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Assessment of Agroforestry Trees in Dry-land Savanna Supports Ecohydrologic Separation

Natalie Ceperley (1), Theophile Mande (2), Nick Van de Giesen (3), Scott Tyler (4), and Marc Parlange (5)

(1) University of Lausanne (UNIL), Lausanne, Switzerland (natalie@ceperley.com), (2) ENAC, EPFL, Lausanne, Switzerland, (3) Civil Engineering and Geosciences, TU Delft, Delft, Netherlands, (4) Hydrogeology, University of Nevada, Reno, USA, (5) Applied Sciences, University of British Columbia, Vancouver, BC, Canada

We use stable isotopes of water to demonstrate the ecohydrologic separation, or the plant controlled compartmentalization, of different water sources in a catchment in South Eastern Burkina Faso. We analyze water extracted from the groundwater, stream water, precipitation, perched aquifer, xylem water of agroforestry trees, and sub-canopy soil water over a 6 year period to explore how the separation affects different components of the system over time. The ratio between deuterium and O18 allows us to assess whether the water that plants use is the same as the water that recharges the aquifer and runs off in the stream.

Water extracted from the tree at leaf out in February corresponded to deuterium and O18 concentrations of the groundwater, a drop from its dry season, enriched, levels which mimicked the soil water. Examination of the isotopic signature suggests that the 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. Dates of leaf out were confirmed by analyzing sub-canopy radiation and photographs. Water extracted from roots suggests that the trees are performing hydraulic redistribution, or lifting the ground water and 'sharing it' with the rooting zone soil during 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 branch, as evidenced by the variation according to size of tree. Vapor pressure deficit, sap flow, soil water, and soil moisture interactions support this picture of interacting controls, separate from hydrologic triggers on the water movement in the tree. A second round of sampling focused on the leaf out period by extracting and analyzing stem water from throughout the canopy during the leaf out.

Simultaneous large eddy correlation revealed high levels of latent energy flux, even during the dry season. Our isotope analysis allowed us to conclude that tree level transpiration explains this discrepancy since it does not access the same reservoirs of water as the rest of the catchment. Most current land surface models do not differentiate between different reservoirs of water.