4. Global water crises and challenges for water security

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1. INTRODUCTION

Without water there is no life; hence, water is at the heart of any form of security – personal, environmental, national, regional, global – whether openly acknowledged or assumed. Human settlement patterns have historically optimized access to water. Hunter-gatherer communities moved with the animals who moved with the rains. Pastoralist communities pushed their livestock around in a similar pattern. With the invention of large-scale agriculture, and the rise of settled societies, easy access to surface and shallow groundwater became the priority. Ingenuity altered humanity's relationship with the natural world, initiating water resources engineering at a variety of scales and levels of complexity. Whereas in the past, human societies developed within boundaries set by their physical environment, today we continue to bend and shape nature to our will. The result, of course, is a wide variety of human-initiated problems, from climate change to deforestation and land degradation; from species loss to polluted oceans and waterways; and from falling water tables to human-induced and/or exacerbated extreme events such as drought and flood. These are only the most obvious examples, for there are many more.

The so-called "world water crisis" is actually a set of many crises born of human practice. To be sure, there are common characteristics across the globe: mega-cities struggling with inadequate supplies of freshwater while badly polluting that which they have; declining water tables resulting from increased competition among closely clustered stakeholders (farmers, urban dwellers, mines) for the resource they all must have; increased numbers and frequencies of climate change-induced extreme events wreaking havoc on the built environment and farm yields (Braga et al. 2014). The popular press is replete with headlines regarding looming water scarcity.

Recently there has been an intellectual and policy-related turn toward "nexus" thinking, i.e. that human communities are dependent for their survival and success on access not only to water, but to sustainable sources of energy and adequate amounts of food. Water, energy and food are tightly drawn together such that decisions regarding behaviour toward one resource directly affect each of the other two. According to the World Economic Forum (WEF) (2011), water is the gossamer strand that holds it all together. Achieving human security, therefore, is a function of getting resource access, use and planning across the Water–Energy–Food Nexus (WEF Nexus) right. Put differently, to achieve water security is to facilitate both energy and food security. Climate change is having a direct impact on local, regional and global water cycles, making WEF Nexus planning and action all the more important.

In this chapter, the focus is on water security. Following on from the WEF (2011), continued mismanagement and poor governance of water resources will ensure abiding issues with food and energy security, as well as undermine any attempts at effective climate change mitigation

and adaptation actions. To reiterate, water is key to all forms of security. The chapter proceeds as follows. Section 2 provides a short discussion of security as a concept and water's place therein. Section 3 centres on water security as a concept. Section 4 presents a variety of water security challenges and responses, with responses drawn from around the world. Section 5 discusses ways forward for dealing with the world's numerous water crises and achieving water security, and Section 6 presents the conclusion. As will be shown in this chapter, defining water security is a relatively straightforward exercise; however, achieving water security is considerably more difficult. What the chapter argues in support of is a more nuanced understanding of the underlying dynamics of water insecurity. Simplistic approaches are almost certain to fail, or provide security for only a privileged few while ensuring water–energy–food insecurity for the many.

2.   SECURITY

What is "security"? The *Oxford English Dictionary* defines "security" (as a noun) as 'the state of being free from danger or threat'. To be "secure" (adjective) is defined as 'certain to remain safe and unthreatened' or 'protected against attack or other criminal activity'. Lastly, as a verb, "to secure" means 'to protect against threats; make safe'.[1] In many ways, this is obvious, or common knowledge. But, what is it that makes us secure; and secure from what?

Often, it is easier to know that you are "secure" by defining or recognizing its opposite – "insecurity". When shown a photo of a person walking down the street, we will feel that that person is secure depending on a number of contextual things: Is it daytime or night time? Is the street clean and the neighbourhood well-kept? Is it a quiet street or one bustling with people and traffic? Is that person walking alone or accompanied by one or more persons? Are there other people walking toward or near that person? As you can see, one's perspective of "security" depends on a wide variety of contextual factors. So, if we say that it is a young woman walking alone at night on a poorly lit street, we perhaps feel that she is insecure – irrespective of the sort of neighbourhood through which she is walking. "Good" neighbourhood or "bad", a woman walking alone at night is perceived as being "more vulnerable" than a man in the same situation. But why is this?

