



UK Centre for
Ecology & Hydrology

Emerging Science for Sustainable Water Resource Management

A GUIDE FOR WATER PROFESSIONALS AND PRACTITIONERS IN INDIA

Edited by
Sunita Sarkar & Harry Dixon

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SUSTAINABLE WATER RESOURCE MANAGEMENT**

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The diverse nature of the science covered in this publication means that a large number of scientists from across India and the UK were involved

in initiating, directing, undertaking or facilitating the projects that underpin it. While each of the chapters have been authored by some of the key scientists involved, the contributions of many more to the work outlined, is gratefully acknowledged. The editors thank the chapter authors for their time and efforts in condensing all such contributions into, what we hope, is an engaging book to read.

This book would not have reached publication without the design expertise and dedication of John Day, who gave countless hours to ensuring that the product looked as professional and accessible as possible. The editors would also like to thank Victoria Barlow, Jake Quinn and Kate Randall for their assistance in the production of this book.

Finally, the editors would like to thank you, the reader, for taking the time to read this book. If we are to solve our myriad challenges, one of the key steps will be to bridge the gap between science and practice. We hope your act of engaging with the book is a step in this direction.

FOREWORD

LEONARDO DA VINCI SAID, “Water is the driving force of all nature.” In addition to this beneficial role, water has a central role across many aspects of life. Life cannot be sustained without water, which is also necessary for food production and processing, energy generation, and economic growth. For water to be beneficial, it should be present within ‘appropriate’ quantities since both the excess and deficit of water are harmful, as is poor quality water that can spread disease through pollution and cannot be allocated for some uses, such as human consumption, irrigation, etc. Noting that water borne diseases are a major concern of the governments across the world, the challenges related to water are both complex and interconnected.

In India, challenges in water security arise from a number of aspects, including the huge spatial and temporal variability in distribution of water resources, variability in water demand as well as the access to water, water quality, rising population and development pressures. About 85% of the water demand arises from the agriculture sector and this is unsustainable. Due to large-scale withdrawals from surface and sub-surface sources, rivers are turning unhealthy and aquifers are depleting. The quality of the resource in many water bodies is poor, although improvements in some cases are visible now. In the absence of adequate and reliable data, at times, decisions around water management and allocation are sub-optimal. On a broader international perspective, India, and indeed most countries, are committed to meet the SDGs, and this path provides a robust and well-tested water management paradigm.

To tackle such complexity requires a combination of science and technological advancements,

with socio-political and financial will and support. Scientific management of any natural resource including water requires a consistent and widely available database of relevant variables at appropriate spatial and temporal coverage. This in turn requires that an appropriate monitoring network for hydro-meteorological variables is established. Analysis of representative data helps in understanding the behaviour of the systems, which is further strengthened by mathematical models. Mathematical models also help in scenario analysis and therefore, before taking decisions, the operators know the consequences of their decisions. Clearly, supported by such information, any such decisions are more likely to meet the competitive and conflicting demands and be sustainable.

This book sets out to share developments in water sciences, which have been piloted in India and other parts of the world, and that have the ability to improve evidence-based decision making in water resources development and management. Developed by a team of researchers with wide ranging expertise and years of experience in the area of water research and practice, this book covers selected topics where substantial progress has been made by the collaborators from India and UK. The editors have carefully selected topics where the research and development outcomes can significantly contribute to water management in India and these include soil moisture measurement, flood risk assessment, drought management, river water quality monitoring and urban lake rejuvenation, among others. Without resorting to complex mathematical equations, the authors of the various chapters have described the problems and the key research outcomes with the focus on translating emerging science to arrive at practical and workable solutions.

The research presented in this book builds on a strong history of scientific collaboration in hydrological research between India and UK. Showcasing the strength of expertise across the two research communities and the positive outcomes of collaboration, thus providing further impetus for continued collaboration as we work together to sustainably manage our water resources.

After years of hard work from both the sides, the fruits of this successful collaboration are before

us and are fully described in peer reviewed journal papers (fully referenced herein). We are sure that this compilation of key outcomes will further incentivize the key stakeholders – professionals, decision-makers, political leaders, and civil societies – in both the countries to get involved and take the collaboration to new heights. The outcomes will most definitely be of value to the water sector and the society.

Professor Sharad K Jain *has over 39 years' experience in the field of hydrology and water resources. He joined the National Institute of Hydrology, Roorkee (India) in 1982 as a scientist and retired as its Director in 2020. Currently, he is serving as a Visiting Professor at the Civil Engineering Department, Indian Institute of Technology, Roorkee.*

Professor Alan Jenkins *has 40 years' experience in hydrology, water quality and water resources assessment. He joined the UK Centre for Ecology & Hydrology (previously the Institute of Hydrology) in 1985 as a research scientist and became Science Director in 2003.*

PREFACE

THIS BOOK BRINGS together new and innovative research and technical advancements arising from research conducted by the UK Centre for Ecology & Hydrology (UKCEH) in collaboration with a number of different partners across India. This book aims to provide evidence for why and how emerging science can support sustainable management and use of water resources. It draws from the work of hydrologists, freshwater ecologists, water chemists and other experts who share the emerging science in their area of expertise. Examples of how and why this science shows promise for future applications to water management are given, particularly in an Indian context.

The challenges involved in sustainable water resources management are both diverse and complex. While this book does not attempt to cover them all, it comprises chapters focusing on a variety of different areas of the water management problem. These range from how emerging science can improve our ability to detect changing hydrological conditions, how we can enhance our understanding of soil moisture and potentially improve water quality monitoring systems. In the context of the pressing challenges associated with climate and land-use change, the book includes chapters on how integrated modelling can enhance river basin planning in the face of growing demands for water resources and how we can understand and mitigate the water related risks associated with floods and droughts.

The layout and style of the book is deliberately accessible, yet comprehensive, with an aim of it being useful to people interested in water resource management, but who may not be scientific experts in the various areas. The book is targeted at water professionals who set the agenda for

water operations at State and national level, decision makers who select and deploy water resource management tools and techniques, as well as governmental and academic trainers in water resource management. Other parties, including NGOs working in the water sector, and early-career researchers who are keen to commence their journey in water science, will find this an accessible introduction to what new science is out there, where it can contribute to securing water resources, and what the next critical science gaps are that need to be filled.

The scientific developments outlined in this book are largely the result of Indo-UK research collaborations supported through the SUNRISE (Sustainable Use of Natural Resources to Improve Human Health and Support Economic Development)¹ programme. Conducted by UKCEH in collaboration with partners in Indian and other parts of the world, SUNRISE was funded by UK Research and Innovation's Natural Environment Research Council (UKRI/NERC), as part of a National Capability Long-Term Science - Official Development Assistance (LTS-ODA) award. The programme, which ran from 2016 to 2021, advanced research aligned with the UN Sustainable Development Goals and aimed to improve livelihoods and wellbeing through science that supports (i) the reduction of environmental risks; (ii) improvement of environmental quality; and (iii) sustainable provision of food, water and other natural resources. As part of the programme, UKCEH researchers collaborated with research institutions across India, China, Malaysia, Indonesia, Kenya, Uganda, Tanzania and Malawi, to provide new understanding to inform and improve sustainable environmental management, at relevant scales within each country.

1 <https://www.ceh.ac.uk/our-science/projects/sunrise>

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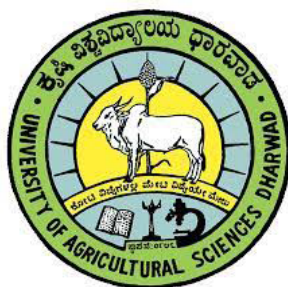
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