

**Reinhard Hinkelmann**

**Efficient Numerical Methods  
and Information-Processing  
Techniques for Modeling  
Hydro- and Environmental  
Systems**

# Efficient Numerical Methods And Informationprocebing Techniques For Modeling Hydro And Environmental Systems

**V. Nassehi,D. B. Das**



## **Efficient Numerical Methods And Informationprocessing Techniques For Modeling Hydro And Environmental Systems:**

*Efficient Numerical Methods and Information-Processing Techniques for Modeling Hydro- and Environmental Systems* Reinhard Hinkelmann, 2005-01-18 Numerical simulation models have become indispensable in hydro and environmental sciences and engineering This monograph presents a general introduction to numerical simulation in environment water based on the solution of the equations for groundwater flow and transport processes for multiphase and multicomponent flow and transport processes in the subsurface as well as for flow and transport processes in surface waters It displays in detail the state of the art of discretization and stabilization methods e g finite difference finite element and finite volume methods parallel methods and adaptive methods as well as fast solvers with particular focus on explaining the interactions of the different methods The book gives a brief overview of various information processing techniques and demonstrates the interactions of the numerical methods with the information processing techniques in order to achieve efficient numerical simulations for a wide range of applications in environment water Computational Methods in the Management of Hydro-Environmental Systems V. Nassehi, D. B. Das, 2007-01-01 This book provides concise up to date and easy to follow information on an increasingly important area of hydro environmental analysis and management It covers important aspects of both surface and subsurface water quality management as they are inseparable components of aquifers and the flow in physical domains occur in combination with the other However the main emphasis of the book is on the practical development and application of computer based algorithms via appropriate schemes to realistic problems Mathematical theories are not discussed as they can be found in many expert books All sections of the book include detailed descriptions of practical examples It also uniquely gives explanations regarding the formulation of practical management schedules and tools for hydro environmental systems There is a lack of books dealing with the practical aspects of the application of computer modelling techniques to complex hydrodynamical phenomena and this book has been written for professionals and researchers especially those who are not trained mathematicians who nevertheless need to make managerial decisions *Computational Methods in the Management of Hydro Environmental Systems* will be an invaluable source of information for post graduate level researchers and decision makers who need to apply numerical modelling techniques to investigate hydrodynamic phenomena and pollutants dispersion in natural aquatic systems Professionals and engineers who now need to gain insights about the working of computer techniques for choosing appropriate schemes and applying them to realistic problems will also value this work Masters level and final year graduate students are also expected to benefit from the book

**Hydrodynamics of Free Surface Flows** Jean-Michel Hervouet, 2007-06-13 A definitive guide for accurate state of the art modelling of free surface flows Understanding the dynamics of free surface flows is the starting point of many environmental studies impact studies and waterworks design Typical applications once the flows are known are water quality

dam impact and safety pollutant control and sediment transport These studies used to be done in the past with scale models but these are now being replaced by numerical simulation performed by software suites called hydro informatic systems The Telemac system is the leading software package worldwide and has been developed by Electricit de France and Jean Michel Hervouet who is the head and main developer of the Telemac project Written by a leading authority on Computational Fluid Dynamics the book aims to provide environmentalists hydrologists and engineers using hydro informatic systems such as Telemac and the finite element method with the knowledge of the basic principles capabilities different hypotheses and limitations In particular this book presents the theory for understanding hydrodynamics through an extensive array of case studies such as tides tsunamis storm surges floods bores dam break flood waves density driven currents hydraulic jumps making this a principal reference on the topic gives a detailed examination and analysis of the notorious Malpasset dam failure includes a coherent description of finite elements in shallow water delivers a significant treatment of the state of the art flow modelling techniques using Telemac developed by Electricit de France provides the fundamental physics and theory of free surface flows to be utilised by courses on environmental flows Hydrodynamics of Free Surface Flows is essential reading for those involved in computational fluid dynamics and environmental impact assessments as well as hydrologists and bridge coastal and dam engineers Guiding readers from fundamental theory to the more advanced topics in the application of the finite element method and the Telemac System this book is a key reference for a broad audience of students lecturers researchers and consultants right through to the community of users of hydro informatics systems

**Numerical Modelling of Hydrodynamics for Water Resources** Pilar Garcia Navarro, Enrique Playán, 2007-11-01  
Overland flow modelling has been an active field of research for some years but developments in numerical methods and computational resources have recently accelerated progress producing models for different geometries and types of flows such as simulations of canal and river networks Flow in canals has traditionally been described using one dimensional depth averaged shallow water models but a variety of simulation techniques now facilitate the management of hydrodynamic systems providing models which incorporate complex geometry and diverse flows Much effort has gone into elaborating canal operational rules based on decision support systems with the dual aim of assuring water delivery and meeting flow control constraints In natural water courses water management problems are associated with the need to meet quality standards Numerical modelling of advection diffusion can be used to manage problems related to the movement of solutes in rivers and aquifers The analysis of solute transport is used to safeguard the quality of surface and ground water and to help prevent eutrophication Solute flow through the soil can be dynamically linked to overland flow for hydrological and agricultural applications Advances in modelling also cast new light on sediment transport in rivers exploring the complex dynamics of river bed erosion and deposition and assist in the analysis of river reservoir systems All these issues are discussed in Numerical Modelling of Hydrodynamics for Water Resources which will be useful to civil engineers applied