We must then reflect on the nature of threats and of vulnerabilities. What threatens us: as individuals, groups, entire societies and nations? Are these particular threats the result of us being vulnerable in one way or another? If we lessen our vulnerability, does that weaken the threat? For example, people whose diet is poor are generally more vulnerable to disease than people whose diets are good. So, even if the threat is equal – say water-borne disease – a person with a poor diet might suffer chronic illness or even die while a person with a good diet will usually recover. Improving the water source will lessen the threat and therefore benefit both groups of people, but people with poor diets will remain more vulnerable than those with good diets. It is obvious, but bears repeating, that poverty increases both threats and vulnerabilities: as illustrated clearly by the coronavirus pandemic, having access to appropriate health care services, for example, and to a wider variety of treatment options, makes rich people less vulnerable to diseases that too often kill the poor (Green 2020). The long-term solution, then, is to lessen both threats and vulnerabilities.

When we look at security in this way – as the lessening of both threats and vulnerabilities – we see its interrelationship with development. "Development", according to the *Cambridge*

Dictionary, may be defined as 'the process in which someone or something grows or changes and becomes more advanced'; for example, 'a development project (= one to help improve industry) in Pakistan'.[2] According to Currie-Alder et al. (2014), in relation to human communities, 'development can be defined as simply how societies change over time' (p. 13). Implied in the term "development", particularly as it relates to humans and human societies, is improvement over time. In other words, becoming more secure, less threatened and less vulnerable.

Lessening the threat means the capacity to act on the thing external to us which constitutes "the threat". Lessening vulnerability means the capacity to act on the thing internal to us that makes us particularly vulnerable to the external factor. Let us take the case of two earthquakes: one in Haiti and one in New Zealand. The earthquakes both occurred in 2010 and both registered 7.1 on the Richter scale. A 2010 article in the *New Zealand Herald* (Tiffen 2010) showed that while the two earthquakes occurred at relatively shallow depths near large population centres (Port-au-Prince in Haiti, Christchurch in New Zealand), the similarities end there. While several hundred thousand people lost their lives in and around Port-au-Prince, no one died as a direct consequence of the Christchurch event. Why? Because while the two cities were equally threatened, they were unequally vulnerable: from building codes to disaster preparedness, from emergency response capacity to the ability to "build back better" after learning the lessons of past incidents, New Zealand's adaptive capacity to such an extreme event dwarfed that of Haiti.

As with Christchurch in relation to Port-au-Prince, so with different socio-economic status groups in Port-au-Prince: not all people are equally vulnerable even within a shared space. In the words of Neil Middleton (1998), 'poverty kills', and it kills within and across all human communities. It is for this reason that international development has come to focus on poverty alleviation, through a wide variety of agendas set by actors at different levels in society, from the local to the global, with the most well-known being the Sustainable Development (SDGs) and Millennium Development Goals (MDGs).[3] The assumption here is that development will enhance security. So, the MDGs focused on a set of eight broad categories for attention, arguing that achieving 'universal primary education' (MDG 2) or 'gender equality and women's empowerment' (MDG 3) are developments that will enhance not only the short-term security of individuals, but the long-term security of everyone. The SDGs are a set of 17 goals whose primary difference with the MDGs is that global North problems of over-development and over-consumption are as central as are the classical development challenges related to the global South.

While the MDGs and SDGs are a set of global goals, the agents held responsible for their realization are in the first instance sovereign states. In striving to achieve these global goals, states are meant to work with each other (called "multilateralism"), with members of "civil society" and elements of the "private sector" (in alliances often labelled PPP – public–private partnerships). This raises three important questions: First, who, exactly, is responsible for our security? Second, how will that security be achieved? Third, who are "we" – a collection of individuals, citizens of a particular state, members of a global community? The answer to these questions depends in part on the nature of the threat: Is the threat common to all or specific to some or to one individual? Is the vulnerability innate (e.g. due to the location of a population living in a floodplain; or due to immune-deficiencies of an individual in relation to peanuts or bee-stings) or constructed (e.g. due to particular choices made by individuals or groups regarding where or how to live)?

Once we start to itemize threats and vulnerabilities, there seems to be no end to the list. But itemize we must, for if we are to be made secure, we must be able to articulate the nature of the threat, our particular vulnerability to it and to other threats like it, in order to craft an adequate response to it so that we may live "free from danger or threat".

