Chapter 1
Towards Global Water Security: A Departure from the Status Quo?

Cecilia Tortajada and Victor Fernandez

Abstract Water resources are, and have always been, a multidimensional resource that crosses all social and economic sectors. Globally, growing population and urbanisation have increased the pressure to meet the water, energy, and food demands of larger populations with higher expectations. As a result, both developed and developing countries seem to be racing against the clock to respond to the needs of societies in which inequalities continue to grow. Water resources are scarcer and more polluted; their management, governance, and development increasingly depend on decisions that are made in other sectors, many times without sufficient coordination; and their availability is more than ever threatened by issues, such as climate variability and change, that impose nothing but uncertainty. These factors have led to water resources being seen through the lenses of risk and security. The security of water resources necessitates a departure from the status quo, to an innovative system that is able to understand and appreciate how different natural, policy, and political variables interact and affect each other. This system requires a wholesome perspective that is able to propose alternatives that consider complexity and that are adaptive to an uncertain future. A departure is necessary because the status quo has proven unable to respond to the present needs and expectations, much less to future ones.

1.1 Introduction

Water security is broadly defined as the availability of an adequate quantity and quality of water to sustain socio-economic development, livelihoods, health, and ecosystems (Grey and Sadoff 2007; United Nations University 2013). Water, as a multidimensional issue, is a prerequisite for human security. Its scarcity has impacts at all levels of society, often exacerbating poverty and holding back socio-economic

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World Water Council (ed.), *Global Water Security*, Water Resources Development and Management, https://doi.org/10.1007/978-981-10-7913-9_1

development. As has been extensively discussed, factors such as population growth, urbanisation, land-use change, changing lifestyles and social expectations, economic activities, and lately climate variability and change and associated extreme events, have far-reaching effects on global human and natural environments (Biswas and Tortajada 2009; van Beek and Arriens 2014; Vörösmarty et al. 2010).

Water use is estimated to have grown sixfold due to global population growth during the twentieth century (Bogardi et al. 2012), putting enormous pressure on available resources. However, not all countries display this trend, for example, the largest world economy. In the United States, total water use declined between 2005 and 2010 in all sectors including public supply, industrial, thermoelectric power, and irrigation. Only mining and aquaculture had larger withdrawals in 2010 than in 2005, but they are comparatively small and did not offset the larger overall reduction from the other uses, calculated at 54 billion gallons per day (US Geological Survey, n.d.).

Poor quality of water is greatly responsible for water insecurity and has large social and economic consequences (World Bank 2007). The most significant sources of water pollution are inadequately treated municipal discharges and inadequately managed and treated industrial and agricultural wastes.

Data and information on water use are essential for a broad understanding of water availability. In most cases, however, data are not available and, when collected, are incomplete and sparse, lacking the temporal and spatial resolution required for an understanding of trends, frequency, timing of shortages, and times of peak use (World Bank 2017).

From the non-traditional point of view, water security has implications at the political and military levels (Zeitoun 2011). From this perspective, water insecurity has resulted in 'explosive conditions' that have even destabilised political regimes (Reed 2017). In the United States, the intelligence community has expressed concern that water problems may contribute to instability in countries important to US national security interests. In general, the risks might include social disruption due to water shortages, greater poverty, social tensions, environmental degradation, and poor governance; depletion of groundwater, which could threaten national and global food markets; and serious negative impacts on important trading partners due to water shortages and pollution (Office of the Director of National Intelligence 2012). Local risks have the potential to escalate to the global level due to scarcity and deterioration of natural resources. This makes it crucial to understand the relation between societies and their political, human, and natural environments (Andrews-Speed et al. 2013; Brauch et al. 2009), as well as the role environment and natural resources play in promoting peace, stability, and human security (Tortajada and Keulertz 2016).

The water outlook differs significantly between OECD and non-OECD countries. Non-OECD countries will experience higher rates of population growth, and dramatic growth in demand for water. On the other hand, in the OECD countries, total water demand is projected to decrease from 1000 km^3 in 2000 to 900 km^3 in

2050. This will be driven by efficiency gains (conservation measures and technological innovations) and a structural shift towards service sectors that are less water-intensive (OECD 2013). In all cases, however, the impacts of water scarcity are most severe for the poorest sectors of society (United Nations 2007) because they face greater exposure to water risks, are more vulnerable, and have more limited access to alternative sources of water and related services (OECD 2013).

1.2 Water Security, Its Dimensions and Risks

Following the sustainability paradigm that proposes equal prioritisation of social, economic, and environmental issues, water security has the same three dimensions: social equity, economic efficiency, and environmental sustainability.

