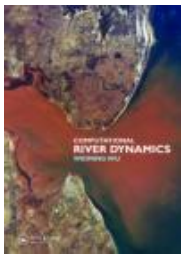
Journal of Sedimentary Research
An International Journal of SEPM
Paul McCarthy and Gene Rankey, Editors
A.J. (Tom) van Loon, Associate Editor for Book Reviews
Review accepted 8 July 2008

Computational River Dynamics, by Weiming Wu, 2007. Taylor & Francis Group, P.O. Box 447, 2300 AK Leiden, The Netherlands. 508 pages. Hardback: price GBP 99.00; ISBN 9780415449618. Paperback: price GBP 39.00; ISBN 9780415449601.



This book promises to offer a comprehensive text on the fundamentals of modeling flow and sediment transport in rivers, based on physical principles and numerical methods. According to the author, Dr Weiming Wu from the National Center for Computational Hydrosciences and Engineering (University of Mississippi), the book should serve river and hydraulic scientists and engineers, undergraduate and graduate students in civil engineering, and professionals in environmental, agricultural and geological sciences. This broad readership demonstrates that numerical modeling of hydro-sediment dynamics is gaining momentum, and it is spreading rapidly from the engineering community to scientific disciplines that, not so long ago, were almost entirely relying on descriptive and empirical modeling. In sedimentary geology, it suffices to open a recent issue of, for example, the *Journal of Sedimentary Research* or *Sedimentology* to discover how important numerical modeling of sediment transport has become, particularly in actuo-sedimentological research. Every process sedimentologist should be aware, even if only superficially, of the rapid developments in the field of computational fluid and sediment dynamics, because this is the only way to keep track of the benefits and pitfalls of numerical simulations.

In my experience, which admittedly is rather superficial, numerical modeling can be a blessing and a curse. There is no better way to model the complex interactions of hydro-sedimentary processes on large spatial scales than with numerical simulations; field work is simply too time-consuming and technically challenging in comparison. On the other hand, numerical models are inevitably simplifications of natural processes and they need tuning and validation by "real" data. This is not as obvious as it sounds, because many "black-box"-type presentations by numerical modelers have left me wondering how accurately their models simulate natural processes, as the mathematical robustness of a model frequently has priority over model validation. There clearly is a role here for physical sedimentologists driven by fieldwork and laboratory experiments. When JSR's book editor asked me to review this book, I questioned if I was the most appropriate person to review a book on numerical modeling. However, I soon swept my reservations aside, deciding to feed my interest in discovering if the book could serve as a link between the numerically skilled and the less numerate, based on the following criteria: (1) the fundamental 3-D equations of flow continuity, momentum and sediment transport, and their derivatives for 1-D and 2-D cases, are explained in simple terms and in sufficient detail; (2) practical methods for solving these equations are described in a step-by-step manner, keeping references to specialist literature to a minimum; (3) each type of model is accompanied by at least one example that illustrates its applicability; and (4) each model simulation is compared with relevant field data, practical limitations are identified, and suggestions for model improvements are made. The information given below shows that the author has met most of these criteria.

The book has a logical structure, starting with a short introduction to the subject (Chapter 1), followed by descriptions of the fundamental numerical, physical and empirical equations of flow and sediment transport (Chapters 2 and 3), methods available for solving the numerical equations (Chapter 4) and their application to 1-D, 2-D and 3-D numerical models (Chapters 5, 6 and 7). Chapter 8 then discusses advanced methods for integrating 1-D, 2-D and 3-D models, and the book ends with worked examples for dam breaks (Chapter 9), vegetated channels (Chapter 10), cohesive-sediment transport (Chapter 11) and contaminant transport (Chapter 12).

Chapter 1 provides an interesting overview of the basic steps required to develop a computational model for simulating hydro-sediment dynamics in rivers. These steps serve as a perfect guideline for the rest of the book. The same chapter also summarizes the main practical problems in modeling river dynamics and describes five key tasks for applying computational models to solving real-life problems (data preparation, estimation of model parameters, model calibration, interpretation of simulation results and analysis of uncertainties. Chapter 2 starts with a description of the properties of water and sediment, before diving into hydrodynamic equations, turbulence closure models, and sediment-transport equations. Next, section-averaged 1-D model equations and depth- and width-averaged 2-D model equations are derived from full 3-D continuity, momentum, and sediment-transport equations. Chapter 2 ends with numerical equations for non-equilibrium sediment transport and the transport and sorting of non-uniform sediment mixtures. All this information is captured in remarkably comprehensible writing. In Chapter 3, basic theories and empirical formulations of bed load, suspended load and total load transport are presented. Other publications give a more complete account of state-of-the-art formulations, but the formulations proposed here probably are adequate for numerical modeling work.

In one of the most useful parts of the book (Chapter 4), various methods for solving non-linear differential equations in irregular and movable domains, characteristic of river flows, are introduced. These include discretization methods for 1-D, 2-D and 3-D problems (finite-difference and finite-volume methods), solution strategies for the Navier-Stokes equations (based on staggered and non-staggered grids) and solution methods for algebraic equations derived from the discretizations. Chapter 5 applies the solution methods to 1-D problems of flow and sediment transport. Separate approaches are given for decoupled and coupled flow and sediment transport. This chapter concentrates on straight channels, meandering channels and channel networks, steady versus unsteady flows, equilibrium versus non-equilibrium sediment transport, and bank-erosion processes. Chapters 6 and 7 have a similar structure to Chapter 5, but extend the information to the governing equations, boundary conditions, and numerical solutions of 2-D and 3-D models, respectively. The focus in Chapter 6 is on depth-averaged 2-D simulation of hydro-sediment dynamics in straight and meandering channels, but also the procedures for less commonly used width-averaged 2-D simulations are described.

One of the highlights of Chapter 7 is a section on 3-D simulation of local scour around in-stream objects. The 1-D, 2-D and 3-D models are illustrated with concise examples within the corresponding chapters, but more comprehensive examples are given in the Chapters 9, 10, 11 and 12. The chapter on cohesive-sediment transport (Chapter 11) is most interesting for sedimentary geologists. Parameterizations of flocculation processes, floc settling velocity, and erosion, deposition and consolidation of cohesive sediment are used to develop single- and multiple-floc-size models for cohesive-sediment transport, and then applied to the Gironde Estuary in France.

It should be clear now that this book meets most of the requirements to provide a link between numerical modelers and field-based geologists. It is highly recommended as a first step into the world of numerical modeling of hydro-sedimentary dynamics, even though a few more examples would have been welcome, and even though the book fails to deliver on a critical assessment of the limitations of numerical models; in most examples, the field data fit the numerical data remarkably well, which may give the false impression that numerical models are always right. The print and bind quality are excellent, and there are no disturbing editorial slip-ups. I congratulate the author for his ability to convert a complex and jargonistic subject

matter into a readable and coherent text book. It has certainly stimulated me to try my hand at numerical modeling, and I am convinced it will have the same impact on others.

Jaco H. Baas
Centre for Catchment and Coast Research
School of Ocean Sciences
University of Wales Bangor
Menai Bridge, Anglesey LS2 9JT
United Kingdom
e-mail: j.baas@bangor.ac.uk

SEPM—The Society for Sedimentary Geology