

Volume Preface

Climate change issues are broad and complex. This book does not present detailed arguments about climate change science or climate change models and scenarios. These arguments are well documented in IPCC reports and many other documents. However, a few chapters in this book present overviews of climate change science to set the stage for work presented in that chapter. Each chapter provides numerous reference citations to support scientific arguments and to lead the curious reader to more detailed information.

This book opens only a small window through which to view the world of climate change. The vulnerability of water resources to effects of climate change is the subject in view from this window. The book presents discussions of climate change models and scenarios, and exposes uncertainties and data deficiencies that affect the reliability of predictions about the consequences of climate change on water resources. Furthermore, this book provides an overview of climate change adaptation and mitigation strategies from water resources availability and water use perspectives.

Themes and issues discussed in this book include the following: (1) the applications and limitations of climate change models and scenarios, particularly those related to precipitation projection which is the critical factor for managing water resources; (2) the potential impacts of climate change on water resources including water quality; (3) the potential impacts of climate change on crop production and adaptation strategies for crop production; and (4) case studies of climate change mitigation strategies, particularly water use and conservation measures for reducing the carbon footprint of water consumption.

This book contains nine chapters. Chapters “Projecting Future Climate Scenarios for Canada Using General Circulation Models: An Integrated Review,” “Evaluation and Comparison of Satellite and GCM Rainfall Estimates for the Mara River Basin, Kenya/Tanzania,” and “Projected Future Precipitation Scenarios for a Small Island State: The Case of Mauritius” focus on the critical issue of precipitation projections. Chapter “Climate Change Impacts on Water Resources in Semiarid Regions: Case Study of Aswan High Dam Reservoir” presents a case study of the climate change impact on water resources in semiarid regions of North Africa. Chapters “Modeling Climate Change Impacts and Adaptation Strategies for Crop Production in Egypt: An Overview” and “Grain Production Trends in Russia, Ukraine, and Kazakhstan in the Context of the Global Climate Variability and

Change” focus on the climate change impact on crop production and adaptation strategies for food security. Chapters “Mitigating Climate Change in Urban Environments: Management of Water Supplies,” “The Impact of Urban Water Use on Energy Consumption and Climate Change: A Case Study of Household Water Use in Beijing,” and “Reducing Carbon Footprint of Water Consumption: A Case Study of Water Conservation at a University Campus” discuss issues and case studies related to water use and conservation and climate change mitigation. A brief outline of each chapter, in order of its appearance, is provided below.

In the chapter “Projecting Future Climate Scenarios for Canada Using General Circulation Models: An Integrated Review,” Dore and Simcisko provide an overview of the General Circulation Models (GCMs) and “downscaling” techniques which can improve model resolution at the regional level. The authors discuss available literature on projections of precipitation and stream flow over the next 100 years in Canada using several GCMs. The authors conclude that changes in the Canadian climate are projected to occur under all scenarios and with all models. Although climate change is projected over the entire country, the northern and western parts of Canada may be affected most severely.

In the chapter “Evaluation and Comparison of Satellite and GCM Rainfall Estimates for the Mara River Basin, Kenya/Tanzania,” Dessu and Melesse address studies in data-scarce regions of the world where satellite rainfall estimates (RFEs) and rainfall outputs from GCMs are increasingly used, but where the reliability of data sources is seldom verified with observed data prior to use. Authors introduce the application of simple evaluation techniques to assess the potential of RFE and GCM outputs as potential rainfall information sources with application in the Mara River Basin of Kenya and Tanzania. They conclude that, in general, RFE and GCMs are promising sources of information, but refining the products with much-improved algorithms is essential.

In the chapter “Projected Future Precipitation Scenarios for a Small Island State: The Case of Mauritius,” Dore and Singh address the impact of climate change in small island countries which are highly sensitive to changes in climate. As a case study, the authors applied four of the IPCC’s Fourth Assessment GCMs to produce precipitation projections for the next 90 years in Mauritius, a small island country, situated about 1,100 km east of the mid-Madagascar. The results show that in Mauritius the net annual precipitation is likely to decline, historically wet months are likely to become even wetter, and dry months could become even drier in the future. Due to limited financial resources, Mauritius, like many small island states, may be unable to expand current water storage facilities in order to adapt to the expected impacts of future climate change. Hence, innovative ways of managing water resources will be critical not only for the water needs of the local population but also for the needs of the growing tourism-based economy.

In the chapter “Climate Change Impacts on Water Resources in Semiarid Regions: Case Study of Aswan High Dam Reservoir,” Elshemy addresses climate change impacts on water resources in semiarid regions, particularly in Egypt. As a case study, the author uses climate change models and scenarios to study the impact of climate change on hydrodynamics and water quality of Lake Nubia which is

located in the southern part of Aswan High Dam Reservoir. The hydrodynamic characteristics studied include water surface levels, evaporative water losses, and reservoir thermal structure. The water quality parameters of the study include pH, dissolved oxygen, chlorophyll-a, orthophosphate, nitrate–nitrite, ammonium, total dissolved solids, and total suspended solids. The results show that hydrodynamic and water quality characteristics of Lake Nubia will be significantly impacted by projected climate changes. The author identifies a critical need for developing a regional climate change model for the Nile Basin and acquiring long-term records of hydrodynamic and water quality characteristics of the Aswan High Dam Reservoir for detailed investigation of climate change impacts.

