Hierarchical Controls on Catchment Runoff Dynamics: Topographic Hydrologic Connectivity, Vegetation, and Geology

Kelsey Jencso and Brian McGlynn
Quantify the hierarchical controls on hydrologic connectivity and catchment runoff dynamics across space and time
Instrumentation/Monitoring

- 24 transects of wells (160 recording shallow GW wells)
- 11 flumes recording stage; 7 with real time specific conductance (SC) and temperature recorders
- ALSM 1m topography data
Quantifying upland drainage along the stream network

> area accumulation
> water accumulation
> increase in streamflow
Hillslope-Riparian-Stream hydrologic connectivity

UAA – HRS Connectivity Relationship

Jencso et al., 2009, Water Resources Res.
Distributed HRS Hydrologic Connectivity

\[ \% \text{Time Connected} = (0.00002 \times \text{UAA} - 0.0216) \times 100 \]

Jencso et al., 2009, Water Resources Res.
How does HRS connectivity relate to streamflow magnitude?

- Alternatively -

< 10% of the year
> 0.18 mm runoff
> 25% network connected

Jencso et al., 2009, Water Resources Res.
Comparison of connectivity and runoff across catchments
Quantifying Connectivity Yield

Jencso, et al., WRR, In Review
Predictors of Connectivity Yield Across Space and Time

Predictors

- Slope
- Aspect
- Riparian Buffering Index
- Flowpath distance / flowpath gradient
- Flowpath elevation above the stream
- % Riparian Area
- % Hillslope Area
- Tree Height
- % Forest Cover
- Vegetation Density
- Vegetation Height * Density (Biomass)
- % Sandstone
- % Sandstone_{UAA > 5000m^2}

Jencso and McGlynn, WRR in review
Hierarchical Predictors of Connectivity Yield across 11 catchments and flow states

Multiple Linear Models
Significant Predictors (p<0.05)

**Annual** ($R^2 = 0.91$)
- >flowpath distance/flowpath gradient
- >vegetation height
  - less yield

**Wet** ($R^2 = 0.80$)
- >flowpath distance/flowpath gradient
  - less yield

**Transition** ($R^2 = 0.91$)
- >flowpath distance/flowpath gradient
  - less yield

**Dry** ($R^2 = 0.81$)
- >Sandstone$_{UAA>5000m2}$
  - more yield

Jencso, et al., *WRR, In Review*
Catchment Structure

Hydrologic Connectivity

Runoff Dynamics

- Vegetation
- Flowpath Length/Gradient
- Geology
Implications

• Increased connectivity $\rightarrow$ increased runoff

• Increased connectivity $\rightarrow$ increased mobilization of solutes, nutrients, and contaminants to stream networks.

• Increased disturbance of hydrologically connected flowpaths $\rightarrow$ decreased stream water quality.

Different watersheds will respond to different degrees, partially as a result of landscape structure
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