NUMERICAL MODELING OF TRANSIENT FLOWS INVOLVING EROSION AND DEPOSITION OF SEDIMENTS

F. Benkhaldoun*, S. Sari*, M. Seaid†

*LAGA, Université Paris 13
99 Av J.B. Clement, 93430 Villetaneuse, France
e-mail: fayssal@math.univ-paris13.fr

†School of Engineering and Computing Sciences, University of Durham
South Road, Durham DH1 3LE, UK
e-mail: m.seaid@durham.ac.uk

ABSTRACT

The main concern of the sediment transport (or morphodynamics) is to determine the evolution of bed levels for hydrodynamics systems such as rivers, estuaries, bays and other nearshore regions where water flows interact with the bed geometry. Example of applications include among others, beach profile changes due to severe wave climates, seabed response to dredging procedures or imposed structures, and harbour siltation. The ability to design numerical methods able to predict the morphodynamics evolution of the coastal seabed has a clear mathematical and engineering relevances. In practice, morphodynamics involve coupling between a hydrodynamics model, which provides a description of the flow field leading to a specification of local sediment transport rates, and an equation for bed level change which expresses the conservative balance of sediment volume and its continual redistribution with time. Here, the hydrodynamic model is described by the shallow water equations, the bed-load is modelled by the Exner equation, and the suspended sediment transport is modelled by an advection equation accounting for erosion and deposition effects. The coupled models form a hyperbolic system of conservation laws with a source term.

Nowadays, much effort has been devoted to develop numerical schemes for morphodynamics models able to resolve all hydrodynamics and morphodynamics scales. In the current study, a class of finite volume methods is proposed for numerical simulation of transient flows involving erosion and deposition of sediments. The method consists of a predictor stage where the numerical fluxes are constructed and a corrector stage to recover the conservation equations. The sign matrix of the Jacobian matrix is used in the reconstruction of the numerical fluxes. Most of these techniques have been recently investigated in [1,2] for solving sediment transport models without accounting for erosion and deposition effects. The current study presents an extension of this method to transient flows involving erosion and deposition of sediments. A detailed formulation of the sign matrix and the numerical fluxes is presented. The proposed method also satisfies the property of well-balancing flux-gradient and source-term in the system. Numerical results and comparisons will be shown for several suspended sediment transport problems. Comparison with experimental data will be presented for a dam-break problem over a Mobil bed. Some of these results are representative and might be helpful for a fair rating of the numerical model, particularly in long time computations.

REFERENCES

[1] F. Benkhaldoun, S. Sahmim and M. Seaid, A two-dimensional finite volume morphodynamic model on unstructured triangular grids, *Int. J. Num. Meth. Fluids.* In press (2009)

[2] F. Benkhaldoun, S. Sahmim and M. Seaid, Solution of the Sediment Transport Equations using a Finite Volume Method based on Sign Matrix, *SIAM J. Sci. Comp.* **31**, pp. 2866-2889 (2009)