# CLIMATE RISK AND SUSTAINABLE WATER MANAGEMENT

Climate change is leading to changing patterns of precipitation and increasingly extreme global weather. There is an urgent need to synthesize our current knowledge on climate risks to water security, which in turn is fundamental for achieving sustainable water management. *Climate Risk and Sustainable Water Management* discusses hydrological extremes, climate variability, climate impact assessment, risk analysis and hydrological modelling. It provides a comprehensive interdisciplinary exploration of climate risks to water security, helping to guide sustainable water management in a changing and uncertain future. The relevant theory is accessibly explained using examples throughout, helping readers to apply the knowledge learned to their own situations and challenges. This textbook is especially valuable to students of hydrology, resource management, climate change and geography, as well as a reference textbook for researchers, civil and environmental engineers and water management professionals concerned with water-related hazards, water cycles and climate change.

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# Preface

As anthropogenic disturbance has reached unprecedented levels, the terrestrial water cycle is undergoing rapid changes, threatening water scarcity and raising new challenges for sustainable water management. In order to achieve the Sustainable Development Goals (SDGs) set by the United Nations General Assembly, water management will have to be improved by reducing climate risks and building climate resilience. Water stress and water-related hazards such as drought, flood, landslide, storm surge and saltwater intrusion have caused huge impacts to the social-economy and the environment. Such water risks are projected to grow under future socioeconomic scenarios and climate scenarios characterized with rising temperature, changing precipitation patterns and increasing extreme weathers. There is an urgent need to synthesize current state-of-art knowledge on climate risks facing the water sector, especially given that professionals in water management agencies are often not well updated with scientific progress. Therefore, it is time to write a book on Climate Risk and Sustainable Water Management using ordinary-language explanations and examples throughout, such that it can be used as a textbook for training courses as well.

This book covers various topics including hydrological extremes, climate variability and climate, climate impact assessment, risk analysis, hydrological modelling, etc. The inter-disciplinary and multi-disciplinary feature of this book could provide a comprehensive knowledge on climate risks to water security, thus guiding sustainable water management in an uncertain future. This book provides relevant theory step-by-step using ordinary-language explanations and examples throughout, making the theory accessible to readers without specialized training in science. The information and advice are conveyed in such an efficient and realistic way that readers can apply the knowledge learned from this book to their own situation and problems.

This book is organized into three closely connected parts. Part I focuses on the interactions between water-related hazards and climate change. It starts with two

chapters on the modelling and analysis of flood risk, followed by droughts, soil erosion and saltwater intrusion. Specifically, Chapter 1 investigates various types of flood risk in a delta area, while Chapter 2 assesses the flood risk in a transboundary river basin impacted by both climate change and reservoir operations. Projection of future drought change patterns in East Africa is presented in Chapter 3. Chapters 4 and 5 focus on the changes in global water erosion vulnerability under climate change and the driving factors behind the changing water erosions, respectively. The last chapter in Part I, Chapter 6 investigates climate change impacts on saltwater intrusion into coastal aquifers.

Part II covers various climate risks to the human and natural systems. Chapter 7 evaluates the impacts of urbanization on local climate in Southeast China, which could further feedback to the spatial-temporal variation of water-related hazards. Chapter 8 investigates the impact of climate change on vegetation dynamics, land cover change and ecological risk in Nepal, followed by Chapters 9 and 10 reviewing the effects of climate change on frozen soil on the Tibetan Plateau and global agriculture production, respectively. Chapter 11 focuses on the impacts of human water use on the terrestrial water cycle, while Chapter 12 assesses the benefits of China's South-to-North Water Diversion project in regulating water scarcity in a water-receiving area under climate change. Chapter 13 focuses on the detection and monitoring of rainfall-induced landslide at global scale, while Chapter 14 introduces the methodology of estimating aquifer depth using satellite remote sensing data.

Part III provides an overview of recent advances in theory and practice towards sustainable water management under future uncertainty. It starts with Chapter 15, on how to manage urban flood risk in a changing climate, followed by Chapter 16, on the application of soft computing techniques for water management. Chapter 17 introduces the benefits of rainwater harvesting for enhancing the resilience to climate risks. Chapter 18 focuses on the variations of runoff coefficient and precipitation elasticity at watershed scale, while the uncertainties from model calibration for future hydrological projections are explored in Chapter 19. Chapters 20 and 21 present two case studies for water risk management under future uncertainty, with one focusing on water scarcity and the other on the shrinking inland lake.

Some of the chapters included in this book are based on discussions with scientists and practitioners at regular conferences organized by the International Association of Chinese Youth in Water Sciences (CYWater). Parts of the chapters are also used for graduate courses at the University of Chinese Academy of Sciences (UCAS) as well as the international training workshop by the Chinese Academy of Sciences (CAS).

We hope this book can facilitate multi-disciplinary and transdisciplinary discussions and exchange between scientists and practitioners for sustainable water management under deep uncertainty, and serve as a textbook for graduate and postgraduate courses in climate change, hydrology, water management, risk analysis and geography.

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