Seasonal isotope hydrology of a coffee agroforestry watershed in Costa Rica

J. Boll1, K. Welsh*1,2, O. Roupsard2,3

1University of Idaho, Moscow, ID, USA; 2Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica; 3UMR Eco&Sols, CIRAD, Montpellier, France

Introduction

In the tropics, the “amount effect” has been recognized as one of the primary influences on stable isotope values in tropical precipitation for monthly samples (Figs 1 and 2). However, when examining event-based precipitation events at a regional scale, lifting condensation levels and surface relative humidity have a greater influence (Sánchez-Murillo et al. 2014). The main goals of this research were to examine what microclimate factors influence local stable isotope (δ18O and δD) values and whether stable isotopes can be used to trace seasonality in this region at different temporal scales.

Methods

- Sampled precipitation (event-based samples), groundwater (weekly samples), and stream water (weekly samples at 4 locations) for 2+ years.
- Micrometeorological data were collected at an eddy-flux tower located on site.
- Study Site: The Mejías watershed (Cartago, Costa Rica) is an agroforestry microwatershed (0.9 km²) located on the Aquiares Coffee Farm.

Results

- Monthly δ18O values: Historic GNIP data
- Monthly δ18O values: Study data
- Δ18O in groundwater

Discussion

- For monthly averaged samples (Figs 4 and 5), dry season precipitation is enriched with respect to the rainy season, but at an hourly or daily basis other trends are evident, such as correlation with meteorological measurements and stream response to precipitation events (Fig 6).
- Air temperature, wind speed, and wind direction are all significantly correlated with δ18O and δD values in precipitation, which could be due to seasonal differences in air mass sources.
- Examining stream water δ18O and δD values at a finer scale (Fig 9) shows how streams respond to precipitation, as the stream becomes enriched with higher amounts of rain due to source contribution of groundwater and overland flow from spring and roads (Figs 10 and 11).
- Stable isotopes are useful for examining seasonality and watershed dynamics when examined at different temporal scales. For example, measuring isotopes in stream samples during storm events assists in our understanding of when storm flow reaches streams.
- Further work will include partitioning stream water sources and quantifying spring contribution to storm flow.

References


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