

Groundwater Modelling in Arid and Semi-Arid Areas

Arid and semi-arid regions face major challenges in the management of scarce freshwater resources under pressures of population, economic development, climate change, pollution and over-abstraction. Groundwater is commonly the most important water resource in these areas. Groundwater models are widely used globally to understand groundwater systems and to guide decisions on resource management and protection from pollution. However, the hydrology of arid and semi-arid areas is very different from that of humid regions, and there is little guidance on the special challenges of groundwater modelling for these areas. This book brings together the worldwide experience of internationally leading experts to fill this gap in the scientific and technical literature. It introduces state-of-the-art methods for the modelling of groundwater resources and their protection from pollution. It is illustrated with a wide-ranging set of examples from a variety of regions, including India, China, Africa and the Middle East.

The book is valuable for researchers, practitioners in developed and developing countries, and graduate students in hydrology, hydrogeology, water resources management, environmental engineering and geography.

HOWARD WHEATER is Professor of Hydrology at Imperial College, London. He is past-President of the British Hydrological Society, a Fellow of the Royal Academy of Engineering, a Fellow of the Institution of Civil Engineers, and a life member of the International Water Academy. His research interests are in hydrology and water resources, with wide-ranging applications including climate change, surface and groundwater hydrology, floods, water resources and water quality. He has published over 200 peer-reviewed papers and 6 books. Academic awards include various UK prizes and the 2006 Prince Sultan bin Abdulaziz International Prize for Water. He has been extensively involved in flood and water resource projects in the UK and internationally, providing advice to states and international governments. He has a particular interest in the hydrology of arid areas, and has worked in Oman, Saudi Arabia, Yemen, UAE, Jordan, Syria and Egypt, and Arizona. He chairs UNESCO's G-WADI arid zone water resources programme and was invited by the Japanese government to give a keynote address on water scarcity to the 2003 Kyoto World Water conference.

SIMON MATHIAS holds a Lectureship in the Department of Earth Sciences at Durham University. Prior to this position he was active in the field of groundwater engineering as a researcher and lecturer within the Department of Civil and Environmental Engineering at Imperial College, London. His principal expertise lies in the development of mathematical models to describe flow and transport of reactive contaminants in porous and fractured porous media. Dr Mathias has worked on a broad range of applications including vadose zone transport of nutrients in fracture rock systems, plant uptake of radionuclides, aquifer characterisation studies, buoyancy-driven flow problems, CO₂ geo-sequestration and hydraulic fracture propagation. He has published widely in international peer-reviewed journals. Dr Mathias is an elected committee member of the British Hydrological Society.

XIN LI is Professor at the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences (CAS). His primary research interests include land data assimilation, application of remote sensing and GIS in hydrology and cryosphere science, and integrated watershed study. He is currently director of the World Data Center for Glaciology and Geocryology, chair of the working group on remote sensing of the Chinese Committee for WCRP/CliC and IUGG/IACS, co-chair of the working group on theory and method of the China Association for Geographic Information System, and a member of American Geophysical Union. He is also the secretary of G-WADI Asia established by UNESCO IHP. He has published over 120 journal articles and monographs. He was recipient of the Outstanding Science and Technology Achievement Prize of the CAS in 2005, First Class Science and Technology Progress Prize of Gansu Province, and the Seventh National Award for Young Geographers in 2003.

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Groundwater Modelling in Arid and Semi-Arid Areas

Howard S. Wheater

Imperial College of Science, Technology and Medicine, London

Simon A. Mathias

Durham University

Xin Li

Chinese Academy of Sciences, Lanzhou, China



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Contributors

S. Ahmed
Indo-French Centre for Groundwater Research
National Geophysical Research Institute
Hyderabad
India

P. Bauer-Gottwein
Institut for Vand og Miljøteknologi
Danmarks Tekniske Universitet
Bygningstorvet
Bygning 115, rum 154
Kongens Lyngby
Denmark

P. Brunner
Centre of Hydrogeology and
Geothermics (CHYN)
Rue Emile-Argand 11-CP158
CH-2009 Neuchâtel
Switzerland

A. P. Butler
Department of Civil and Environmental Engineering
Imperial College London
London
UK

J. Carrera
Department of Geotechnical Engineering
and Geosciences
Technical University of Catalonia
Barcelona
Spain

W. M. Edmunds
School of Geography and the Environment
University of Oxford
Oxford
UK

T. Graf
Institute of Fluid Mechanics
Department of Civil Engineering
Gottfried Wilhelm Leibniz University
Hannover Appelstrasse 9A
30167 Hannover
Germany

L. Kgotlhang
Tsodilo Resources
Maun
Botswana

W. Kinzelbach
Institute of Environmental Engineering
ETH Zurich
Zurich
Switzerland

H. Kooi
Department of Hydrology and Geo-Environmental Sciences
Faculty of Earth and Life Sciences
VU University Amsterdam
De Boelelaan 1085
Amsterdam
Nederland

