Disaster Risk Reduction

Methods, Approaches and Practices

Series editor
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About the Series

Scope of the Series
Disaster risk reduction is a process that leads to the safety of communities and nations. After the 2005 World Conference on Disaster Reduction, held in Kobe, Japan, the Hyogo Framework for Action (HFA) was adopted as a framework for risk reduction. The academic research and higher education in disaster risk reduction has made, and continues to make, a gradual shift from pure basic research to applied, implementation-oriented research. More emphasis is being given to multi-stakeholder collaboration and multi-disciplinary research. Emerging university networks in Asia, Europe, Africa, and the Americas have urged process-oriented research in the disaster risk reduction field. With this in mind, this new series will promote the output of action research on disaster risk reduction, which will be useful for a wide range of stakeholders including academicians, professionals, practitioners, and students and researchers in related fields. The series will focus on emerging needs in the risk reduction field, starting from climate change adaptation, urban ecosystem, coastal risk reduction, education for sustainable development, community-based practices, risk communication, and human security, among other areas. Through academic review, this series will encourage young researchers and practitioners to analyze field practices and link them to theory and policies with logic, data, and evidence. In this way, the series will emphasize evidence-based risk reduction methods, approaches, and practices.

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Urban Drought

Emerging Water Challenges in Asia
The world has witnessed unprecedented urban growth since the beginning of the twenty-first century. Much of this growth is concentrated in the less-developed countries of Asia. Asia is home to 54% of the world’s urban population, and the percentage share is expected to increase to 66% by 2050. Ninety-three percentage of the growth is expected to be in the less-developed countries with more than 60% in the cities of Asia. It is also the million-plus cities that are witnessing the most phenomenal urban growth under the impact of rural-to-urban migration. Along with climate change impacts, the rapid pace of mass urbanization is putting cities under increasing water insecurity and water stress. There is also an increased demand for water in order to maintain the intense pace of activities and a high standard of living in urban areas. Cities also concentrate on anthropogenic carbon emissions that accelerate global warming and impact the hydrological cycle to further increase water stress in cities. Increase in impervious surface and consequent depletion of groundwater reserves, increased water pollution from city waste, and industrial affluent decrease the availability of finite water resources. Choked water bodies and urban drainage systems increase the vulnerability to floods. Cities thus spatially concentrate the water demand of millions into a small area and also increase the frequency and intensity of water-related disasters like floods and droughts under climate change impacts, hindering development prospects.

Confronted with multifaceted and complex challenges, conventional water management practices have proved to be inadequate to address urban water insecurity and water stress. Transforming urban water systems into more resilient and hence more sustainable systems would require innovative approaches. Urban communities are seeking resilience in the urban water system and to future uncertainties in water supply, to create resilient, livable, productive, and sustainable cities.

This book in 24 chapters deals with the various aspects of urban water insecurity, concepts, and relevance with special reference to urban water insecurity in Asian cities. The first section discusses the concepts of urban water insecurity and the implications of climate change on urban drought and develops an urban water security index. The second section deals with various case studies from Asia.
covering varied dimensions of urban water insecurity and the policy responses to manage urban water crisis. The selected cities range from megacities in developing countries like Delhi and Kolkata in India and Dhaka in Bangladesh to million-plus cities and even small towns in developed countries like Japan.

Covering all aspects of urban drought and water insecurity, this book is intended for students, researchers, academia, policy makers, and development practitioners in the fields of water resource management, urban planning, and disaster management, especially in the Asia-Pacific region. It will help to better understand the complex scenario of urban drought caused by rapid urbanization, unplanned urban growth, and climate change and to evolve policies for sustainable water systems and resilient cities.

Fujisawa, Japan

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Bhaswati Ray
Rajib Shaw
It is already evident that urban areas are threatened by water insecurity under the impacts of rapid urbanization, competing and increased water use, and climate-change-induced water stress particularly in the cities of Asia. Yet, nearly half of the world population lives in urban areas and the percentage is expected to reach 60 in the next two decades. Ensuring water security is a defining global challenge and involves, in addition to having enough water resources, the mitigation of water-related risks, such as flood and drought, addressing conflicts over shared water resources and resolving stress among stakeholders that compete for increased water use. It is embedded in all aspects of development, poverty reduction, food security, health, social equity, and environmental sustainability. It also involves increasing the economic efficiency.