It was John Donne (1623) who famously remarked that 'No man is an island, entire of itself'. In relation to questions of security, it is important to think of this in terms of linkages, relationships, interdependencies, shared threats and mutual vulnerabilities. While we may take personal steps in order to enhance our security, it is clear that there are some threats we cannot face alone, no matter how much we try to reduce our individual vulnerability. It is also clear that we exist within the context of a wide variety of social relationships, if only by sharing proximate physical space such as a neighbourhood. We are therefore interdependent: our personal actions impact not only our own lives but the lives of others, and the more concentrated we are in the space we inhabit, the more we come to share threats (e.g. of industrial pollution, waste production) and suffer mutual vulnerabilities (e.g. a shared water supply that becomes tainted will affect us all). As we have globalized over the last several decades, the scale of these linkages, relationships and so on transcends both the local and national: it is in the interests of Canadian consumers to ensure proper food processing not only in Canada, but in Peru, Mexico and China, among other places. Thus, *our security and development* depends upon *their security and development* and vice versa. In this way, then, the "island" mentality fostered by the conception and application of "sovereignty" is being challenged by the reality of "one world", of global-scale threats and vulnerabilities that now require us to think differently about what security, how and for who?

We have now entered the territory of the "security debate", whereby the "traditionalists" focus on "national security". To quote Barry Buzan (1991, p. 19), 'Security is primarily about the fate of human collectivities, and only secondarily about the personal security of individual human beings. In the contemporary international system, the standard unit of security is thus the sovereign territorial state.' And, according to traditionalists, 'In the case of security, the discussion is about the pursuit of freedom from threat. When this discussion is in the context of the international system, security is about the ability of states and societies to maintain their independent identity and their functional integrity' (Buzan 1991, pp. 18–19).

But for many others, the state is the primary source of insecurity, threatening citizens who are made more vulnerable by a system which abides by the generally held rule that intervention by one state in the affairs of another is illegal. We are thus caught in a sort of "sovereignty trap", where, because of historical convention and the numerous structures we have created over time, we must organize our approach to collective security through the state which, in many parts of the world, serves the interests of an elite or particular ethnic or social group which thereby threatens the lives of other, often subordinate groups who may in fact constitute the majority of "citizens" in that state (Agnew 2005; Caporaso 2000).

Think of recent events in Syria, for example, or historical events such as the genocides in Rwanda in 1994 and in Germany during the Second World War. Given that these events are separated by almost 70 years, there are strong criticisms to be levelled at a system which permits such atrocities in the name of "system stability". According to the World Health Organization, more than 2 million people, the majority being children under 5 years of age, die each year from a waterborne disease.[4] Is this not an atrocity? Yet, while their citizens die, those in control of states are more worried that their counterpart in another state will attempt to take "their water". Scholars such as J. Ann Tickner (1992), focusing on gender, and Simon

Dalby (2002), focusing on environmental change, argue that if we only focus on "state security" then we end up following the narrow pathways carved out by the militaries before us. In using a different lens – e.g. gender or environment – we are able to see not only a different set of threats and vulnerabilities, but to also piece together a picture of causality obscured by the broad brush of "national security": so, in some instances the state may be the source of "national security" (meaning keeping the state safe from invasion by other states) but also, and simultaneously, of "citizen insecurity" (meaning oppressing civil society in the name of "stability" and sometimes using the argument of "protecting our women" as the basis not only for action, but as the basis to deny freedoms to women readily available to men).

Following on from "the different lenses" approach to seeing and understanding security and insecurity, many people now argue for a redefinition of security which privileges *people* as the primary referent object of security, *not states*. This is known as a "human security" approach (Hampson and Penney 2008). First articulated by the UNDP in 1994, proponents of human security argue that freedom from fear and freedom from want are ineluctably linked. The traditional security agenda has focused on freedom from fear: states provide militaries to secure against external invasion and police forces/criminal justice systems to ensure compliance with the rule of law. At the same time, freedom from want has traditionally been associated with the field of development and it has been parcelled out to states to organize on their own, with international development constituting the terrain of inter-state and inter-organization cooperation for mutually agreed-to ends. At every turn, one bumps into the contradictions of sovereignty, with "land-grabbing" being perhaps the best current example of this (Borras and Franco 2011). State governments, in the name of "economic development", have entered into agreements with private sector actors and other states to transfer communally held, low-production lands essential to rural livelihoods over to agri-business enterprises interested in producing either biofuels for a global market, or food crops for an international market, or both. If the state derives significant revenue from these activities and then uses that money to enhance urban services for millions of city-dwellers, then the argument can be made that the trade-off is necessary if not fair. If the state uses this revenue to enhance the wealth of the elite, while ignoring the rest of the citizens, then it is neither necessary nor fair. But what to do about it?

