River Corridor Hydrobiogeochemistry from Reaction to Basin Scale

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Project Abstract: *The Pacific Northwest National Laboratory (PNNL) River Corridor Science Focus Area (RCSFA) is transforming understanding of spatial and temporal dynamics of coupled hydrologic and biogeochemical processes in river corridors from reaction to watershed and basin scales, thus enabling mechanistic representation of river corridor processes and their response to disturbances in multiscale models.* Rivers are integrators of watershed processes as their composition and dynamics reflect conditions in the surrounding landscapes and subsurface environments. Hydrologic exchange flows (HEFs) between river channels and surrounding sediments are a ubiquitous feature of river corridors but vary substantially in their character and impacts. HEFs are known to promote enhanced hydrobiogeochemical function in river corridors, yet we lack transferable understanding of how their governing processes vary through space, time, and across scales and watershed settings. Furthermore, the representation of river corridors in basin-scale integrated land surface models is currently limited, and their cumulative impacts on watershed function are poorly understood. Accordingly, it is difficult to predict how river corridor hydrobiogeochemistry will respond to future disturbances. Our team is developing mechanistic understanding of the processes that link hydrologic, geochemical, and microbial processes in river corridors and integrating that new knowledge into numerical models at scales from fundamental reactions to major river basins to enable robust prediction. Wildfires and the compounding effects of precipitation events are key disturbances that influence river corridor hydrobiogeochemistry and are prevalent in the Columbia River Basin (CRB) and its constituent watersheds. To elucidate the impacts of spatial and temporal variability of hydrobiogeochemical processes across scales, as perturbed by wildfire disturbances, we are performing integrated field, laboratory and modeling studies in the Yakima River Basin (YRB), a major watershed that includes a wide ranges of stream orders and all major watershed classes in the CRB from forested mountains to shrub-steppe desert lowlands. Prediction is focused on elemental (C, N, P) cycling and key water quality variables including temperature and contaminants such as nitrate. We are using a distributed, open science approach based on our successful development of WHONDRS to develop regional and national partnerships that will underpin this research. A multiscale ModEx approach integrates process-based and data-driven models with experiments and observations across reaction to basin scales in coupled iterative learning cycles. Connecting project outcomes to the efforts of other agencies will enable robust watershed predictions to facilitate the solution of national challenges in water quality/quantity and Earth System prediction.