This book attempts to study the various concepts and dimensions of urban water insecurity and to analyze the threats to urban water security with case studies from Asia. Inefficient water use by households and industries, fragmented management of water resources between sectors and institutions, climate-induced water shortage, environmental degradation of water sources, and inadequate use of alternate sources are issues of major concern. While developing a water security index for urban areas, the book also explores the mitigation measures for increased urban water resilience that would require innovative approaches, both infrastructure-based and system-based. The 24 chapters include overview articles on the theoretical framework of water security and lessons learnt from Asian cities including the analysis of problems and best practices adopted in urban water governance.

The book is principally targeted to study the concepts and dimensions of urban water insecurity and the implications of climate change on urban drought and to explore the parameters for developing urban water security index. The book also deals with various case studies from Asian cities covering varied dimensions of urban water insecurity and explores the innovative approaches to water development and management in these cities.

Covering all aspects of urban drought and water insecurity, this book will be a valuable resource material for students, researchers, academia, policy makers, and development practitioners. The primary target groups for this book are students and
researchers in the fields of water resource management, urban planning, and disaster management, especially from the countries of the Asia-Pacific region. The collective knowledge from this book will help policy planners and practitioners to better understand the complex scenario of urban drought caused by rapid urbanization, unplanned urban growth, and climate change and to evolve policies for sustainable water systems and resilient cities.
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Chapter 1
Defining Urban Water Insecurity:
Concepts and Relevance

Bhaswati Ray and Rajib Shaw

Abstract  Nearly half of the world’s total population resides in towns and cities, and the percentage is projected to reach 60 in the next two decades. The United Nations predict that by 2050, the urban population of the world will reach 6.3 billion from 3.5 billion. 93% of the growth would be in the developing countries with more than 80% in the cities of Asia and Africa. The rapid increase in population and the fast pace of urbanization along with climate change are putting cities under increasing water stress. The two main challenges facing urban areas are the inadequate and inequitable access to safe water and improved sanitation facilities on one hand and increased frequency and intensity of disasters including floods and droughts with adverse consequences on economic growth, health and well-being on the other. Water insecurity can be defined as the lack availability of sufficient water of good quality to meet basic human requirements, livelihoods and ecosystem functions, and an increased risk of water-linked disasters. Water security thus involves, in addition to having enough water resources, reduction of disaster risks associated extreme weather events floods, resolving conflicts over shared water systems, reducing stress among different stakeholders and competing uses of water. It is thus embedded in various development issues including poverty alleviation, food security, social equity and environmental sustainability. It also involves increasing the economic efficiency. Based primarily on literature review, the chapter intends to include the various concepts and threats to urban water security and measures to improve the same.

Keywords  Urbanization · Climate change · Water stress · Water security

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1.1 Introduction

The world has witnessed unprecedented urban growth since the beginning of the twenty-first century. The world’s urban population, which stood at just 10% of the global total at the onset of the century, reached an unprecedented 50% by the beginning of the twenty-first century (United Nations Department of Economics and Social Affairs 2010), when the total urban population was 3.6 billion. It is the million plus cities that witnessed the most phenomenal urban growth. In 1900, there were 16 ‘million cities’ across the globe with population exceeding one million or more, most of them being located in the developed nations. By 2000, the number of million cities increased to 400, with three quarters of the cities located in developing countries (United Nations Department of Economics and Social Affairs 2010). The United Nations predicts that by 2050, urban population of the world will increase from 3.6 billion to 6.3 billion.

The next few decades will witness the most rapid urban growth in human history, with 2.6 billion additional urban dwellers expected by 2050 (McDonald et al. 2014; United Nations Population Division 2011). The world’s urban population would then reach 6.2 billion, an increase from the global population of 3.6 billion (United Nations Population Division 2011). 93% of the growth is expected to be concentrated in the less developed countries with more than 80% in the cities of Asia and Africa. 37% of this growth would be contributed by just three countries—India, China and Nigeria. The rapid increase in population and the fast pace of urbanization along with climate change are putting cities under increasing water insecurity.