Kenneth Waltz (1979, p. 137) once said, 'the death rate of states is very low', and it remains low despite all of the changes in the world after the end of the Cold War. And while many states are "rogue" or "failed" or "failing", in terms of their capacity to deliver in relation to their constitutionally pronounced ideals, as one member of the US State Department once said to me, 'there is no way around the state'. In theory, states provide order through the rule of law. Citizens, also in theory, abide by these rules in return for freedom from fear and freedom from want. Where performance of the state and/or compliance of the citizenry is lacking, we must ask why this is so.

Buzan (1991) argues that national security concerns fall within five broad categories of threat and response: military, economic, political, environmental and social. Put simply: states may be challenged by (i) other states and armed groups in the world system; (ii) complex pressures of economic growth and globalization; (iii) direct challenges to the government by other groups within the state, sometimes supported by foreign powers; (iv) natural resource scarcities, environmental degradation, natural disasters and climate change; and (v) social breakdown due to, for example, ethnic or sectarian violence, which may or may not be fomented by external actors, forces and factors. The goal for Buzan, in every case, is preservation of the state. And to this end, all states have developed a wide array of tools to ensure survival.

Oftentimes, these tools are turned to problematic ends, involving, in the main, preservation of existing ruling elites. The Human Development Index (HDI) was developed by the UNDP (1994) as one means of tracking state performance. The argument was that "development" was more than economic growth. It was equally important to know that revenue was being spent to the benefit of all citizens. How to track this? Through proxy measures of education and health. If everyone was educated and healthy, then human development was being achieved. And if these goals were being attained where capital accumulation was actually limited (as in Cuba or Sri Lanka), then it suggested that the compact regarding rights and responsibilities between the state and civil society was being observed.

In 1994, the UNDP's Human Development Report articulated the concept of "human security". 'In the final analysis, human security is a child who did not die, a disease that did not spread, a job that was not cut, an ethnic tension that did not explode in violence, a dissident who was not silenced. Human security is not a concern with weapons – it is a concern with human life and dignity' (UNDP 1994, p. 22). The architects of the human security concept argued that 'the concept of security must thus change urgently in two basic ways: from an exclusive stress on territorial security to a much greater stress on people's security; from security through armaments to security through sustainable human development' (UNDP 1994, p. 24). The authors then went on to identify a list of threats to human security 'that is long but most can be considered under seven categories' (ibid.):

● Economic security
● Food security
● Health security
● Environmental security
● Personal security
● Community security
● Political security.

And while this list is not that different from Buzan's list highlighted earlier, the fundamental difference is that the primary referent object of security here is the individual, not the state.

In a world divided up on the basis of sovereign territorial states, shifting the lens toward individuals asks us all to consider the other as the self: in human security terms, there can be no outside; we are all part of the same human community and should pursue the linked agendas of freedom from fear and freedom from want on that basis.

Am I being naïve? Perhaps. As I said earlier, law is bound up with sovereignty, so there is no getting around the state. We need the state. We need better states. Indeed, I would argue that an important part of the human security agenda is to improve state performance. But if we are to construct a world based on human dignity, we must get beyond the narrow lens of "the national" and ask more nuanced questions regarding why some people are perpetually insecure – even in the richest states – and why others seem as safe as can be – even in the poorest and most unstable of states.

