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Watershed and stream network geometry: Implications for water and solute fluxes from watersheds

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Landscape influences on the timing and magnitude of water delivery from watersheds are poorly understood. Watershed and stream network geometry (topography and topology respectively) may play a significant role in controlling fluxes of water from catchments. Recent research has indicated that stream network geometry can influence watershed hydrology. Stream network shape and topology as well as riparian and upland watershed structure can each influence the timing and magnitude of water delivered to watershed outlets. Here, we analyzed six watersheds in the Sawtooth Mountains of central Idaho, USA ranging in size from 11 to 63 km2 to explore the relationships between watershed structure and watershed hydrology. We performed detailed terrain analysis on 10m resolution digital elevation models (DEMs) for each watershed. We calculated a wide array of watershed metrics including: frequency distributions of slope, aspect, distance from creek (DFC), elevation above creek (EAC), gradient to creek (GTC), median subcatchment size, and lateral inflows. We also calculated stream network indices: drainage density, length per Strahler stream order, distance from outlet (DFO). In these moderately small alpine watersheds in the same area with comparable geology, age, and climate, some distributions such as DFC, GTC, and EAC, were more similar across watersheds. However, metrics including drainage density, DFO, local inputs, riparian area versus subcatchment size and slope show stronger differences across the watersheds indicating differences in watershed and stream network structure. For example, as a measure of stream network geometry, less uniform distributions of DFO (more dendritic networks) should result in a more attenuated outlet hydrograph. However, less uniform distributions of lateral inflows (an indicator of topographic convergence and divergence) could result in flashier stream hydrographs. We suggest that these metrics, among others, can be considered quantitative metrics of watershed and stream network geometry and aid elucidation of landscape characteristics that partially control the timing and magnitude of water and solute fluxes from watersheds.