Water scarcity is the inability to meet the demand for water in an area due to the unavailability of sufficient amount of water. Water scarcity can be both physical water scarcity and socio-economic scarcity of water. Physical scarcity is denoted by demand for water exceeding supply and is a consequence of inadequacy of available water resources to fulfill the demand for water. This occurs due to overexploitation of water resources. A socio-economic scarcity, on the other hand, results from insufficient investment and political apathy to develop water resources. It is often a result of poor governance rather than insufficient availability. Water scarcity is further accentuated by climate change and altered patterns of flood and droughts, increased pollution, depletion and overuse. It thus emerges from a combination of hydrological variability and high human use, which may in part be mitigated by storage infrastructure (United Nations 2016). Water stress, a component of water scarcity, is defined as the difficulty of obtaining fresh water for use during a specific period of time and may result in further depletion and deterioration of water resources, resulting in increased water scarcity (Science Daily 2017). According to the World Bank, roughly 1.6 billion people already live in countries with water scarcity, and that number is likely to increase in future. Large tracts of Central and West Asia suffer from physical water scarcity, while South Asian countries, particularly India, Nepal and Bangladesh, suffer from socio-economic scarcity. China and India, where urban growth is expected to be maximum, suffer most from water scarcity—both physical and socio-economic (Fig. 1.1).
Water insecurity, on the other hand, can be defined as the lack of availability of adequate water of good quality to meet basic human requirements, livelihoods and ecosystem functions, and an increased risk of water-linked disasters. The two main challenges facing urban areas are the inequitable access to safe water and sanitation facilities and the increased frequency and intensity of disasters like flood and droughts, with adverse consequences on economic growth, health and well-being. It prevents both accessibility and affordability of the resource to the vulnerable sections of the population and is more a governance issue than absolute shortage of water availability. Water insecurity is an effect, rather than a cause, of sociopolitical domination and infrastructural exclusion. While policy experts often respond to water insecurity by focusing on the issue of physical scarcity and estimates of water availability to explain water insecurity, it is often more than a technocratic response. Both geographical limitations like location in dry climates or far from water sources as well as financial limitations, with the poor cities unable to construct robust urban water infrastructure increases their vulnerability to urban water insecurity, at a time when the rationale for delivery of water services in a non-discriminatory manner is well documented. Institutional, operational and financial causes of water insecurity dictate the response path that differs in the rural and urban contexts.

Exponential population growth is a major challenge in the Asian cities. Growth in urban population is accompanied by a trend towards smaller, and therefore more,
households with the associated cost of individual piped service delivery provision and maintenance (Hope and Rouse 2013). The most in need and the most difficult to reach remain largely unserved (Hope and Rouse 2013). The shortfall is being made up of other improved supplies at a higher cost highlighting the water insecurity issues in cities already suffering from financial gaps. Significant loss of revenue due to finances channelized to alternate safe water sources often reduces the ability of urban services to meet escalating demands in Asian cities. Increased investment needs coupled with low-cost recovery results in deteriorating services. It increases the inability of the service providers to extend services to unplanned or expanding urban areas which limits access to low-income and vulnerable groups (Hope and Rouse 2013). A major risk to water security is the neglect of existing infrastructure associated with inadequate cost recovery (Hope and Rouse 2013), high leakage loss, rationing water supply by hours per day that accelerates deterioration and introduces the risk of ingress of contaminated water (Hope and Rouse 2013; Rouse 2007).

1.2 Water Security: The Concept Defined

While the concept of water security is not new, the term appears to have gained greater profile recently, judging from a range of reports and conferences that have considered water security in isolation or in relation to the security of other resources, notably energy and food/land (Mason and Calow 2012; Martin-Nagle et al. 2012; National Intelligence Community 2012; Oxford University Water Security Network 2012; World Economic Forum 2011). The Global Water Partnership (GWP) (2000) first defined water security as an overarching goal where every person has access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring the environment is protected and enhanced. Water security was also defined as the availability of water in adequate quantity and quality in perpetuity to meet domestic, agricultural, industrial and ecosystem needs (Cook and Bakker 2012; Swaminathan 2001). The emphasis was on the availability of water and on environmental protection. Later, water security went on to add new dimensions of prevention and reduction of disaster risks. The Ministerial Declaration of the Second World Water Forum in Hague in 2000 defines water security as ensuring that fresh water, coastal and related ecosystems are protected and improved; that sustainable development and political stability are promoted, that every person has access to enough safe water at an affordable cost to lead a healthy and productive life and that the vulnerable are protected from the risks of water-related hazards (Gerlak and Mukhtarov 2015). Water security has also been defined by Cheng et al. (2004) as access to safe water for healthy living and food production at affordable cost while ensuring that the environment is protected from pollution and water-related disasters like floods and droughts. The concept of water security thus entails managing the effects of both overabundance and water scarcity. It implies the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people,
environments and economies (Halmatov et al. 2017; Grey and Sadoff 2007). For the Global Water Partnership (GWP), the essence of water security is that concern for the resource base itself is coupled with concern that services which exploit the resource base for human survival and well-being, as well as for agriculture and other economic enterprise, should be developed and managed in an equitable, efficient and integrated manner (Mason and Calow 2012; Global Water Partnership 2009). The World Bank defines water security as reliable availability of acceptable quantity and quality of water for production, livelihoods and health and acceptable level of often unpredictable water related risks to society (Hutchinson and Herrmann 2008).