Water in Security

This long discussion of security, in my view, is necessary for us to understand how different discourses of security shape approaches to achieving security and, in theorizing security, set out a particular ontology (e.g. sovereign states or humans or genders or environment) wherein

water is articulated as a component part of the security challenge. As suggested above, in traditional approaches to achieving national security, the referent object (that which is to be secured) is the sovereign state. Water features in this discourse in several ways, both in terms of being a threat and a vulnerability. In terms of threat, water creates hazards for large concentrations of people, particularly at coastlines, in terms of its role in extreme events such as floods and hurricanes. The climate change and security narrative aims to mobilize states and other levels of political authority, e.g. cities, toward effective climate action using this framing. Too much water is depicted as a threat to lives, infrastructure and finances. In terms of vulnerability, water's centrality to all aspects of human life, especially to economic productivity, makes the state vulnerable not only to the occasional occurrence of too much water, but especially to the occasional occurrence of too little water. Climate change models endeavour to predict how local and global water circulation will be impacted by increasing temperatures and what this will mean for people, states, infrastructure and economies (Bates et al. 2008). For example, IPCC Working Group II states:

> Climate change affects the function and operation of existing water infrastructure – including hydropower, structural flood defences, draining and irrigation systems – as well as water management practices. Adverse effects of climate change on freshwater systems aggravate the impacts of other stresses, such as population growth, changing economic activity, land-use change and urbanisation (*very high confidence*). Globally, water demand will grow in the coming decades, primarily due to population growth and increasing affluence; regionally, large changes in irrigation water demand as a result of climate change are expected (*high confidence*). (Bates et al. 2008, p. 4)

Conceptualizing water in security is everywhere impacted by the fact of sovereign states. The state arrogates to itself the right to use its water resources however it sees fit. The preamble to all international agreements contains this rider, irrespective of the content of the agreement and how water is conceptualized therein. Almost all data regarding water is presented in terms of state endowments, with the most well known being freshwater availability and freshwater stress maps from the Food and Agricultural Organization (FAO), the United Nations Environment Program (UNEP) and various partners. Most recently, the World Resources Institute (WRI) released a report on the 17 most water-stressed countries in the world.[5] Granted, there are many other mappings and articulations of water as it flows through the planet such as those provided by the USA's NASA,[6] and the very useful and user friendly 'watershed reports' from the World Wildlife Fund (WWF)[7] but almost all of these present options for policy-making with an emphasis on states and other levels of national (and regional, e.g. European Union (EU), Southern African Development Community (SADC)) government. Aggregated data from the UNDP[8] and the World Bank[9] are presented in terms of water for states. Hence we are presented with a security paradox: water is a system in constant flux that flows and cycles through space and time (Savenije 2002); every living thing requires water for its survival; however, management and governance of this resource is parcelled out to political entities, each of which is tasked with making decisions regarding resource access, use and management in its own interests. Thus, the logical and rational way to ensure security for humans and nature would be to collectively manage a resource which no one can live without; yet, the logical and rational way of ensuring state security is to capture the resource in support of state power.

    As discussed above, human security attempted to shift the focus away from the sovereign state toward humanity, in effect erasing political boundaries by changing the referent object

of security. Water in human security reveals the difficult truth that abiding inequalities (and insecurities) are reflected in access to water, leading Kornfeld (2010) to quote former South African President Thabo Mbeki who suggested that concerted action is necessary to overcome a 'global water apartheid'. In its 2006 Human Development Report, the UNDP (2006, pp. 41–54) highlighted 'the human development costs of the [global water] crisis', arguing that access to clean water and improved sanitation had a direct impact on reducing income poverty and child mortality, breaking lifecycle disadvantages, holding down wider health costs, improving girls' education, freeing girls' and women's time; and ensuring a sense of human dignity.

The talking points are well known, in particular the oft-quoted facts that seven out of ten people used a safely managed drinking water service in 2017 and only four out of every ten people used a safely managed sanitation service in the same year.[10] Such facts have led the United Nations, through SDG 6 – safe water and sanitation for all – to set out ambitious targets for successfully addressing this water insecurity challenge.[11]

Beyond access to adequate amounts of good quality water for domestic purposes, the vast majority of water consumed by humans is contained in food. Falkenmark and Rockstrom (2004) estimate that roughly 40% of our food comes via irrigated agriculture, i.e. it is grown with freshwater withdrawn from surface and groundwater sources. The rest of the food we consume is produced by rainfed agriculture, i.e. from crops wholly dependent upon adequate amounts of rainfall. Given that more than 50% of humanity resides in urban areas, access to water for food creates tension between rural and urban dwellers. On the one hand, those in urban areas want adequate amounts of food at an affordable price (i.e. food security). On the other hand, rural farmers need to be paid enough for their crops to make farming worthwhile (i.e. livelihood security). Economies of scale have led to the rapid decline in the number of farms and farmers in the high consumption, so-called "developed" world and recent trends suggest the same is happening across the low-consumption global South. Perceived state vulnerabilities to climate change have led wealthy states to engage in a land grab across much of the global South, in particular Asia and Africa. Worried about changing water cycles, countries such as Korea, China, India and Japan have facilitated state-owned enterprises and private sector actors in their efforts to acquire arable land in poorer countries. Governments across the global South are eager to participate as *rentiers* leasing out land in exchange for much needed revenue but in doing so contribute to increasing livelihood insecurity among millions of smallholder farmers and their families. So, enhanced state security (through revenue generation) and urban security (through reliable supplies of foodstuffs) is likely to come at the cost of enhanced rural insecurity (through the loss of land and access to state support).

