Guest editorial

Predictive modeling in sediment transport and stratigraphy

For over 40 years, scientists have been developing numerical models to help understand and constrain how sedimentary systems are formed (Bonham-Carter and Sutherland, 1967; Briggs and Pollack, 1967). The International Association of Mathematical Geologists (IAMG), through its journal Computers & Geosciences, has played a strong role in supporting this active area of research (e.g., Bitezter and Harbaugh, 1987; Martinez, 1987, Syvitski and Daughney, 1992; Syvitski and Alcott, 1995; Skene et al., 1997), culminating in a C&G special issue in 2001 edited by Syvitski and Bahr (2001) that focused on the formation of stratigraphy on continental margins. A recent publication provides readers with a generalized summary along with hundreds of references through this interesting period of computational advances (Syvitski et al., 2007). This special issue is firstly a contribution to the EuroSTRATAFORM project (Syvitski et al., 2004c; Trincardi and Syvitski, 2005; Weaver et al., 2006; Milligan and Cattaneo, 2007), and secondly a formal contribution to the new international effort to develop a Community Surface Dynamic Modeling System1 (Anderson et al., 2004; Syvitski et al., 2004a, b).

The contributing authors include civil engineers, earth scientists, oceanographers, hydrologists, and geophysicists. Their contributions are substantial and state-of-the-art; we thank contributors and their dedicated reviewers. The volume begins with three papers on the fluvial and coastal environment (Table 1): the first provides a climate-driven hydrological water balance and transport model that simulates the flux of sediment to the coastal ocean through distributary channels; the second provides a GIS method for locating small upstream reservoirs from limited data; and the third provides an analytical solution to the solution of the suspended sediment concentration in river plumes, with application to satellite imagery. The next five papers deal with sediment transport in the marine environment (Table 1): a 1D vertical sediment transport model able to predict the flux of both cohesive and non-cohesive sediment; a model to calculate bottom orbital velocities directly from surface water parameters; 1D transport model for integrating the impact of sediment transport, bioturbation, consolidation, and armoring; a 3D regional coupled wave-current and sediment transport model; and 2D transport model for depositional particulate density currents. The final six

Table 1
Special issue contents

Fluvial and coastal environment
(1) HydroTrend3.0: a climate-driven hydrological transport model that simulates discharge and sediment load leaving a river system: A.J. Kettner (Delft U. Technology) and J.P.M. Syvitski (INSTAAR)
(2) Geolocation of man-made reservoirs across terrains of varying complexity using GIS. D.M. Mixon (INSTAAR), D.A. Kinner (Western Carolina U.), R.F. Stallard USGS), and J.P.M. Syvitski (INSTAAR)
(3) A new method for estimating suspended sediment concentrations and deposition rates from satellite imagery based on the physics of jets and plumes: S.D. Peckham (INSTAAR)

Marine environment
(4) Sedtrans05: An improved sediment-transport model for continental shelves and coastal waters with a new algorithm for cohesive sediments: U. Neumeier (U. Québec-Rimouski), C. Ferrarin (ISMAR-CNR Venice), C.L. Amos (NOC U. Southampton), G. Umgiesser (ISMAR-CNR Venice), and M.Z. Li (GSC)
(5) Calculating wave-generated bottom orbital velocities from surface wave parameters. P.L. Wiberg (U. Virginia) and C.R. Sherwood (USGS)
(6) Modeling a dynamically varying mixed sediment bed with erosion, deposition, bioturbation, consolidation, and armoring: L.P. Sanford (U. Maryland)

1http://csdms.colorado.edu/.
papers illustrate morphodynamic and stratigraphic models and their complexities (Table 1): an advanced modular process-response model to generate 3D stratigraphy in marine basins; a method to determine the various influences on shelf stratigraphy due to loading and subsidence; an analytical solution for the determination of shelf-slope profiles based on the Laplace transform; a method of subgrid parameterization used in stratigraphic simulations; a river-network model that simulates fluvial incision of continental shelves during sea level fluctuations; and a rule-based simulator of continental-shelf stratigraphy.

Many of the models are available either through the lead author or through the Computers & Geoscience web site. We are strong proponents of code transparency and code sharing, as the only viable way of advancing the field.

References


Community surface dynamics modeling system (CSDMS) science plan. A Report to the National Science Foundation, NCED (the National Center for Earth-surface Dynamics), University Minnesota, Minneapolis, p. 47.


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