These definitions thus combine to focus on availability of potable water for human consumption, providing water for productive activities in the agricultural and industrial sectors, for environmental protection and conservation, and for the prevention of water-related disasters and issues of national security. Water security may increasingly be referred to in articulating water’s role in national and international peace and stability due to water’s strategic significance as both a fugitive resource that often traverses borders and, in its embedded or virtual form, a globally traded commodity (Mason and Calow 2012; United Nations Development Programme 2006). The competition for water will aggravate in the coming decades, and people with the weakest rights like women and the landless will see their entitlements to water threatened and challenged by the more powerful. By traversing borders through water bodies, rivers and wetlands, water is often responsible for cross-border tensions in water-stressed regions. Water security also implies the ability of a population to enjoy sustained access to adequate quantities of safe water to support livelihoods, human well-being and economic development, protection against water pollution and water-related disasters, for preserving ecosystems, ensuring peace and political stability (United Nations 2013).

The Asian Water Development Outlook (AWDO), developed in 2007 by the Asia-Pacific Water Forum (APWF) and the Asian Development Bank (ADB) to highlight the important water management issues (Asian Development Bank 2013), introduced the concept of quantitative measurement of water security. Asian Water Development Outlook 2013 by the Asian Development Bank was the first comprehensive attempt to measure progress towards a water-secure future in Asia and the Pacific region. The report provides a robust, pragmatic and the first-ever quantitative and comprehensive framework for assessing water security in the countries of Asia and the Pacific (Asian Development Bank 2013) involving five different dimensions. The national water security of any country is assessed by the composite score of the five dimensions measured on a scale of one to five (Asian Development Bank 2016), where one indicates extremely poor water security while five denotes the best.

1. Household water security: it is to be measured in terms of access to piped water supply, access to sanitation and hygiene (Asian Development Bank 2013). Providing safe and reliable safe water and sanitation is essential for efforts to eradicate poverty and support economic development (Asian Development Bank 2013).
2. Economic water security: measured across various sectors, agricultural, industrial and energy water security, it is the productive use of water to sustain economic growth in food production, industry and energy sectors of the economy (Asian Development Bank 2016).

3. Urban water security: defined in terms of water supply, wastewater treatment and drainage (Asian Development Bank 2013), the indicators measure better water management designs and services to create and sustain vibrant and liveable water-sensitive cities.


5. Resilience to water-related disasters: it includes the exposure, vulnerability, hard coping capacities and soft coping capacities to water-linked disasters like flood, drought, storm surges and coastal floods. There is a need to build resilient communities in Asia and Pacific region that can adjust to climate variability and reduce disaster risks.

1.3 Urban Water Security in Asia: Its Current Relevance

The main reason behind a growing urban population in the developing countries of Asia is rural-to-urban migration for better economic opportunities, improved standards of living and better provision of basic services like education and health. The urban population of the world has grown rapidly from 746 million in 1950 to 3.9 billion in 2014 (United Nations 2014). The number is projected to reach 6.2 billion in 2050. Asia, despite its lower level of urbanization, is home to 53% of the world’s urban population (United Nations 2014). The percentage share is projected to increase to 66% by 2050.