In the chapter “Modeling Climate Change Impacts and Adaptation Strategies for Crop Production in Egypt: An Overview,” Ouda et al. address the climate change impact on crop production and the need for developing adaptation strategies to reduce the risk of future climate change. The authors introduce studies that highlight the importance of using climate change models to quantify the risk on wheat and maize production in Egypt. Field experimental data from case study sites located in four geographically different Egyptian regions and a crop simulation model output are incorporated in a climate change model to assess the effect of climate change scenarios and adaptation strategies on wheat and maize production. Results show that the yields of both crops will decline under future climate change scenarios, and the levels of decline depend on geographic location, soil type, and irrigation method. The authors conclude that it is necessary to improve adaptation strategies to present-day climate variability in order to reduce vulnerability to extreme events that may occur in the future.

In the chapter “Grain Production Trends in Russia, Ukraine, and Kazakhstan in the Context of the Global Climate Variability and Change,” Lioubimtseva et al. discuss complex interactions between climate change and other factors and note that global grain production is highly sensitive to a combination of internal and external factors, such as climate variability, water resources, land-use changes, institutional changes, and global economic trends. The authors report studies on grain production potential in Russia, Ukraine, and Kazakhstan based on agroecological models driven by climate change scenarios and land change analysis. Results suggest that in these countries, a combination of winter temperature increase, extended growing season, and CO₂ fertilization could increase water availability and land suitability resulting in higher crop yields. However, the authors note that projections based on biophysical modeling alone should be considered with caution as they do not take into account regional socioeconomic and political factors. Furthermore, the authors state that due to the cross-scale contingent dynamics of coupled human and natural systems, it is critical to approach the planning, assessment, and implementation of adaptation strategies at the regional, national, and international levels simultaneously.

In the chapter “Mitigating Climate Change in Urban Environments: Management of Water Supplies,” Lawson discusses the linkage between urban water supply and climate change, including the effects of climate change on water supplies and the greenhouse gases produced by water treatment and distribution.

Lawson argues that the possibility of mitigating climate change through water supply decisions has not been fully explored. The author investigates the potential for improved efficiency through analysis of water supply systems in the five largest US cities: New York, Los Angeles, Chicago, Houston, and Philadelphia. These cities demonstrate opportunities to reduce greenhouse gas emissions from water supplies through protecting water sources, selecting alternative water supplies, repairing and replacing old infrastructure, conserving water, and using alternative energy supplies. The author also discusses the potential of decentralizing water supply system and using alternative approaches such as rainwater harvesting for improved energy efficiency in managing urban water supplies.

In the chapter “The Impact of Urban Water Use on Energy Consumption and Climate Change: A Case Study of Household Water Use in Beijing,” Chen et al. discuss the linkage between household water use and energy, and explore potential pathways for climate change mitigation. The authors argue that understanding energy consumption patterns of urban dwellers can be used in the integrated management of water and energy, amplifying the potential of energy savings by water conservation and thus reducing greenhouse gas emissions by cities. The authors report studies on energy consumption related to household water use in Beijing during summer and winter. Their study shows that household water conservation leads to significant energy savings that can be credited toward mitigating climate change effects in Beijing.

Finally, in the chapter “Reducing Carbon Footprint of Water Consumption: A Case Study of Water Conservation at a University Campus,” Parece et al. discuss the linkage between environmentally relevant behavior and water conservation that leads to reductions in energy use thereby mitigating effects of climate change. The authors report on studies conducted at an American university campus and the effects of student behavior on water use and conservation. Occupants of ten residence halls at the university were studied, and the project employed five different strategies, each with a different number of prompting strategies to determine the approach that was most effective in influencing less water use. Lower water consumption was observed in most residence halls participating in the study. In turn, energy used to treat river water to potable standards and transport it to university campus was also reduced. Ultimately, these energy savings reduce the size of the university’s carbon footprint and mitigate climate change effects.

The scientific study of climate change and technologies for adaptation and mitigation continue to evolve. The global economy, the health of people, animals, and plants, and the quality of our global environment are all affected by climate change. There is a critical and urgent need to develop climate-change-related educational programs that teach the basic science of climate change, and teach cutting-edge technologies and policies for mitigating and adapting to climate change. Regulatory aspects of climate change mitigation and adaptation at the local, regional, and global levels should also be taught. Furthermore, there is a significant need to develop appropriate local, regional, national, and international socioeconomic policies to minimize the adverse effects of climate change.

We hope this book will serve as a valuable resource and reference for graduate and undergraduate students in water and environmental sciences, and those in international studies programs, and that it will serve as a useful guide for governmental agencies and policy makers who plan and manage water and energy resources.

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