Brian L. McGlynn, Kelsey Jencso, Fabian Nippgen, Sam Carlson, Tyler Smith, Lucy Marshall, and Ryan Emanuel

Moving from field observations of catchment storage and hydrologic connectivity to new modeling conceptualizations.

It is widely accepted that there is correspondence between the structure of a catchment system and its functional hydrologic response. However, understanding the nature of and developing model representations of these relationships remain a challenge in gauged and ungauged basins. Catchment water storage and its release to streamflow is mediated by hydrologic connectivity between catchment upland and near stream areas. Connectivity is essential for the transmission of water, solutes, and nutrients to streams. While significant progress has been made in experimental hydrology to observe and quantify landscape scale hydrologic connectivity, new model conceptualizations based on these observations have lagged. While numerous models are able to recreate observed hydrographs at the catchment outlet, few are consistent with or comparable to internal catchment observations of hydrological patterns and processes. Here we present a new parsimonious modeling framework that represents hydrologic patterns and connectivity at the catchment scale based on easily observable measures of catchment structure (e.g. topography). We applied the model to the Stringer Creek watershed of the Tenderfoot Creek Experimental Forest (TCEF), located in central Montana, USA. We independently tested model consistency with internal catchment behavior and field observations of shallow groundwater connectivity across 30 hillslope-riparian-stream transects (180 groundwater wells). Our model represented streamflow dynamics well and more importantly was consistent with internal catchment observations of hydrological connectivity through space and time. This new model structure informed by catchment structure demonstrated increased model realism with relatively low data requirements and provides one way forward for prediction in ungauged basins.