Spatial variation in the response of summer streamflow to climate forcing for the mountains of the Western US

In the Western US, streamflow is typically lowest during late summer when precipitation inputs are minimal and evapotranspiration rates are high. Understanding how past, current and future climate variation is likely to alter summer streamflow regimes is critical, given their importance for water-supply and aquatic ecosystems. Existing year to year climate variation associated with El Niño/Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) and projected climate warming have been linked to temporal variation in summer streamflow. The mountainous topography of the western US offers a scenario where in many places, changes to snow accumulation and melt play a central role in climate control on streamflow. Current analyses generally show that warmer temperatures result in diminished snowpacks, leading to lower summer streamflows throughout the West. In these analyses, however, other landscape controls, notably geology and vegetation which may also alter streamflow responses to warming have received less attention. Understanding how these different controls vary and interact with each other within a regional landscape may be critical in determining within-region differences in availability of water during the low flow season. To illustrate these interactions, I use a combination of empirical streamflow analysis and spatially distributed physically based modelling (using RHESSys - Regional hydro-geologic ecosystem simulation system). Within the Oregon Cascades, results show that regional geologic differences are critical controls on the spatial pattern of summer streamflow. Using a case-study of two headwater catchments in the Cascade mountains of Western Oregon, model results show that that including geologic-based differences in drainage efficiency or groundwater dynamics is as important as including elevation-based differences in snowpack in assessing hydrologic impacts of climate variation and change. A similar approach can be used to examine the potential role of vegetation in mediating the response of summer streamflow to climate variability and warming. The role of vegetation is particularly significant if changes in fire frequency are considered. I will illustrate results from a study in a chaparral-dominated catchment in Southern California which modeled the sensitivity of summer streamflows to a combination of future fire frequencies and climate forcing. Results from both studies are used to develop a framework for future investigation of the geography of summer streamflow sensitivity to climate change for the mountains of the Western US.