Book review

MODELLING FOR COASTAL HYDRAULICS AND ENGINEERING

K. W. Chau. Spon Press, Abingdon, 2010, ISBN 978-0-41548-254-7 (hardback), 978-0-20388-476-8 (electronic), £75.00, 232 pp.

This book provides a review of 'standard' process-based modelling of flow and water quality and an introduction to what have been termed 'soft computing techniques'. These include methods such as: artificial neural networks; fuzzy logic; genetic algorithms and knowledge-based or expert systems.

The book begins with a contents list and then starts straight away. There is no preface, acknowledgements or list of symbols, although these are defined within the text. Chapter 1 is short and serves more like a preface, concluding with 'This book may furnish some useful advice to inexperienced engineers on how to establish a numerical model, although an understanding of the underlying theories is still necessary.'

In chapter 2, 'Coastal modelling', the pace is swift and ruthless: the Navier–Stokes equations are introduced on the first page; Reynolds decomposition for turbulent flow on the second page; depth-averaged flow equations on the third page; and transport equations for water quality on the fourth. Chapter 3 provides a brief, and highly selective, review of numerical methods developed over the last 20 years or so for solving the equations presented in chapter 2. As such it provides the researcher with a useful signpost for finding out more about particular techniques. The review is in the form of a chronological list: a citation followed by a précis of the results. It is a style that this reviewer finds unhelpful.

Chapters 4 and 5 are devoted to a discussion of finite difference and finite-element methods, respectively. Chapter 4 includes practical information about the Princeton ocean model; and discusses stability criteria, solution techniques such as the alternate-direction-implicit scheme, treatment of boundary conditions as well as some case studies from Hong Kong. Chapter 5 presents a constructive introduction to finite element methods with a more extensive discussion of accuracy and the relative advantages/disadvantages this method has in comparison with finite difference techniques. The chapter also includes some case studies taken from projects in and around Hong Kong.

Chapter 6 onwards deals with 'soft computing methods'. For those not familiar with such techniques it is perhaps worth mentioning here that they generally require much less computing resource than process-based models. This is achieved by codifying knowledge in various ways. In a data-driven model this might be through a

relationship found by regression for example. The author provides a brief survey of methods in chapter 6, ending with a section on integrating process-based models into a sophisticated 'intelligent' system or 'inference engine'. Artificial neural networks (ANNs) are the focus of chapter 7, which describes how ANNs work mathematically as well as some interesting case studies. Chapter 8 covers fuzzy logic. This topic stems from the 1960s and has recently seen renewed activity as a means of describing uncertainty. Again, some interesting case studies are presented together with a comparison with results produced using an ANN.

Evolutionary algorithms are the subject of chapter 9. In essence, these are methods to optimise a solution or find a functional description fitting observational data. This optimisation is performed through the process of mutation and selection (among others) in an analogy to biological evolution. The best solution is the one that fits a prescribed target the best. A range of examples is given covering ecological and flood forecasting problems. The chapter does not explain *how* to set up an evolutionary algorithm but does point the reader to suitable original sources and software available over the internet.

Perhaps the most contentious subject, knowledge-based systems (KBS), or expert systems as termed in earlier decades, is left to chapter 10. A great deal of hyperbole, both positive and negative, has been expended on this subject. The author presents a commendably balanced view of KBS: what they are, how they function and their advantages and limitations. One of the shortcomings of earlier expert systems was that they tended to operate in a highly constrained 'if – then – otherwise' manner, whereas human experts in many fields would often form an opinion by asking questions on sometimes apparently unrelated topics. While the appropriate information might have been contained in a database within computer expert systems, the way the system was programmed to process the information did not match that of human brains. This chapter provides a historical account of the development of KBS and an amenable exposition of how these systems are structured. The more recent KBS tend to use databases coupled with a fuzzy logic or ANN interface to the human user.

Chapter 11 is a short conclusion which gives a brief summary of current research directions in the area of soft computing. Overall, I think this book will appeal most to researchers and experienced engineers who wish to discover more about soft computing techniques. The production of the book is good, with clear illustrations and relatively few typographic errors.

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