mathematicians hydrologists and physicists      **Stochastic and Statistical Methods in Hydrology and Environmental Engineering** Keith W. Hipel, 2012-12-06 Objectives The current global environmental crisis has reinforced the need for developing flexible mathematical models to obtain a better understanding of environmental problems so that effective remedial action can be taken Because natural phenomena occurring in hydrology and environmental engineering usually behave in random and probabilistic fashions stochastic and statistical models have major roles to play in the protection and restoration of our natural environment Consequently the main objective of this edited volume is to present some of the most up to date and promising approaches to stochastic and statistical modelling especially with respect to groundwater and surface water applications Contents As shown in the Table of Contents the book is subdivided into the following main parts GENERAL ISSUES PART I PART II GROUNDWATER PART III SURFACE WATER PART IV STOCHASTIC OPTIMIZATION PART V MOMENT ANALYSIS PART VI OTHER TOPICS Part I raises some thought provoking issues about probabilistic modelling of hydro logical and environmental systems The first two papers in Part I are in fact keynote papers delivered at an international environmetrics conference held at the University of Waterloo in June 1993 in honour of Professor T E Unny In his keynote pa per Dr S J Burges of the University of Washington places into perspective the historical and future roles of stochastic modelling in hydrology and environmental engineering Additionally Dr Burges stresses the need for developing a sound scien tific basis for the field of hydrology Professor P E      *Stochastic and Statistical Methods in Hydrology and Environmental Engineering* Keith W. Hipel, Liping Fang, 2013-06-29 In this landmark set of papers experts from around the world present the latest and most promising approaches to both the theory and practice of effective environmental management To achieve sustainable development organizations and individual citizens must comply with environmental laws and regulations Accordingly a major contribution of this book is the presentation of original techniques for designing effective environmental policies regulations inspection precedures and monitoring systems Interesting methods for modelling risk and decision making problems are discussed from an environmental management perspective Moreover knowledge based techniques for handling environmental problems are also investigated Finally the last main part of the book describes optimal approaches to reservoir operation and control that take into account appropriate multiple objectives Audience The book is of direct interest to researchers teachers students and practitioners concerned with the latest developments in environmental management and sustainable development      Introduction to Numerical Methods for Water Resources W. L. Wood, 1993 Numerical methods provide a powerful and essential tool for the solution of problems of water resources This book gives an elementary introduction to the various methods in current use and demonstrates that different methods work well in different situations and some problems require combinations of methods It is essential to know something of all of them in order to make a reasoned judgement of current practice Their applications are discussed and more specialised versions are outlined along with many references making this an invaluable comprehensive coverage of the field      *Efficient*

*and Reliable Mathematical Modeling Techniques for Multi-phase Environmental Flows* Kaveh Zamani, 2015 This research is on using recent techniques of Software Quality Assurance SQA and developing Verification and Validation and Uncertainty Quantification VVUQ tools to improve mathematical models of contaminant sediment and air bubble transport in natural aquatic bodies A comprehensive toolkit for VVUQ is developed for a code and calculation verification with Methods of Exact Solutions MES Method of Manufactured Solutions MMS and cross code verification b Richardson extrapolation for code and calculation verification c model validation via common statistical methods and model skill assessment metrics d quantification of uncertainty in numerical discretization of PDEs In the next section of this dissertation seven new closed form analytical solutions of scalar transport equation devised for code verification with MES The set of developed analytical solutions was complete in the sense that it is able to check nonlinearity as well as spatial and temporal non homogeneity in all terms of scalar ADR equation In addition a 2D analytical description of air bubbles distribution in hydraulic jumps was derived The new analytical model was validated versus various empirical datasets via common model skill assessment metrics The experimental dataset was also used to design an analytical empirical model for air entrainment detrainment in the two phase flows of hydraulic jumps In the rest of this dissertation the emphasis was changed from two phase flows of air and water into two phase flows of sediment particles and water First a comprehensive assessment of former methods of computing total sediment discharge with Einstein s method was conducted Sequential and parallel subroutines of computing the Einstein s integrals with existing methods developed Then local and global accuracy convergence behavior singularities CPU time and parallelization efficiency were studied via common metrics of model skill assessment Second four new methods of computing Einstein s integrals for calculation of total sediment discharge were devised a a numerical technique which exploits the similarity of integrand functions to devise a numerical recycling of values for reduction of computational time b nested adaptive Gauss Kronrod quadrature c perturbation techniques to find a fast asymptotic series representation to approximate the Einstein integrals d semi analytical solutions based on Gauss hypergeometric function All of the developed methods were benchmarked against machine precision accurate results Efficiency of those new methods in parallel computing was evaluated

