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Climate change on water quality: are we reaching a tipping point?

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High elevation mountains supply three fourth of the surface water in western United States. Although it is well ducumented that climate change can shift precipitation from snow toward rainfall and decrease snowmelt in these areas, its impact on water quality is much less investigated and poorly understood. Here we examine the dynamics of water quality change using 4 decades of data on climate, water and water chemistry from Coal Creek, Colorado, a high elevation headwater catchment in central Rocky Mountain with 100 years of mining in the past. The data show that although the annual mean temperature in the U.S. has increased by $< 1^{\circ}$C since 1980s, it has increased by 6.5°C in Coal Creek. Snow fraction has deceased from about 75% in 1980 to 50% in 2018, paralleled by significant decrease in peak flow during snowmelt. Accompanying these are the changes in solute concentrations and their response to discharge variations. Although geogenic species (e.g., Ca, Mg, Si) have remained relatively similar, changes with heavy metals deriving out of mining tails are much more erratic. Some species (e.g., Cr, Co, Fe) see substantial increase in inter annual concentrations whereas others (e.g., As, Cu) remain relatively constant. The most dramatic alterations are observed for dissolved organic carbon (DOC): it remained within a narrow range of 1-5 mg/L until in 2017 and 2018, when its concentrations escalate to as high as 15-20 mg/L. This dramatic increase may be an early sign in a high-elevation mountain that is most vulnerable to climate change, and may indicate a tipping point of climate change, above which the rates of soil carbon decomposition increase substantially. The contrasting behavior of different solutes accentuate the complex nature of biogeochemistry and water quality response to climate change.