Hydrological extremes shift controls and pathways of carbon loss from floodplain soils

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Floodplains within mountainous watersheds are dynamic reservoirs of carbon that experience seasonal flooding due to snowmelt and drainage. Climate change dramatically alters snowpack levels across alpine ecosystems within the Western US, which results in more extreme flood and drought years. The variable hydrology drives spatial and temporal redox gradients within floodplain soils, with unknown consequences for carbon storage and export. In this presentation, I will show how extreme flooding and drought events alters controls and pathways of soil carbon loss within a mountainous floodplain system. Specifically, we aimed to resolve the balance between mineral and metabolic constraints on floodplain carbon loss. I will report on an extensive monitoring campaign and associated biogeochemical measurements across extremely low and high river discharge years, which foreshadow climate change predictions across mountainous ecosystems in the Western US. Combining in-field geochemical measurements and DOC and CO₂ flux measurements, we showed that reducing conditions during extreme flooding decrease the stability of mineral-organic associations, causing concomitant mobilization of metals and DOC. However, extensive metabolomic and metagenomic analysis showed that newly liberated reduced DOC compounds were subject to metabolic constraints, decreasing CO₂ fluxes. Conversely, during the extreme drought year, the stability of mineral-organic associations was increased due to sediment oxygenation, diminishing DOC export. Our results suggest that hydrological extremes alter the magnitude and pathways of CO₂ and DOC export in mountainous watersheds. Implications for carbon storage potential of floodplain soils will be discussed.