As discussed by van Beek and Arriens (2014), the social dimension is about ensuring equitable access to water services and resources for all sectors of society, through robust policies and legal and regulatory frameworks, as well as governance practices. The economic dimension refers to increasing water productivity and conservation in all sectors. Economic efficiency is essential because increasing water productivity is key to addressing present and future water security. Water productivity could certainly be optimised in both the agriculture and energy sectors, since, at the operational level, water use for energy, and water consumption for irrigation, are largely unquantified. This will require more efficient practices and also closer coordination among local, regional, and national institutions. Without further improvements in water efficiency and productivity, water use for domestic, agricultural, and industrial activities may continue increasing to unsustainable levels in the long-term (United Nations 2007). Last but not least is the environmental dimension: managing water sustainably as part of a green economy.

Addressing water security concerns requires more comprehensive planning, policy and management, technological innovations, and closer collaboration across sectors, communities, and political borders (European Commission 2015; United Nations University 2013; Zeitoun 2011). It also requires mitigating water-related risks, because water is not only vital for humans, but also the economic foundation for millions of businesses, farms, power plants, and manufacturers, which all depend on a supply that is reliable in both quantity and quality (Kane 2017).

Water insecurity as it relates to climate variability and water-related disasters can be addressed by managing risks and reducing vulnerabilities (Asian Development Bank 2016). The objective is to understand how societies can cope with variability by prioritising thresholds of acceptable level of risks both at present and in the future.

As a risk-based approach to water security, the OECD (2013) has proposed a framework that combines technical risk assessments with contextual factors, such as risk perceptions and risk evaluation (Fig. 1.1). The OECD proposes that increasing water security means achieving and maintaining acceptable levels of risk in the following water-related areas: water shortages, inadequate water quality, excess

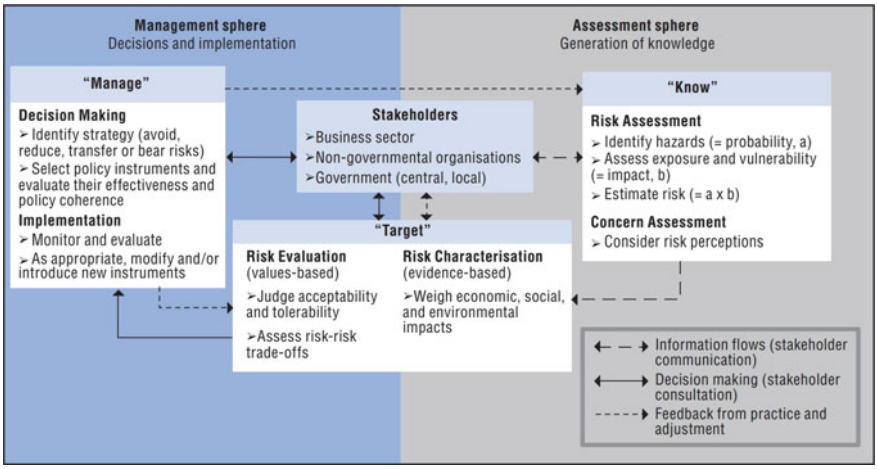

Fig. 1.1 A risk-based framework for water security. *Source* OECD (2013)

water, and weakened resilience of freshwater bodies. Since these risks are interrelated and influence each other, their management should focus on events that have as many positive impacts as possible (OECD 2013). The framework proposes that management of risks, as well as risk evaluations, are in the 'management sphere', which is about decision-making and implementation instruments. On the other hand, risk assessment, characterisation, and concern assessments are in the 'assessment sphere', which is about generation of knowledge.

According to this framework, the first step is *knowing* the risk (labelled 'know' in the diagram)—that is, identifying the main drivers of water-related risks and projecting their long-term trends. Drivers of water risks include policies and institutions, socio-economic trends, water resources (quantity and quality), and natural events. Building an adequate information base to inform decisions about water risks requires scientific risk assessment. It also requires understanding the risk perceptions of the actors who are affected (Grafton et al. 2012; OECD 2013).

The second step, *targeting* the risk ('target' in the diagram), identifies the possible responses and which ones would be the most appropriate. Based on the risk appraisal, evidence, and value-based judgments, this step considers the acceptability of the risk, which can be categorised as acceptable, tolerable, or intolerable. The process is characterised by potential trade-offs, given that the efforts to reduce water risks for a given population, ecosystem or activity may affect each other, or may result in other water risks. The level of acceptability of the water risk for society and the environment should, at least theoretically, depend on the balance between economic, social, and environmental consequences as well as the costs and trade-offs of ameliorating them (OECD 2009, 2013; van Beek and Arriens 2014).

In the third step, *managing* the risk ('manage' in the diagram), decision-making on the appropriate response to water risks and its implementation takes into consideration all the previous steps. The objective of this step is to avoid, reduce,

transfer, or simply accept the risk, by attempting to manage its drivers or by limiting exposure of populations, ecosystems, and activities to negative impacts or making them less vulnerable. In general, a risk-based approach has the potential to develop a more holistic approach to water security, better assessment of policy priorities enabling preventive action, and more informed decision-making (OECD 2013). In all cases, the countries, regions, and basins that are more prepared to manage the different risks and respond to them will be those with the most functional, accountable, and inclusive institutions (Rüttinger et al. 2015).

