Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Numerical simulation of turbulence and sand-bed morphodynamics in natural waterways under live bed conditions[1] ALI KHOSRONEJAD, FOTIS SOTIROPOULOS, Saint Anthony Falls Laboratory, University of Minnesota — We develop and validate a 3D numerical model for coupled simulations of turbulence and sand-bed morphodynamics in natural waterways under live bed conditions. We employ the Fluid-Structure Interaction Curvilinear Immersed Boundary (FSI-CURVIB) method of Khosronejad et al. (Adv. in Water Res., 2011). The mobile channel bed is discretized with an unstructured triangular grid and treated as the sharp-interface immersed boundary embedded in a background curvilinear mesh. Transport of bed load and suspended load sediments are combined in the non-equilibrium from of the Exner-Poyla for the bed surface elevation, which evolves due to the spatio-temporally varying bed shear stress and velocity vector induced by the turbulent flow field. Both URANS and LES models are implemented to simulate the effects of turbulence. Simulations are carried out for a wide range of waterways, from small scale streams to large-scale rivers, and the simulated sand-waves are quantitatively compared to available measurements. It is shown that the model can accurately capture sand-wave formation, growth, and migration processes observed in nature. The simulated bed-forms are found to have amplitude and wave length scales ranging from the order of centimeters up to several meters.

[1]This work was supported by NSF Grants EAR-0120914 and EAR-0738726, and National Cooperative Highway Research Program Grant NCHRP-HR 24-33. Computational resources were provided by the University of Minnesota Supercomputing Institute

Ali Khosronejad
Saint Anthony Falls Laboratory, University of Minnesota

Date submitted: 03 Aug 2012 Electronic form version 1.4