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Investigation of Fine Particle Transport, Deposition, and Resuspension between Surface Water and Sediments in an Immobile Sand System

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Fine particles (<100 μm, e.g., fine sediment, particulate organic carbon, microplastics) are ubiquitous in natural systems, but in excess can be a pollutant to freshwaters. This study investigates the transport, deposition, and resuspension of fine particles between surface water and sediments in a simple Tóthian system. Our system consists of two regions of surface water bisected by a divider, which continues into the sand forcing water (and fine particles) to flow from the surface water inlet through sand towards the surface water effluent. A conservative tracer (dyed salt solution), measured by electrolytic conductivity and video, was first added to confirm our measured sediment parameters and validate a spatial flow model for this system. Fine particles (DayGlo AX-11-5 Aurora Pink Pigment) were then added and measured by both grab samples at the effluent and by video. At the end of the experiment, sand samples were collected and processed to determine the spatial distribution of deposited fine particles. We found a strong correlation between the measured number of deposited fine particles in the samples and color values extracted from the final video footage, allowing us to use the video to approximate two-dimensional spatial deposition data as a function of time. We then modeled particle deposition spatially in two ways: (1) with a constant probability per distance step and (2) with a constant probability per time step. For experiments with two different flow rates, deposition patterns were best reproduced using a constant probability per time step. Neither flow condition showed evidence of deposited particles resuspending, demonstrated by a lack of particles in the late tailing of the experiments (both from grab samples and surface water video footage), the distribution of particles measured in the sediment (sand samples and sediment video footage), and the constant color levels in the sediment video footage of the tail of the experiments. We hypothesize that resuspension was limited by sand immobility within our system, suggesting that sediment mobilization may be a key driver in the resuspension of fine particles in natural systems.