Space-Time Variability of Baseflow in Headwater Streams of the Southern Appalachians H23L-1045

Introduction
➢ Watershed shape and structure have an important but poorly understood role in modulating the spatiotemporal variability of baseflow in first-order headwater catchments.
➢ We studied relationships between landscape variables and baseflow (magnitude and isotopic composition) using a combination of geospatial analysis, stream gauging and isotope hydrology.

Research Questions
➢ How does baseflow vary longitudinally along streams in two forested headwater catchments of the Southern Appalachians?
➢ How does watershed structure inform our understanding of the spatiotemporal variability of baseflow in these mountainous catchments?

Study Site
➢ Coweeta Hydrologic Lab (CHL), Southern US Appalachians
➢ Two paired, south facing catchments: WS01 (15 ha), WS02 (12 ha)
➢ Number of study hillslopes were (WS01)14 and (WS02)14

Hydrometric Methods
➢ Dilution gauging was used to estimate discharge along streams under 3 different baseflow conditions and discharge-area relationship was developed for each stream.
➢ Discharge-area relationships were combined with continuous flow measurements at the outlets to estimate discharge at synoptic sampling points and to derive lateral hillslope inflows.

Isotopic Methods
➢ Monthly synoptic samples of stream water at 25-50m intervals along streams under base flow condition, bulk rainfall (4 RG) and shallow groundwater (12 wells) samples were collected (June ‘11 – July ’13).
➢ Synoptic samples were split into two periods based on annual rainfall: Y1, June ‘11 – May ‘12 (Normal); Y2, June ‘12 – June ‘13 (Wet).
➢ Samples were analyzed for δ18O (referenced to VSMOW) using CRDS (Picarro L212i); Precision ±0.05 (δ18O %).

Geospatial Methods
➢ LIDAR derived 10 m DEM was used to compute terrain variables such as upslope drainage area (UAA), distance from creek (DFC) and gradient to creek (GTC) for each 10 m pixel.
➢ Incremental contributing area (ICA) was derived for each reach as the ratio of local reach drainage area to total drainage area upstream of the reach.
➢ Summary statistics of terrain variables were computed for the local hillslope area contributing to each stream reach.

Results - Estimated Discharge and Lateral Inflow
➢ Discharge relative to watershed outlet.
➢ Q=UA, A=area (m2)

Results-Catchment Structure and Relationships to Stream δ18O
➢ Above: Cumulative distribution of distance from creek (DFC) for hillslopes adjacent to each ~100m stream reach showing location of reach from channel head (light orange) to outlet (black). Red line shows cumulative distribution of DFC for entire catchment. Insets show hillslopes where high isotopic variability was observed.
➢ Below: Correlations between medians of landscape variables and ranges of stream δ18O for sampled reaches. Note: These correlations do not account for auto-correlations in the stream δ18O.

Discussion and Conclusions
➢ Discharge for WS01 was generally greater than discharge for WS02, but several hillslopes in WS02 had lateral inflows exceeding those in WS01.
➢ In general, δ18O of stream water increased moving from the channel head to the catchment outlet.
➢ Both catchments had higher temporal variability in stream δ18O for all sample reaches during the normal year than during the wet year.
➢ Combination of ICA and DFC explained most of the spatiotemporal variability in stream δ18O for both catchments.
➢ For both catchments, relationships between stream δ18O and landscape variables deteriorated during the wet period.

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