*An Efficient and Guaranteed Stable Numerical Method for Continuous Modeling of Infiltration and Redistribution with a Shallow Dynamic Water Table* ,2015

### **Computational Methods in Water Resources X**

Alexander Peters, Gabriel Wittum, Bruno Herrling, Udo Meissner, C.A. Brebbia, William G. Gray, George F. Pinder, 1994-07-31

This two volume work constitutes the edited proceedings of the Tenth International Conference on Computational Methods in Water Resources formerly Finite Elements in Water Resources held at Heidelberg University Germany in July 1994 organized jointly by Interdisziplinäres Zentrum für Wissenschaftliches Rechnen Interdisciplinary Center for Scientific Computing and Sonderforschungsbereich 359 of Heidelberg University and the Institute of Supercomputing and Applied Mathematics of IBM Heidelberg The 1994 proceedings present the work of authors from 23 countries Numerical methods mathematical modeling

and applications to subsurface and surface hydrology are covered by a wide variety of papers. Issues of formation description and modeling including parameter estimation, heterogeneity and scaling up continue to attract the attention of a large number of researchers. Several papers edited in this book concern the solution of the Navier Stokes equations. For applied mathematicians, engineers and geoscientists working in the fields of numerical methods, hydrology, ecology, water resources, planning and management, remediation, design, porous media, research, petroleum engineering and coastal engineering.

*Stochastic and Statistical Methods in Hydrology and Environmental Engineering* Keith W. Hipel, A. Ian McLeod, U.S. Panu, Vijay Singh, Liping Fang, 1994-08-31. Volume 1 edited by Keith W Hipel. In this landmark collection of papers, highly respected scientists and engineers from around the world present the latest research results in extreme value analyses for floods and droughts. Two approaches that are commonly employed in flood frequency analyses are the maximum annual flood and partial duration series or peak over threshold procedures. Recent theoretical advances as well as illustrative applications are described in detail for each of these approaches. Additionally, droughts and storms are systematically studied using appropriate probabilistic models. A major part of the volume is devoted to frequency analyses and fitting extreme value distributions to hydrological data. Other thought provoking topics include regionalization techniques, distributed models, entropy and fractal analysis. Volume 1 is of interest to researchers, teachers, students and practitioners who wish to place themselves at the leading edge of flood frequency and drought analyses. Volume 2 edited by Keith W Hipel. World renowned scientists present valuable contributions to stochastic and statistical modelling of groundwater and surface water systems. The philosophy of probabilistic modelling in the hydrological sciences is put into proper perspective and the importance of stochastic differential equations in the environmental sciences is explained and illustrated. The new research ideas put forward in groundwater modelling will assist decision makers in tackling challenging problems such as controlling pollution of underground aquifers and obtaining adequate water supplies. Additionally, different types of stochastic models are used in modelling a range of interesting surface water problems. Other topics covered in this landmark volume include stochastic optimization, moment analysis, carbon dioxide modelling and rainfall prediction. Volume 2 is of interest to researchers, teachers, students and practitioners who wish to be at the leading edge of stochastic and statistical modelling in the environmental sciences. Volume 3 edited by Keith W Hipel, A. Ian McLeod, U.S. Panu, Vijay P Singh. International experts from around the globe present a rich variety of intriguing developments in time series analysis in hydrology and environmental engineering. Climatic change is of great concern to everyone and significant contributions to this challenging research topic are put forward by internationally renowned authors. A range of interesting applications in hydrological forecasting are given for case studies in reservoir operation in North America, Asia and South America. Additionally, progress in entropy research is described and entropy concepts are applied to various water resource systems problems. Neural networks are employed for forecasting runoff and water demand. Moreover, graphical nonparametric and parametric trend analyses methods are

compared and applied to water quality time series Other topics covered in this landmark volume include spatial analyses spectral analyses and different methods for stream flow modelling Volume 3 constitutes an invaluable resource for researchers teachers students and practitioners who wish to be at the forefront of time series analysis in the environmental sciences Volume 4 edited by Keith W Hipel Liping Fang In this landmark set of papers experts from around the world present the latest and most promising approaches to both the theory and practice of effective environmental management To achieve sustainable development organizations and individual citizens must comply with environmental laws and regulations Accordingly a major contribution of this book is the presentation of original techniques for designing effective environmental policies regulations inspection procedures and monitoring systems Interesting methods for modelling risk and decision making problems are discussed from an environmental management perspective Moreover knowledge based techniques for handling environmental problems are also investigated Finally the last main part of the book describes optimal approaches to reservoir operation and control that take into account appropriate multiple objectives Volume 4 is of direct interest to researchers teachers students and practitioners concerned with the latest developments in environmental management and sustainable development

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