Geophysical Research Abstracts, Vol. 8, 02739, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02739

Discontinuous Finite Element River Hydraulics and Morphology with Application to the Paraná River, Argentina

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We consider the one-dimensional shallow water equations with quadratic friction coupled to a bed-load transport equation. Scaling of these equations shows that the time scale of sediment transport is much longer than the hydraulic time scale with a ratio of $\epsilon \sim 10^{-6}$ estimated for the Paraná River, Argentina. In the limit $\epsilon \to 0$, the shallow water equations become decoupled from the sediment conservation law giving rise to the so-called quasi-steady state flow approximation of Exner. Consequently, the bed-load equation describing the sediment transport becomes an implicit nonlinear advection-diffusion equation in one spatial dimension and time. We use a discontinuous Galerkin finite element method (akin to the method in Bokhove, Woods and De Boer, 2005) to discretize this advection-diffusion sediment equation on the slow sediment time scale. We first verify the model results against graded river flow and a dam filling problem. Then, the model is tested with a real case given by the bed evolution data of a trench excavated in the main channel of the Paraná river in Argentina. In that cross section, an underwater tunnel became partly uncovered during the extreme flood of 1983 due to the propagation of a large dune. To avert the problem, a protection blanket was laid over the bed on top of the underwater tunnel at the beginning of the 90's. Thus, a trench was dredged to determine the sedimentation rates before the blanket was set in place. The field data from the trench evolution are then used, finally, to present a (preliminary) validation of the numerical simulations.

Bokhove, O., Woods, A.W., and Boer de, A. 2005: Magma Flow through Elastic-Walled Dikes. *Theor. Comput. Fluid Dyn.* **19**, 261-286.