From the governance viewpoint, one of the most contentious tasks is that of identifying risks as acceptable, tolerable, or intolerable. Here, the so-called traffic light model is often used: green if risks are acceptable, yellow if further management actions are necessary, and red if risks are intolerable (Klinke and Renn 2012). In this model, risks are ranked and prioritised based on their likelihood and their consequences. A risk is acceptable if it is highly unlikely and would have only slight consequences. A tolerable risk is one with occasional serious impacts, for which risk reduction measures are necessary. A risk becomes intolerable when there is a high probability of catastrophic consequences (Fig. 1.2).

Risks can be deemed more or less acceptable from the socio-economic and environmental viewpoints depending on their magnitude, consequences, and cost of amelioration. In Fig. 1.3, the magnitude, consequences, and costs of specific risks are presented on the horizontal axis, and their probability on the vertical axis. Water management is usually effective only when events have acceptable risk, for example, events of moderate impacts with low probability. Larger events with higher probability can have very large, very expensive impacts on water resources, making them very difficult to manage. One of these events is climate change, which could increase water risks to very high levels (OECD 2013).

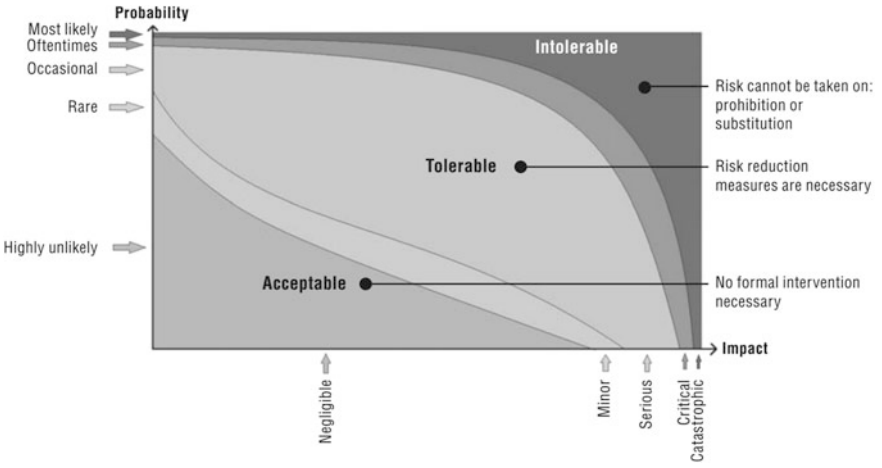

Fig. 1.2 Acceptable, tolerable and intolerable risks. *Source* Klinke and Renn (2012)

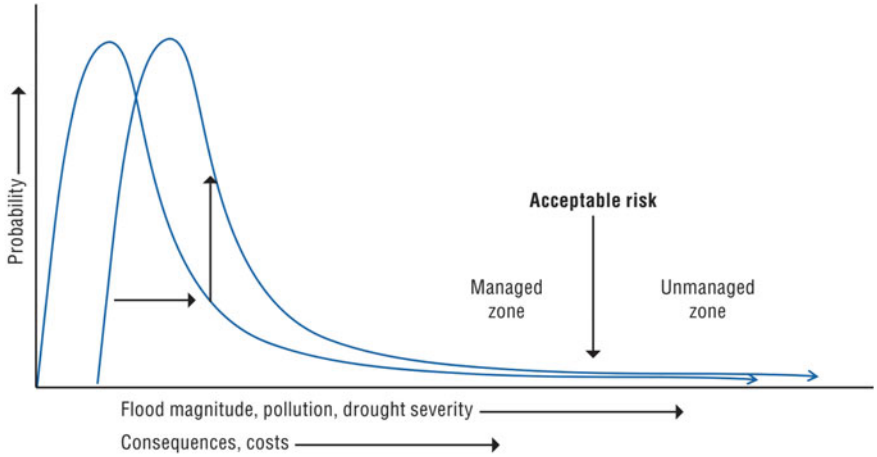

Fig. 1.3 Setting the acceptable level of risks. *Source* Prosser (2012)

1.2.1 Water and Climate-Related Risks

Water management and climate change and variability have numerous interlinkages. These interlinkages, in addition to their numerous hydrologic, economic, social, environmental, and political impacts over time and space, make policy alternatives, management, governance, and development decisions, as well as investment choices on mitigation and adaptation strategies, most challenging under the best of circumstances (Tortajada 2016).

Climate change has increased the complexity of managing water resources (World Bank 2010). It presents numerous challenges to the traditional water management paradigm of stationarity or historical variability for estimating and managing risks (Milly et al. 2008). Since these principles are no longer valid, water resources have to be managed in different ways, and water systems have to be optimised in different ways. As discussed by Milly et al. (2008) and further explained by the World Meteorological Organization (2012), the extent of anthropogenic impacts on the means and extremes of precipitation, evapotranspiration, and rates of river discharge makes it essential to identify new non-stationary probabilistic models of the relevant environmental variables.

