Title: Effects of Microbial Growth and Death and Sediment Movement on Hyporheic Zone Biogeochemistry

Erich Hester,[1*] W. Seth Lotts,[1] Hector Monterroso,[1] Kyle Strom,[1] and Mark Widdowson,[1]

[1]Virgina Tech, Blacksburg, VA

Contact: ehester@vt.edu

Project Lead Principal Investigator (PI): Erich Hester

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Project: Effects of Surface Water Fluctuations and Sediment Movement on Hyporheic Zone Biogeochemistry and Microbial Communities (University project)

Project Abstract: The area beneath and adjacent to river channels where surface water and groundwater interact in shallow sediments is known as the hyporheic zone. The hyporheic zone is often more reactive than overlying surface water or deeper groundwater, and thus is an important area for chemical transformation and contaminant attenuation within river corridors and watersheds. This exploratory project is developing a predictive mechanistic modeling approach to quantify the effects of surface water fluctuations and bed migration on hyporheic zone microbial community distribution and hence hyporheic biogeochemical cycling. We started this work by focusing on 1) relatively low flows (e.g., baseflow and modest increases for hydropower peaking) across the annual cycle because they occur for most of the year and sediment migration is well understood, and 2) riverbed dunes which are widespread in larger streams and rivers and often dominate hyporheic effects on water quality, and 3) the effects of the interaction of oxygen and carbon infusion from surface water and sediment migration on microbial heterogeneity, aerobic metabolism, and denitrification. We are linking a series of existing models that simulate surface water hydrodynamics (OpenFOAM), groundwater flow (MODFLOW), and groundwater transport/reaction (SEAM3D). We are currently 1) developing and testing a moving frame of reference (MFOR) modeling approach to simulate dune migration effects on biogeochemical transformations through modification of SEAM3D, and 2) testing existing microbial population growth and decay functions of SEAM3D. After linking and testing are finished, we will conduct sensitivity analyses of controlling factors such as hydraulic, biogeochemical, and microbial model parameters and boundary conditions. Given the recent start to this project, results at the time of this writing are limited. But we anticipate quantifying the effect of varying the ratio of dissolved oxygen to dissolved organic carbon concentrations in surface water, surface water and groundwater boundary heads, bedform movement celerity, and sediment hydraulic conductivity on microbial biomass and distribution, microbial response time, and aerobic oxygen consumption and nitrate consumption due to denitrification in hyporheic zone sediment. These results will have important implications for material processing in watersheds where microbial and sediment dynamics are important.