Urbanization in Asia is best described as pseudo-urbanization or mass urbanization, with maximum concentration of urban population in the megacities, cities with population exceeding 10 million. The total population in ten megacities was 153 million in 1990 accounting for 7% of the total urban population. By 2014, the number of megacities increased to 28 (Hussein 2017), housing a population above 450 million and accounting for almost 12% of the world’s total. A total of 16 of these megacities are located in Asia, 4 megacities are in Latin America, 3 each in Africa and Europe, and 2 megacities in North America (United Nations 2014). The rapid rate of urbanization has caused an immense increase in the slum population in the less developed countries. The number of slum dwellers increased from 200 million in 1990 to 853 million in 2014. Apart from putting stress on basic urban services including housing, basic infrastructure like potable water supply, good sanitation, electricity, health and education services, mass urbanization also makes cities prone to environmental degradation and increased frequency of disasters. Increasing access to municipal water supply for the world’s poor is one of the Millennium Development Goals, since municipal supply is generally cleaner and safer than other water sources (McDonald et al. 2014; Howard and Bartram 2003).
Past research has shown that as cities grow in population, the total water needed for adequate municipal supply grows as well (McDonald et al. 2011, 2014; Bradley et al. 2002; Postel et al. 1996; Falkenmark and Widstrand 1992; Falkenmark and Lindh 1974). This increase in total municipal water demand is driven not just by the increase in urban population, but also by a tendency for economic development to increase the fraction of the urban population that uses municipal supply rather than other sources such as local wells or private water vendors (McDonald et al. 2014; Bartlett 2003; Bhatia and Falkenmark 1993). Urbanization and a higher standard of living further increase per capita water use, as new technologies such as showers, washing machines and dishwashers increase residential use of water (McDonald et al. 2011, 2014). Thus, cities by their nature spatially concentrate the water demand of thousands or millions of people into a small area, which by itself would increase stress on finite supplies of available fresh water particularly near the city centre (McDonald et al. 2011, 2014). Cities also concentrate the sources of greenhouse gases caused by anthropogenic carbon emissions that impact the hydrological cycle and increase water stress. With increased concentration of greenhouse gases, cities are responsible for accelerated global warming impacting the hydrological cycle and increasing the water stress in cities. Increase in impervious surface and consequent depletion of groundwater reserves, increased water pollution from city waste and industrial affluent decrease the availability of finite water resources. Choked water bodies and urban drainage systems increase the vulnerability of floods. Two-thirds of the megacities are located in regions vulnerable to urban water scarcity.

Asia and the Pacific region continue to be affected by inadequate water security. Ten largest cities under water stress are located mostly in this region which includes Tokyo, Delhi, Shanghai, Beijing, Kolkata, Karachi and Moscow, in addition to Mexico City, Los Angeles and Rio de Janeiro. 60% of the households live without safe, piped water supply and improved sanitation (Asian Development Bank 2013, 2014). The Asia-Pacific Water Forum predicts that climate change impacts will impose additional threats to the vulnerable countries in Asia and the Pacific region, challenging the very concepts of sustainable development, poverty alleviation and improved water security. Poor water management is also responsible for the occurrence of natural disasters that include frequent and endemic floods and droughts, storm surges and landslides. The densely populated coastal cities in India, including Mumbai, Kolkata, Chennai, Surat and Thiruvananthapuram, are vulnerable to cyclones and associated hazards such as storm surges, high winds and heavy rainfall (Parikh et al. 2013, 2014). Although improved forecasting has reduced the number of deaths from water-related disasters, the cost of flood disasters in the region has increased over time (Asian Development Bank 2013).

Rapid urbanization is a cause of greenhouse gas emissions and global warming that is expected to present imminent challenges for urban areas, especially in the less developed countries of Asia, way beyond the physical risks such as sea level rise and increased frequency of extreme events. It will become increasingly difficult for cities to provide basic services like water supply and sanitation to the residents. Climate change would also increase the occurrence of extreme events like floods and
droughts and alter the precipitation pattern by impacting the hydrological cycle with devastating consequences.