Confidence in stationarity in the face of climate change is low in many countries in the developing world, where institutional capacities, legal and regulatory frameworks, and infrastructure development to cope with non-stationarity are historically low (Weaver et al. 2013). Water managers at the basin scale and at the municipal level face numerous difficulties when trying to make decisions that involve climate change risks, even with qualified management and technical capacities (Conway 2013).

Climate variability and change will have and are already having, direct consequences for water security. The majority of the impacts will be on the water cycle, resulting in higher climatic and hydrological variability. More frequent and more intense droughts, floods, and other extreme events are expected (Tortajada 2016; United Nations University 2013). This will vary depending on the location of countries, cities, and basins (United Nations University 2013), but also on the policies, institutions, governance and management practices, investment funds available, and, overall preparedness for change (Tortajada et al. 2017). Even if climate change proves to be neutral in some places, major increases in water scarcity are expected. People in countries that already suffer from water shortages, poor institutional capacities, and inefficient services will face the most difficult situations (United Nations 2007). In the medium and long-term, climate variability and change are very likely to increase the number of people living under water scarcity conditions globally, making them more vulnerable and less secure (World Bank 2015).

1.3 Instruments to Address Water Security

Addressing water security concerns is necessary, mainly due to the extent of the impacts on the social and natural environments. Even if complete water security cannot be achieved, policy instruments should be developed to move towards better water security and better preparedness. These instruments may include institutional reforms, governance and management aspects, market-based instruments, water pricing, capacity building, and information and data sharing (United Nations University 2013; OECD 2013; World Bank 2015). The ever-changing physical, economic, and social conditions, which require continuous adaptation of natural and social systems, make these instruments more relevant (van Beek and Arriens 2014).

According to the Asian Development Bank (2016), strategies have been proposed at the international level for countries, regions, and cities to improve their water security. One example is the 'integrated water resources management' paradigm. The bank submits that one reason this paradigm has been unsuccessful is that individual governments have tried to adopt it without considering that their own stage of development, needs, and capabilities differ from those for which the paradigm was initially proposed. (For in-depth discussion of the practical limitations of this paradigm, see Biswas 2008; Giordano and Shah 2014).

The Asian Development Bank (2016) explains that the water economies are not homogeneous: they are at different evolutionary stages. And the conditions necessary to improve water security regarding financial aspects, institutional reforms, capacity building, water instruments, and management of impacts on ecosystems are different in each stage. In Table 1.1, water economies are indicated by the percentage of users in the formal sector: Stage 1 is completely informal (less than

Table 1.1 Priorities for improving water security in water economies at different stages of evolution

Evolutionary stage	Stage 1: completely informal	Stage 2: largely informal	Stage 3: formalising	Stage 4: highly formal water industry
Users in formal water economy (%)	5–15	15–35	35–75	75–95
Examples	Afghanistan, Bhutan	Bangladesh, Pakistan	People's Republic of China, Indonesia, Thailand	Australia, Republic of Korea
Capacity building	Invest in techno-managerial capacities for creating affordable infrastructure and services	Build capacities for efficient management of water infrastructure and water service provision	Build local capacities for catchment/river basin-level water resources management	High-level techno-managerial capacity for water and energy-efficient water economy
Policy and legal regime	Effective policies for water supply and food security Create a regulatory framework for bulk water users	Establish basic water policies and water laws consistent with local institutions and customary law	Introduce policy and legal regimes for a transition to basin-level water governance	Policy and regulatory frameworks for a modern water industry and transboundary water governance
Investment priority	Establish and improve water infrastructure for consumptive and productive use by entire population, including disadvantaged groups	Invest in infrastructure modernisation for improved service delivery and water use efficiency	Invest in infrastructure for basin-level water allocation and management, including interbasin transfer and managed aquifer recharge	Technologies and infrastructure for improving water and energy efficiency
Managing ecosystem impacts	Create broad-based awareness of aquatic ecosystems Regulate water diversions and pollution by corporate consumers	Proactive management of water quality and ecosystem impacts at project level Invest in low-cost recycling	Focus on water quality and health management Urban wastewater recycling Control of groundwater depletion	Zero or minimal discharges Reduce carbon footprint
Water pricing and subsidies	Minimise perverse subsidies Make subsidies smart Rationing to minimise waste	Volumetric water pricing for bulk users Partial cost recovery for retail consumers Targeted subsidies for the poor	Full financial cost recovery of water services Metered water supply Ninety per cent of population covered by service providers	Full cost recovery of water services, including costs of impacts on ecosystems

Source Asian Development Bank (2016). Adapted from Shah (2016), 'Increasing Water Security: The Key to Implementing the Sustainable Development Goals', TEC Background Paper No. 22, Global Water Partnership Technical Committee, Stockholm

15%); Stage 2 is largely informal (15–35%); Stage 3 is when the sector is formalising (35–75%); and Stage 4 represents a highly formal water industry (over 75%).

