

Numerical study of the scour of sediment beds caused by vortices

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Scouring is the process of soil or sediment erosion due to flowing water, which can lead to bed degradation and compromised transportation infrastructure. In the decade before 2000, over half of the 500 bridge failures in the United States were caused by flooding or scouring. To gain a better grasp of the effects of extreme weather events, such as Tropical Storm Irene, on the scouring process, this work is focused on a first principle understanding of the mechanism(s) of scour. The field of Computational Fluid Dynamics (CFD) is particularly well suited to this task. Utilizing a Direct Numerical Simulation (DNS) code, the repeated impacts of a vortex dipole on a particle bed are simulated and analyzed. The fluid phase is treated as a continuum and the discretized Navier-Stokes equations are solved down to the smallest scales of the flow, on an Eulerian grid. The particles in the bed are represented by the Discrete Particle Model (DPM), whereby each individual particle is tracked in a Lagrangian framework. Particle-particle and particle-wall collisions are accomplished with a soft-sphere model. The fluid phase and the solid phase are coupled through a forcing term in the fluid conservation of momentum equation, and a drag force in the particle equation of motion, governed by Newton's second law of motion. A parametric study is conducted to elucidate the role of repeat events on the scouring process.