According to the population-weighted Regional Water Security Index developed by Asian Development Bank (2013) in countries of Western and Central Asia, East, Southeast and South Asia, as well as the Pacific region, it is evident that South Asia is more insecure than all other regions in terms of its household water security (including sanitation), urban water security, environmental water security and resilience to water-related disasters (Asian Development Bank 2013). West and Central Asia are least developed in economic water security (Asian Development Bank 2013). The lowest water security index of 1.6 is found in South Asia. Inequity in access is also the highest in South Asia (Asian Development Bank 2013). Impacts of climate change are likely to put these economies under additional water stress and affect the economies of these countries. The water security index value is 2.2 for West and Central Asia, 2.4 for Southeast Asia, 2.6 for East Asia and 2.5 for the Pacific region. The advanced economies including Hong Kong, Singapore, China and Japan have a water security index value of 3.3. A similar trend is also witnessed in the population-weighted disaster resilience and water security being lowest in South Asia.

However, the overall increase in total municipal water demand causes cities to search for new adequate, relatively clean water sources, leading to the creation of sometimes quite complex systems of urban water infrastructure (McDonald et al. 2014; Alcott et al. 2013; Brown et al. 2009; Chau 1993). Cities represent a concentration of economic and political power (Bettencourt et al. 2007), which cities use to build urban water infrastructure to satisfy their demand (McDonald et al. 2014). As this infrastructure can go out far from the city centre, cities exploit new sources of surface water and groundwater or adopt scientific knowledge and technology like desalination to escape water stress (McDonald et al. 2014). Cities can also reduce the emission of greenhouse gases and adapt to changing climate through policy initiatives. International Conventions are also emphasizing on such adaptations.

Local communities in urban areas are focusing on resilience in the urban water system and to future uncertainties in water supply because of climate change and population growth. It is now well accepted that the conventional urban water management approach is highly unsuited to addressing current and future sustainability issues (Wong and Brown 2009; Ashley et al. 2003, 2005; Newman 2001; Butler and Maksimovic 1999). Transforming urban water systems into more resilient and hence more sustainable systems would require innovative approaches. It is pertinent to note that there are a wide range of water sources that cities can have access to supplement the existing ones in the form of rain water harvesting, construction of storage devices, appropriate and sustainable extraction of groundwater, groundwater recharge, urban storm water use, treated wastewater and desalination options. Such sources may be found to already exist within urban areas. A strategy built around a diversity of water sources would allow cities the flexibility to access a portfolio of water sources (Wong and Brown 2008) and harvesting, treatment and delivery options.

This would include both centralized and decentralized water supply schemes, ranging from the simple rainwater tanks (Wong and Brown 2008) with secondary
supply pipeline for non-potable use to city-scale indirect potable water reuse schemes and the pipeline grid, linking regional reservoirs (Wong and Brown 2009). The non-potable water from a variety of local sources can replace the use of potable water for such uses as toilet flushing, laundry, garden watering and open space irrigation (Wong and Brown 2008, 2009). Designing cities for climate change, particularly the sustainable management of water resources, requires a reversal in the conventional philosophical approach of urban communities drawing on their depleting ecosystems and natural environments (Wong and Brown 2008). The traditional value of open spaces and landscape features needs to be reinforced with an understanding of the ecological functioning of the urban landscapes that capture the essences of sustainable water management, micro-climate influences, facilitation of carbon sinks and use for food production (Wong and Brown 2008, 2009). Technological improvements and institutional capacity building is needed for sustainable urban water management. It is being argued that unless new technologies are socially embedded into the local institutional context, their development in isolation is insufficient to ensure their successful implementation in practice (Wong and Brown 2009; Brown 2008). There has been a significant boost in the involvement of local communities in defining the urban water problem, developing water-sensitive urban designs adapted to local conditions and participating in the processes of decision-making. Cities and countries of Asia have already adopted innovative measures in managing water stress and drought in urban areas. The densely populated country of Singapore, for example, with no source of freshwater supply, is highly water stressed with its demand exceeding the naturally occurring supply. Yet Singapore city is able to provide enough and sustained water for its industrial, agricultural, commercial and domestic use through investment in technology, international agreements and effective water management. Advanced rainwater detention systems account for 20% of the water supplied in Singapore. 40% is given by Malaysia. Use of grey contributes another 30% while desalination process provides the remaining 10% of the supply.