Lack of capacity related to water, not only institutionally but financially and technologically, is a major hindrance to achieving water security. Better water security depends on the quantity and quality of water available but also on the institutional and governance capacities to implement plans and policies that have been agreed to. Regarding financial aspects, the mobilisation of domestic capital, such as from banks, capital markets, pension funds and insurance companies, is necessary and requires extensive credit capacity to support utilities, introduce the opportunities to the water sector, and try to remove legal or policy obstacles to mobilise funds (United Nations University 2013; World Bank 2015).

It is known that market-based instruments provide incentives such as water taxes, like abstraction and pollution taxes, and tradable permit systems. They provide incentives for users to improve their practices. It is proposed that the advantage of taxes, compared to regulatory instruments, is that they are often less demanding in terms of the information public authorities require for them to be environmentally effective and economically efficient. Water taxes can also have relatively low administrative costs. Regarding tradable permit systems, 'caps', as well as promotion of direct investment in environmentally beneficial outcomes, contribute to the achievement of water security goals. A caveat is that the transaction costs associated with some trading systems can be very high and affect the net social gains that could be realised from trading. Overall, it should be kept in mind that economic efficiency alone is not sufficient to address water security problems and that environmental and social goals need to remain the main priority (OECD 2013). These goals make governance (or decision-making by multiple actors with numerous and dissimilar interests, and the formal and informal institutions they form) particularly relevant for water security.

From the point of view of governance, countries require institutional and legal frameworks that are prepared to respond when situations are different, with management structures that can be adapted to local, regional, and national contexts, new forms of relationships, and multilayered models capable of integrating the complexity of natural and social dimensions (United Nations University 2013). Closer institutional coordination among sectors that depend on water resources (such as energy and agriculture) will strengthen water policy, management, and development (World Bank 2017).

Good governance is thus proposed as an enabler of water security. Using a water security index (ADB 2013) and a governance index, Makin et al. (2014) argue that countries with good governance have achieved higher levels of water security compared to those countries where water governance is still a limitation (Fig. 1.4). As discussed elsewhere (e.g., Biswas and Tortajada 2016), this supports the argument that water scarcity and insecurity are related more to poor governance than to the physical scarcity of water resources.

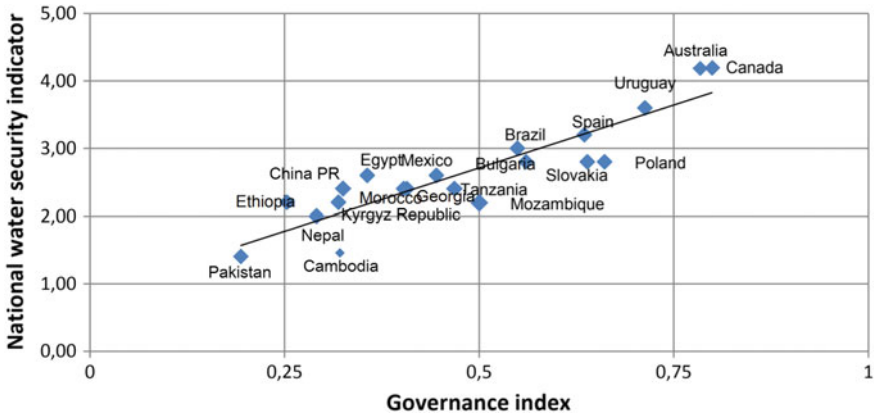

Fig. 1.4 National water security index against governance index. *Source* adapted from Makin et al. (2014)

1.4 Implementation of the Water Security Paradigm

This book includes case studies of countries, regions, and cities with different water security challenges, each in its own socio-economic, political, and environmental contexts. An effort has been made to make these analyses policy-and-practice-oriented so that the lessons learnt are based on actual experiences. The case studies are on Australia, China, Singapore, and Central Asia in the Asia and Pacific region; Morocco and Southern Africa in the African continent; France in Europe; and in the Americas, Brazil, California, and Latin America as a whole.

In the case study on Australia, it is explained that water resource planning is calibrated to scarcity. As Horne (2018) discusses, the microeconomic reform in the 1990s started the contemporary process of strengthening water security in both urban and rural areas. In 2004, the National Water Initiative further emphasised the importance of strengthening water security. The National Water Initiative took place during the Millennium Drought, which lasted from 1997 to 2009 in the south-east of the country. It aimed at improving the governance framework and encouraging change of behaviour (Council of Australian Governments 1994). Shortly after, in 2006, the national government introduced a National Plan for Water Security. It focused on governance reforms in the Murray-Darling Basin, strengthening agriculture sustainability and water markets, and enhancing the quality of information (Howard 2006). At present, even though there has been enormous progress on water security, it remains on the agenda, although with a much lower profile. Large investments in climate science and in upgrading water information systems are an indication of the priority they represent for the country when considering climate change. Horne also mentions that in spite of the overall successful management of water security, there are still two serious concerns: the poor water security in remote and regional communities of the country, such as in

small towns in the state of Tasmania and indigenous settlements in the Northern Territory; and the trade-offs between public benefit and private profit, unresolved issues at the policy level.

