Coupled dynamics of drying-wetting areas and erodible beds by a continuous FEM model

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ABSTRACT

The communication introduces a sign--preserving and continuous finite element method (FEM) for coupled transport equations, incorporating the shallow water equations and a sediment transport equation. The sediment transport equation interacts with the fluid flow equations by time--dependent sources for momentum. Transport equation relates position of the bed--fluid interface to the divergence of sediment fluxes [1], casted as standard advection--diffusion PDE, and then suitable for an efficient positive--definite continuous FEM model. The bedload transport is written as convective fluxes with velocity representing transport rates averaged over the local effective thickness of the erodible stratum. Otherwise, sediment avalanches, acting as a natural slope limiter, are represented as diffusive fluxes with an anisotropic, inhomogeneous diffusion coefficient depending critically on the local slope [1].

The continuous FEM is developed by integrating a high order finite element procedure with a conservative flux--correction that imposes sign--preservation, permitting simulation of flows with dry fronts without spurious mass exchanges and oscillations [2], as well as simulation of the evolution of layers of erodible sediment over partially non--erodible stratums.

Experiments concentrate on the comprehensive simulation of real river local morphodynamics when civil engineering works, as for instance road enbankments, modify substantially the erosion-deposition process under severe floods. Dam--break lab test for non--frictional, frictional, with obstacles, and with erodible beds, illustrates several capabilities of the model. In particular, strict sign-preserving property permits an efficient simulation of fluid-solid interfaces and erodible-non erodible layer interfaces.

REFERENCES

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