1.4 About the Book

It is already evident that urban areas are threatened by water insecurity under the impacts of rapid urbanization, increased water use and climate change-induced water stress particularly in the cities of Asia. This book attempts to comprehend the various aspects of urban water security and to analyse the threats to urban water security with case studies from Asia. Inefficient water use practices by households and industries, fragmented management of water resources between sectors and institutions, climate-induced water shortage, environmental degradation of water sources and inadequate use of alternate sources are issues of major concern. Despite recent advances in the literature, there exists a considerable gap in policy and practice in the integrated water resource management approach (Ibisch et al. 2016). The book thus intends to look into the indices to measure water security while evolving a water security index for urban areas and to explore the innovative approaches to sustainable urban water
development and management. The book, constituting of 23 chapters, constitutes two segments. The introductory segment consists of overview articles on theoretical frameworks of water security, while the second part deals with specific examples from Asian cities. In this chapter, an attempt has been made to provide an insight into the concept of urban water security and its present-day relevance.

In Chap. 2, Ray and Shaw have highlighted the impact of rapid urbanization on urban water management along with the global concern for sustainable water systems. The chapter also identifies water insecurity issues in selected cities across Asia and discusses the best practices adopted for urban water development in these Asian cities.

In Chap. 3, the authors Ray and Shaw highlight how climate change impacts urban drought, more so in urban areas disadvantaged by urban heat island effect. The chapter explores the linkage between urban areas and the changing climate. It also assesses the significance of global conventions and the modified local adaptations in finding suitable solutions.

Chapter 4 by the same authors explores the reasons for water insecurity, which is rarely one of physical scarcity. Based on a number of water stress and urban sustainability indicators, the chapter further explores the possibility of identifying various parameters for developing a water security index to assess sustainability of the urban water systems.

In Chap. 5, Mitra et al. discuss the water-energy-food nexus as an integrated tool to manage increasing water crisis in the context of rapid urban growth through multi-sectoral cooperation at in-boundary and transboundary level. The need for the water-energy-food nexus in urban areas arises from the twin impact of rapid urban growth on finite resources and the water footprint caused by intensive food and energy consumption. Highlighting some selected good practices of the nexus around the world, this chapter argues that through realizing synergies across urban water energy food system, cities deliver inclusive growth, even with increasing drought risk.

In Chap. 6, Marome focuses on the institutional factors including a lack of coordination among different agencies that hinder climate change adaptations in the city region of Udon Thani province in Thailand, aggravating its vulnerability to drought and flood. Udon Thani’s capacity to cope with the risk of flood and drought was also assessed through the creation of three transient scenarios: business as usual, population increase according to the strategic plan of the Provincial Waterworks Authority and the scenario where all of the province’s envisioned development projects of the strategic plan are materialized, leading to significant urban growth.

Chapter 7 by Iwasaki is a case of successful urban water management in Japan through the historical process of canal restoration in Yanagawa city. The case study highlights the traditional water management system linked to the concept of ‘near water’ and the continuing efforts to strengthen the water–human relationship in the Horiwari River system with active involvement of local people to bridge the gap between near water and far water.

In Chap. 8, Abedin and Kibria explore the vulnerabilities of water-related disasters like floods and groundwater depletion, their causes and impacts, as well as the causes
of drinking water scarcity in Dhaka city and the role of the government in enhancing the resilience of the city.

Chapter 9 on Nagpur city by Deshkar discusses the role of urban infrastructure in building urban resilience and promotes an integrated approach involving local communities and the natural resources. It also highlights some of the challenges for planning urban water infrastructure in Nagpur particularly from the resilience perspectives.

Urban drought and water availability conditions are discussed in Chap. 10 for National Capital territory of Delhi by Singh and Singh. They also discuss in length the probable strategies that may be adopted for drought mitigation.

Chapter 11 on Kathmandu by Adhikari et al. is on the impact of urban growth and surface sealing in decreased infiltration and the inadequacy of the Kathmandu Upatyaka Khanepani Limited (KUKL) which supplies only around 30% of total demand. The rest comes from groundwater pumping, traditional water spouts, supply from private water vendors and bottled water companies. Hence, the need for water management strategies has been highlighted.

In Chap. 12, Porio et al. explore water security in the Philippines by examining the effect of drought on risk governance and its social impacts in the 1997–1998 and 2015–2016 El Niño episodes in Metro Manila, Iloilo City and Cebu City. During these periods, widespread dryness occurred in both urban and rural areas, as rainfall was reduced by more than 50%, affecting the urban poor and increasing the cost of provisioning of urban water services.