The case study on China (Ministry of Water Resources 2018) points out that rapid urbanisation and industrialisation have led to increasingly acute conflicts between water supply and demand. Background contributing factors include limited water resources per capita, uneven distribution of precipitation in time and space, and the intensification of the impacts of global climate change. Also effects are excessive growth of water demand, increased wastewater discharges with no appropriate treatment, inadequate water supply infrastructure, soil erosion, deterioration of water bodies, and shrinkage of rivers, lakes, and wetlands. More than 400 cities suffer water shortage to varying degrees. This has resulted in water security becoming a matter of national interest. Flooding and waterlogging constitute the most hazardous and damaging natural disasters. Approximately two-thirds of the country and more than 90% of the people are exposed to flood threats to different degrees, and losses from floods and waterlogging represent 70% of the aggregated loss caused by all kinds of natural disasters. In response, the government has implemented a national flood control and drought relief command system, which is expected to be a nationwide and multilevel system for monitoring rainfall and water regimes, as well as forecasting floods. Also, to address increasing water demand, the government has implemented the policy of 'three red lines': total control of water use, improvement of water use efficiency, and restriction of water pollution in water functional zones. Looking towards the future, the Chinese government plans to uphold the new development concept of innovation and coordination to improve water security. Implementation of these policies has the objective to improve the conditions of the human and natural environments.

The case study on Singapore points out that historically, the city-state has strongly pursued the objective of being water-secure (Tortajada and Wong 2018). Today, in terms of planning, the aim is to be fully water-secure and self-sufficient by 2060. The country's limitations of having no natural water resources, being dependent on water, energy, and food from outside sources, and having no hinterland, have been overcome with long-term comprehensive planning, sound policies, and innovation in all sectors. The strategies that have ensured that Singapore can successfully meet present and projected requirements have included diversification of water supply sources within and outside the city-state, cleaning-up of rivers and waterways, protection of water catchments, water conservation measures, wastewater treatment and disposal, production of high-grade reclaimed water for potable and non-potable purposes, and desalination (Tortajada et al. 2013). It is expected that by 2060, Singapore's demand for water will double. To cope with this, the government has put in place long-term strategies, including increasing the proportion of the land used for water catchment to 90%, and doubling the production capacities of high-quality reclaimed wastewater (NEWater) and desalination by 2030. The latter two sources are expected to supply up to 85% of Singapore's water requirements by 2060 (Parliament of Singapore 2016). In the future, to augment its water resources and provide clean water to all users and for all

uses, Singapore will have to develop an even more comprehensive strategy focusing much more on water demand, public engagement, and pricing instruments.

Central Asia is the last case study from Asia (Xenarios et al. 2018). The Central Asian countries are among the most water-intensive economies in the world, with mean water withdrawals of 2200 m^3/y per capita and nearly 90% of water diverted for irrigation purposes (Sehring and Diebold 2012). As Xenarios et al. (2018) explain, Tajikistan and Kyrgyzstan, the two upstream countries, are rich in surface water, with 81% of the region's water. Since they are poor in hydrocarbon resources, for them, water security is mainly interpreted as energy independence, reduction of disasters stemming from water, and sufficient water for irrigation and pastoralism. The downstream countries (Uzbekistan, Turkmenistan, and Kazakhstan) have abundant hydrocarbon resources. The first two have 23 and 44%, respectively, of the region's natural gas deposits, while the third is one of the world's top 20 oil producers. But all three of them face severe water scarcity. For them, water security mostly means intensified agriculture, fisheries and pastoralism, and reduction of water scarcity incidents. Despite local frictions, all the Central Asian states have recently agreed to set up regional organisations to adopt water management decisions by consensus. In the last decade, a river basin management approach was gradually introduced in each of the Central Asian countries in an attempt to improve national water use and allocation plans on the principle of the European Union's Water Framework Directive. River basin management plans have gradually been developed in three countries. However, there is still a notable lack of coordination, monitoring, and assessment of these interventions, mainly due to overlaps between too many governmental authorities. As discussed in the chapter, water security is a multidimensional concept that is perceived differently by each country in the region. Looking towards the future, it is expected that the common goal of improving socio-economic development will also result in better water security at the regional level.

