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New Policy Research at CU and Beyond

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ECOHYDROLOGICAL VULNERABILITY TO CHANGES IN CLIMATE AND LAND USE IN THE ROCKY MOUNTAINS

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Abstract: The impacts of climate change on water sustainability in the Western U.S. is inherently linked to changes in mountain snow accumulation and snowmelt timing which sustains agricultural and municipal water demands for 60 million people in the region. Snowpack measurements over the past 50+ years suggest a broad scale reduction in snowpack water storage associated with regional warming. Projected onto this storage-reduced scenario, the demand for water in the region is escalating as agricultural, industrial, and societal pressure on the current system grows. Furthermore, land cover changes associated with ex-urban population growth, fire suppression, and mountain pine bark beetle outbreaks have altered the functioning of ecosystems with regard to hydrological processes. New remote sensing and in situ measurement capabilities afford improved understanding of ecosystem-human sensitivity to these changes. In this regard, distributed ecohydrologic instrument clusters allow us to observe micro-scale variability in snow-vegetation interactions while remotely sensed data allow us to observe integrated ecosystem-scale response to water availability. Instrument clusters deployed in the Central and Southern Rockies reveal the dominant role of vegetation in controlling the timing and magnitude of snow accumulation and snowmelt. In this regard, vegetation structure largely controls the distribution of snow accumulation with 29% greater accumulation in open versus under-canopy locations. Snow ablation rates are increased by 39% in open locations, indicating reductions in vegetation density (e.g. due to forest disturbance) act to reduce the duration of the snowmelt season. Soil water availability is strongly dictated by these snow-vegetation interactions as the timing of peak soil moisture occurs within a few days of snow disappearance. Analysis of remotely sensed vegetation greenness data at the regional scale reveals a coherent signal with regard to these plot-scale measurements. Observations of forest greenness from polar orbiting satellites indicate strong forest and understory growth dependencies associated with snow accumulation and snowmelt. Forest sensitivity to energy availability is also evident in the satellite record whereby anomalously low snow accumulation combined with anomalously high potential evapotranspiration result in anomalously low forest greenness. Examples of these dependencies will be presented based on the 2012 drought in the Southern Rockies whereby near record low snow accumulation and record high potential evapotranspiration have resulted in record low forest greening as evident in the 30+ year satellite record. Implications for water resource and land management, water allocations, and water policy will be discussed. In this regard, the colliding resource pressures associated with the aforementioned processes may exhibit tipping points with respect to operational water distribution procedures and legal agreements associated with water allocations.