Quantifying Basin-Scale Hydrological, Biogeochemical and Thermal Inputs to River Corridors Under Baseline and Disturbance Conditions

Xingyuan Chen[1*], Pin Shuai[1], Kyongho Son[1], Glenn Hammond[2] , Gautam Bisht[1], Heping Liu[3], Peishi Jiang[1], Kyuhyun Byun[1], Kevin Bladon[4], Yilin Fang[1], Xuehang Song[1], James Stegen[1], and Emily Graham[1]

[1]Pacific Northwest National Laboratory, Richland, WA; [2]Sandia National Laboratories; Albuquerque, NM; [3]Washington State University; Pullman, WA; [4]Oregon State University, Corvallis, OR

Contact: (xingyuan.chen@pnnl.gov)
Project Lead Principal Investigator (PI): Tim Scheibe
BER Program: SBR
Project: PNNL SBR SFA
Project Website: https://sbrsfa.pnnl.gov/

This element of the PNNL SFA seeks to provide spatially and temporally distributed inputs of water, solutes, and energy to river corridors under baseline and disturbed conditions using integrated watershed models. Disturbance by wildfires, in combination with post-fire precipitation scenarios, can dramatically influence dominant surface and subsurface flow paths and residence times, as well as water, energy, and dissolved organic matter (DOM) inputs to river corridors. However, the impacts of such disturbances on water quantity and quality remain poorly understood. Our previous studies have shown that river corridor processes are strongly influenced by hydrological, biogeochemical, and thermal inputs from the surrounding surface and subsurface environments. Integrated watershed models can link potential controlling factors (e.g., precipitation distribution, surface and subsurface flow paths, land use and disturbance histories) to define the heterogeneity and dynamics of these inputs that drive river corridor biogeochemistry, allowing more accurate evaluation of the roles of river corridors in mitigating or enhancing watershed responses to environmental disturbances.

We will develop and improve integrated hydrologic and biogeochemical watershed models using community codes hosted in the model ecosystem of IDEAS-Watersheds, linking hydrologic and biogeochemical models through particle tracking, tracer simulations, and interfaces to available biogeochemistry engines. We will use a paired-watershed (disturbed vs. reference) approach under various climate scenarios to evaluate the impacts of wildfires and precipitation on watershed functions. To incorporate wildfire impacts into watershed models, we will relate soil burn severity maps to key factors that control surface and subsurface flow and transport pathways. We will leverage available eddy covariance flux tower network data to better understand and quantify how wildfires change ecosystem structure and functions, modify soil properties, and alter land surface processes including surface energy budget components, and CO_2 fluxes at multiple spatiotemporal scales. These data will inform the parameterization of ecohydrological components of our watershed models under environmental disturbances.

Integrated watershed models are fundamental to understanding terrestrial inputs to river corridors under baseline and disturbance conditions. Our model will enable the evaluation of the interplay between hydrologic connectivity and terrestrial DOM (including pyrogenic organic matter) transport to rivers through both surface and subsurface pathways, thus enabling mapping of hydrobiogeochemical regimes across watersheds and basins without the need to measure everything and everywhere. Stream and riverbed temperature regimes simulated by the model can also be used to map thermal refugia for resilient aquatic habitat.