In the case of Morocco, Ait Kadi and Ziyad (2018) explain that, despite being endowed with extensive groundwater resources, including 32 deep aquifers and more than 46 shallow ones, the country is enduring a changing climate, with decreasing precipitation and rising frequency of droughts. The risks to water security resulting from these challenges as well as from population growth, increasing urbanisation, and growing water scarcity, have driven the country to implement major policy reforms in its water management system. These have included the adoption of a long-term strategy for integrated water resources management, using the National Water Plan as its framework; the development of a new legal and institutional framework to promote decentralized management and increase stakeholder participation; economic incentives in water allocation decisions through rational tariff and cost recovery; and monitoring and control of water quality to reduce environmental degradation. Other policies implemented that have contributed to securing the supply of water in Morocco include the rapid construction of dams, from 16 in 1967 to 140 by 2016; an extended water transfer system between 13 basins; major infrastructure projects that aim to capture most of the remaining surface runoff by the year 2020; and development of wells and

boreholes for groundwater extraction, which today contributes about one-third of the country's drinking water supply, a percentage that can reach 90% in rural areas. Current threats to water security in Morocco are the decline in available water resources, the increase in frequency of extreme events, the decrease in annual total rainfall, a positive trend in the maximum number of consecutive dry days, and a change in the hydrological regime that is lower average runoff and higher frequency and intensity of flash floods. Current climate change projections also suggest higher frequency and intensity and longer durations of droughts, with substantial impacts on the food, water, energy, and health sectors. Therefore, all policies and management and governance-related instruments continue to be strengthened.

The case study on Southern Africa discusses that the first challenge for water security in the region is economic, and that investments in infrastructure for storage and transmission have the objective to address water resources variability and unequal spatial distribution. As Muller (2018) explains, Southern Africa is a region with an area of 6.6 million km^2 and a population of 155 million. While there are pockets of prosperity, most people in the region live in poverty. In spite of the impact of water scarcity in the several countries in the region, the physical availability of water is not the main impediment to water security. While the situations in the countries vary, in general, the main constraints are financial and institutional, followed by a high level of inequality: people in urban areas are more likely to have access to clean drinking water and sanitation compared to rural areas. Today, water security in Southern Africa derives primarily from the economic capacities of the households, communities, and countries concerned. Improving institutional capacity is the second-most important priority to break Southern Africa's cycle of underdevelopment.

In the case study on France, it is explained that in the French public policy realm, the expression 'water security' is not commonly used (Tardieu 2018). Water security is not perceived as a critical issue, mainly for two reasons. First, France enjoys abundant water resources. Since almost all of the catchment areas of the major French rivers are on its national territory, the country depends little on other countries for water resource availability. Second, the country invested heavily in the governance of water resources in the past, starting in 1964, when the river basin was taken to be the relevant scale for water management, and the focus of water management was shifted to shared governance and dialogue among stakeholders. Despite the abundance of water and the apparently strong water governance, there are still challenges to water management in France. These include adapting to climate change; combating diffuse pollution, in particular agricultural pollution; and urban water supply and sanitation in overseas territories. In the country, the need for security in regard to floods has remained relevant. Floods have caused on average €650–800 million of annual damage over the last 30 years. The State has overall responsibility for preventing and combating flooding through the adoption of a national flood risk management strategy, the coordination of measures to anticipate floods and manage crises, and the gradual establishment of flood risk prevention plans. Nonetheless, local authorities or regroupings of municipalities now have some responsibilities for aquatic environment management and flood protection.

The general abundance of water has not prevented seasonal difficulties and local conflicts, particularly during dry summers. Water conflicts exist due to droughts, and partly due to climate change, which has increased environmental imbalances in south-west France and around Paris. And droughts have had cascading effects, including lower flows and levels in rivers, but also lower groundwater levels. The State has implemented several measures to improve water management during droughts, including promoting water-savings awareness campaigns, the implementation of flow control systems, better monitoring and control of irrigation activities, and even more drastic measures such as water use restrictions.

The case study on Latin America focuses on infrastructure development (Carrera et al. 2018). Latin America is the most urbanised region in the world. The urban population is projected to reach 585 million by 2030. Today, 80% of the population lives in cities, most of which have grown on top of the informal occupation of urban areas with inadequate urban services. Water supply coverage in urban areas has increased from 40% in 1950 to more than 90% in 2010, but the quality of services is still low. In most Latin American countries, water is abundant in less populated areas. For example, in Peru, 70% of the population and 90% of the economic output are located along the Pacific coast, which has only 1% of the country's endowment of water. Furthermore, the seasonal distribution of rainfall is quite uneven during the year. In Mexico, for example, 68% of the rainfall takes place in the four months from June to September, and only 16% in the months from November to April. Urban water management is complex, and it is generally handled in a rather segmented way, separating three distinct and linear components: water, sanitation, and drainage. This is very different from the natural hydrological system, which is closed and circular. Development of water infrastructure in the region has been insufficient to consolidate water security. According to the Development Bank of Latin America, this prospect could change. In 2011, the bank showed that annual investments equivalent to 0.31% of 2010 GDP would suffice to close the gap of water and sewerage services, expand water sources and drainage infrastructure, and treat almost two-thirds of the sewage that is collected. These investments would total USD250 billion over the period 2010–2030. Looking towards the future, even if large investments are made to close the infrastructure gap and achieve universal service, it will not be enough unless countries improve their weak institutions and governance practices and improve the administration and efficiency of water services (Mejia 2012).