In Chap. 13, Ray and Shaw study the existing water supply system of Kolkata and highlight the inadequacies in the formal water system and the role of the parallel informal supply system in the light of Sustainable Development Goals for a resilient and sustainable water future.

In Chap. 14, Gupta and Nikam emphasize the use of various water conservation measures with the use of water conservation devices, leak detection and repair, water reuse, metering and incremental rates. Two applications of rainwater harvesting and wastewater reuse in Thane City in Mumbai Metropolitan Region have been described as a management strategy adapted against urban drought and water insecurity.

Chan and Ying-en Ho discuss water supply in Hong Kong city in Chap. 15 which imports water from River Dongjiang of Guangdong province in China through a dedicated aqueduct. This chapter further examines the health risks associated with poor water resources management in the city based on three cases highlighting water pipeline pollution, climate variability and its impact and the potential threat of disasters in the urban context.

Chapter 16 by Ardalan et al. focuses on the water resource management and urban water issues in the megacity of Tehran. It highlights the impact of rapid urbanization, high growth of population, an arid environment and the resultant challenges in the urban water system. The authors also discuss short-term and medium-term solutions for sustainable urban water management.

Rahman et al. explore trend of population growth, soil sealing and its impact on water infiltration and loss of groundwater potential in Peshawar city district in
Chap. 17. The chapter has also highlighted the consequences impacts of soil sealing on human life and environment.

In Chap. 18, Aviruppola and Rekha Nianthi discuss water management issues in urban areas in Sri Lanka, aggravated by climate variability and improper practices. The paper further highlights the policy responses of Sri Lanka towards managing the issue of urban water crisis and examines the overall position of Sri Lanka in urban water crisis management. It provides profound understanding of the policy formulations on urban water crisis management in Sri Lanka.

Chapter 19 also focuses on urban water issues and possible solutions for sustainable urban water management in the city of Colombo where the author Wickramasinghe identifies the current threats in the existing urban water system including pollution by domestic sewage, municipal wastewater and industrial effluent, policy and governance issues, salinity intrusion in Kelani River and the threats posed by climate variability. The chapter also examines available options in enhancing water security for a sustainable water future.

Chapter 20 is a similar study on the water challenges in Ulaanbaatar by Dalai et al. and focuses on water scarcity and flash floods caused by climate change, urbanization and water consumption increase in the city.

Chapter 21 deals with the water crisis in hill towns based on the case of Darjeeling town with suggested measures to be adopted as well as planning interventions as proposed by Mondal and Roychowdhury.

In Chap. 22, Haque explores the present state of water governance in the slums of Dhaka metropolis and water pricing issues based on two survey reports. Slum dwellers often pay a higher price for illegal connections, while the middle-class households consume 7.5–10 times more water.

In Chap. 23, Rahman et al. discuss the urban water management issues and challenges in the post-2004 Indian Ocean Tsunami Recovery phase based on the learning experiences from Banda Aceh City, Indonesia.

In Chap. 24, the editors provide a summary of the book that covers all aspects of urban drought, the threats and challenges brought about by rapid urban growth, climate change, environmental degradation and increased frequency of extreme events across Asia. The case studies include cities from less developed nations of India and Bangladesh as well as from developed countries like Japan. This chapter also highlights the mitigation measures for increased urban resilience. It is now quite evident that the conventional systems of water management are inadequate to address water insecurity and water stress. Transforming urban water systems into more resilient and hence more sustainable systems would require innovative approaches. These approaches have been discussed under two broad categories—the infrastructure-based approaches and the system-based approaches.
1.5 Expected Readership

The book intends to look into water insecurity issues in urban areas while evolving water security index and explore the innovative approaches to water development and management with examples from Asian cities. Covering all aspects of urban drought and water insecurity, this book will be a valuable resource material for students, researchers, academia, policymakers and development practitioners. The main target groups would, however, be the students and researchers working in the fields of sustainable management of water resources and urban water systems, urban planning and disaster management, focused mostly on the less developed countries of Asia. The shared knowledge and experiences that may be gathered from the book will help the various stakeholders including local communities, service providers and policymakers to better understand the complexities of urban drought caused by rapid urbanization, unplanned urban growth and climate change and to evolve policies for sustainable water systems and resilient cities.

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References