L. Li
Centre for Eco-Environmental Modelling
Hohai University
Nanjing
P R China

S. A. Mathias
Department of Earth Sciences
Durham University
Science Laboratories
Durham
UK

LIST OF CONTRIBUTORS

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- | | |
|---|---|
| <p>C. Milzow
 Institut for Vand og Miljøteknologi
 Danmarks Tekniske Universitet
 Bygningstorvet
 Bygning 115, rum 154
 Kongens Lyngby
 Denmark</p> <p>A. Nabi
 Indo-French Centre for Groundwater Research
 National Geophysical Research Institute
 Hyderabad
 India</p> <p>S. Owais
 Indo-French Centre for Groundwater Research
 National Geophysical Research Institute
 Hyderabad
 India</p> <p>V. Post
 Department of Hydrology and Geo-Environmental Sciences
 Faculty of Earth and Life Sciences
 VU University Amsterdam
 De Boelelaan 1085
 Amsterdam
 Nederland</p> <p>H. Prommer
 Land and Water – Floreat WA
 CSIRO
 Underwood Avenue
 Floreat Park
 Australia</p> <p>S. Sarah
 Indo-French Centre for Groundwater Research
 National Geophysical Research Institute
 Hyderabad
 India</p> <p>C. T. Simmons
 School of the Environment and National Centre for Groundwater
 Research and Training
 Flinders University
 Adelaide
 Australia</p> | <p>R. Therrien
 Department of Geology and Geological Engineering
 Laval University
 Quebec City
 Canada</p> <p>A. von Boetticher
 Eidg. Forschungsanstalt WSL
 Zürcherstrasse 111
 Birmensdorf
 Switzerland</p> <p>C. I. Voss
 USGS
 431 National Center
 12201 Sunrise Valley Drive
 Reston
 Virginia
 USA</p> <p>J. Ward
 School of the Environment
 Flinders University
 Adelaide
 Australia</p> <p>A. Werner
 School of Chemistry,
 Physics and Earth Sciences
 Flinders University
 Adelaide
 Australia</p> <p>H. S. Wheeler
 Department of Civil and Environmental Engineering
 Imperial College London
 London
 UK</p> |
|---|---|

Preface

Arid and semi-arid regions present special challenges for water management. They are, by definition, areas where water is at its most scarce, and face great pressures to deliver and manage freshwater resources. Demand for water has increased dramatically, due to population growth, increasing expectations for domestic water use, and expansion of industrial and agricultural activities. Available water resources have been reduced by pollution and over-abstraction. Many of the world's arid regions are further threatened by climate change. In addition, the science base to support water management remains limited. Hydrological processes can be very different from those of humid regions, precipitation and flow exhibit extreme variability in space and time, and data are often restricted in spatial coverage, record length and data quality.

UNESCO has identified, within the International Hydrological Programme, a special need to exchange knowledge on scientific aspects of water resources (with respect to both quantity and quality) in arid and semi-arid lands, and is supporting a number of regional centres to promote exchange of information and dissemination of good practice. At the global level, UNESCO has initiated G-WADI, a Global network for Water and Development Information for arid lands. Information on G-WADI products and a news-watch service can be found on the G-WADI website (www.gwadi.org). G-WADI aims to facilitate the global dissemination of state-of-the-art scientific knowledge and management tools, and to facilitate the sharing of scientific and technical knowledge and management experience of new and traditional technologies to conserve water.

With the support of UNESCO and the UK Government, the first major G-WADI event was held in Roorkee, India, in March 2005, focusing on the surface-water modelling tools required to support water management in arid and semi-arid areas. The strategy was to bring together the world's leading experts to provide lectures and tutorials on this topic. This resulted in a book in the International Hydrology Series, *Hydrological Modelling in Arid and Semi-Arid Areas*, published by Cambridge University Press in late 2007.

Groundwater is commonly the most important water resource in arid areas, but is particularly difficult to quantify in terms of sustainability, and almost universally suffers from problems of over-abstraction, declining water tables and degradation of water quality. Hence, a second event was held in Lanzhou, China, in 2007, focusing on groundwater modelling in arid and semi-arid areas, and attended by 56 participants from 22 countries. The aims of the workshop were:

1. to bring together the world's leading experts in arid zone groundwater modelling to deliver a definitive set of lectures and case studies to an audience of active researchers from the world's arid regions;
2. to draw on the experience of the workshop participants in developing this material and to consider recommendations for future activities;
3. to make this material available to the global community through UNESCO and in particular the G-WADI website (www.gwadi.org);
4. to stimulate follow-up activities, regionally and globally.

The material from this workshop provides the content of this book. It brings together state-of-the-art information on groundwater data, modelling and management, specifically focused on the challenges of arid and semi-arid areas, and we can say with confidence that the authors represent some of the world's most distinguished authorities.

The structure of the book is as follows:

Chapter 1 describes the context for groundwater management in arid and semi-arid areas, including historical development and current pressures, and the associated needs for modelling, and provides a summary of the book content and structure. Chapter 2 provides a review of some of the special hydrological features of arid areas, with a particular focus on groundwater recharge processes, and examples from the Arabian peninsula. Chapter 3 introduces isotopic and geochemical methods as important sources of information and insight into groundwater systems, with case studies from Africa and the Mediterranean. Chapter 4 provides an

overview of groundwater modelling, including the treatment of spatial variability, calibration and uncertainty, and Chapter 5 illustrates the application of geostatistics to an Indian case study. Groundwater source protection is discussed in Chapter 6, and Chapter 7 provides a comprehensive discussion of the problems

of density-dependent groundwater flows associated with salinity effects. Finally, Chapter 8 addresses sustainable water management in arid and semi-arid regions, with case studies from North Africa, Southern Africa and China.

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