The case study on Brazil presents an overview of water security at the national level in general, and São Paolo and Ceará in particular (Souza Filho et al. 2018). Brazil, the largest country in Latin America, is known for having the greatest availability of water on the planet, yet the unequal distribution of water across its territory is also well known. The north holds 65% of Brazilian water, but has only 5% of the population. The north-east has only 4% of the water resources, but 30% of the population. The south, responsible for 60% of the country's output, has 40% of the population but only 6% of the water. The case study explains that water security has become more relevant in Brazil due to the severe droughts that have affected the different regions in the country. Among the different droughts that have

affected the country in recent years, the ones in the states of São Paolo and Ceará have been the most extreme. According to Souza Filho et al. in São Paolo, during the severe 2014–2015 drought, rainfall averages were well below historical records, the outflow rate from the state reservoir system was the lowest in 85 years, and practically the entire flow of surface water was being used. However, the state opted not to implement rationing in light of the possible negative outcomes, including health risks, and having to interrupt the supply of essential services. Instead, it implemented various water conservation measures, among which was reduction of water consumption through a bonus programme. In the aftermath of the crisis, water security has assumed greater importance in the political agenda of the state. As a consequence, technical and operational innovations, and investments in infrastructure, have been carried out. As for Ceará, it has faced multiannual droughts from 2012 onwards. The four years following 2012 were among the 10 driest years since 1950, and probably the most severe in the last 50–100 years. The initiatives implemented by the state government to cope with the drought have included the strategic expansion of water infrastructure, planning and management measures, and emergency actions for water security at specific moments. Thanks to these measures, a large proportion of the impacts have been minimised.

The last case study is on California (Lund and Medellin-Azuara 2018). If California were to be considered as a country, California would be one of the largest economies in the world, with high population and economic growth. The state has managed to successfully guarantee water security to most of its territory, overcoming to some extent the threats of water shortages and floods and being relatively efficient in balancing human, economic, food production, and ecosystem goals. The water management system in California has been in constant evolution. Water resources were initially managed by individual landowners and businesses, and later by local organisations, mainly to address local flood control problems and for the construction of local irrigation infrastructure. More recently, larger agencies were established to address the more challenging scarcity of water resources and the more severe threats of floods and droughts. The globalized nature of the state's economy has contributed considerably to its water security by supporting overall economic prosperity and providing substitute inexpensive food supplies normally and in times of drought. California's mountainous terrain and extensive sedimentary geology provide unusual geologic opportunities for substantial surface water storage, significant hydropower production, and immense aquifer storage. In terms of innovation, one of the state's most featured policies is a portfolio management approach, where a wide range of water supply and demand management options are integrated, along with actions to provide support for the entities involved working together. Actions include improvements in water source availability, conveyance capacities, agricultural and urban water use efficiency, and incentive pricing and markets. The biggest threats to water security in California include possible groundwater overdraft in the San Joaquin Valley, pollution in the groundwater supply of some rural areas, ineffective implementation of ecosystem objectives

(which becomes evident during dry periods), and the perennial threat of floods and water management conflicts in the Sacramento–San Joaquin Delta.

In all the case-study discussions, plans, policies, and management and governance practices have been developed to address water scarcity and thus water insecurity. The common denominator is the concern that the effects of water scarcity on global and local human and natural environments will be such that policies and institutions may not be robust enough to provide appropriate and timely responses; and that this, in turn, will result in economic, social, environmental, and political vulnerabilities that will expose humankind to risks of irreversible change (Carrao et al. 2016; Turner et al. 2013).

1.5 Initiatives and the Burden of the Status Quo

There are numerous local, regional, and global initiatives to address water insecurity. Some of the global ones are the World Economic Forum's Global Water Initiative; the World Bank's A Water-Secure World for All; the Global Water Partnership and OECD's Global Dialogue on Water Security and Sustainable Growth; The WWF's Water and Security Initiative; the Water programme of the Nature Conservancy's Global Solutions; and the Global Human Water Security Fund (Grafton et al. 2017). Each one is making efforts to improve the status of water resources locally, regionally, and globally.

From a more practical point of view, larger transnational companies are embracing and implementing the concept of sustainability, and becoming increasingly efficient in terms of water and energy use, generation of waste, greenhouse gas emissions, etc. Performance varies greatly among them, but the best example of efficiency so far is Unilever. With its Sustainable Living Plan, the company has established a new business model whose objective is to double the company's size but halve its environmental footprint, with concrete targets, by 2020. With its over 600 industrial sites (and its 400 brands used by 2.5 billion people), efficiency measures could have a truly global impact.

In the case of governments, many have not departed from the status quo and are unlikely to do so in the near future. Nevertheless, they are trying to improve water security from the management, governance, and development viewpoints, with the objective to encourage overall development, improve quality of life, and reduce poverty. Global initiatives such as the Millennium Development Goals for 2015, the Sustainable Development Goals for 2030, and those related to climate change and its impacts (with no end in sight) have added targets that have helped countries pursue more sustainable development. One only hopes that governments, private companies, academia, and society are willing and able to depart from the status quo and work towards development that is more sustainable.

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