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Stochastic modeling of fine particle deposition, resuspension, and hyporheic exchange in rivers

Aaron Packman, Jennifer Drummond, and Antoine Aubeneau
Northwestern University, Civil and Environmental Engineering, Evanston, United States (a-packman@northwestern.edu)

Fine suspended particles are responsible for substantial flux of organic matter and contaminants in rivers. Further, microorganisms delivered from the terrestrial system or resuspended from benthic and hyporheic biofilms also propagate downstream in rivers, providing connectivity in the river microbial community. Because fine particle concentrations are often similar along the length of rivers, there has been a tendency to think that their dynamics are simple. Historically, fine suspended particles have been considered to show little interaction with streambed sediments. This is a fallacy. Recent observations have demonstrated that fine particles show complex dynamics in rivers, including ongoing deposition and resuspension. This provides substantial opportunity for interaction with benthic and hyporheic sediments and biofilms, which can lead to enhanced processing of fine particulate organic carbon, accumulation of pathogens in riverbeds, and mixing of particle-bound contaminants into bed sediments. Here I will briefly review current understanding of fine particle deposition, resuspension, and hyporheic exchange processes, develop a conceptual model for fine particle dynamics in rivers, and present a stochastic modeling framework that can represent most of these processes. I will close by discussing the limits of current modeling capability and prospects for future development of more general models.