rooting zone in the dry season. The enriched level of xylem in this case is a product of water loss, and enrichment, along the travel path of the water from the roots to the tip of the stem, as evidenced by the variation according to size of tree. Vapor pressure deficit, soil water, and soil moisture interactions support this picture of interacting controls, separate from hydrologic triggers on the water movement in the tree.