3.   WATER SECURITY

At this point in the chapter it should be clear that water is an integral element in security. Given its necessity and ubiquity in human life and endeavour, the highly disintegrated nature of human social groups (divided across race, class, nation, gender), and the extremely varied uses to which water is put, in highly uneven amounts, there is no easy agreement regarding the uses to which water should best be put in order to ensure state, human, regional or environmental security. This complexity notwithstanding, numerous actors involved in water

resource governance and management have attempted to shape the discourse by focusing on water security itself.

Like most concepts, "water security" has been defined in numerous ways (Zeitoun et al. 2016). Global Water Partnership (2000, p. 1) offered the following definition: '[W]ater security at any level from the household to the global means that every person has access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced.'

The most cited definition is that from Grey and Sadoff (2007, p. 509): '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.'

Grey et al. (2013) amended this to simply state that water security equates to 'a tolerable level of water-related risk to society' (p. 4). In their paper, they describe this definition as 'science-based' which they say is complementary to the GWP definition which is 'policy-useful'. To elaborate somewhat:

> The concept of tolerable risk is an important idea in risk science, referring to a level of risk that is 'as low as reasonably practicable', describing the zone between unacceptable and acceptable that is both context and values dependent. Water-related risk includes risks of water-related events and risks to water services – examples of the 'external' risks and the 'manufactured' risks described in the work of Beck and Giddens … Society encompasses the individual, family, farm, firm, city, nation, region and planet; capturing all scales, needs and values (such as culture and ecosystems). (Grey et al. 2013, p. 4)

The authors go further to contrast 'the world's poor people' from 'wealthy societies', and set up an investment-relative-to-hydrological-complexity typology of states and regions, where, for example, Eastern North America and Northern Europe are described as 'water secure', having higher investment in information, institutions and infrastructure while enjoying lower 'hydrological complexity'. In contrast, Southern China, South- and South East Asia and sub-Saharan Africa are described as water insecure, caught in a low-level equilibrium trap (with lower investment in information, institutions and infrastructure) while suffering higher hydrological complexity (Grey et al. 2013).

Norman et al. (2010, p. ii) define water security as 'sustainable access, on a watershed basis, to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health'. Lastly, Van Hofwegen (2007, p. 1) states: 'Water security is the perception of having the possibility of being provided under varying circumstances with the needed quantity and quality of water and of being protected against the adverse and destructive effects water may bring.'

Each of these definitions places emphasis on humans (i.e. "every person" or "people") and/or human collectivities (i.e. "household" or "society") as the primary referent object(s) of security, meaning that "securing water" is really about governing and managing water in a way that ensures the health and well-being of people and ecosystems (Falkenmark and Rockstrom 2004), where ecosystem health is filtered through a largely anthropocentric lens. While some individuals and organizations support more ecocentric approaches to environmental security, arguing for example that nature has intrinsic value, the implication nevertheless is that a healthy biosphere is a necessary foundation for human security.

It is interesting to note that only Norman et al. (2010) specify a geographic unit, that is, a watershed, as the foundation for enabling water security. At the same time, none of the definitions mentions the sovereign state as the spatial basis for water security. However, when

interrogating the ways and means of achieving water security, established political authorities are either directly discussed (Grey et al. 2013) or implied. For instance, Van Hofwegen (2007, p. 1) continues:

> Providing water security comes at a financial, environmental and social cost. The level of security planned will be decided by government, resource and utility managers ideally with the participation of the users. This will be based on the resource availability and characteristics, the needs, the infrastructure available or foreseen, the costs, the accepted level of risk and the price users and government have to pay.

Benchmarking "Water Security"

Irrespective of the primary referent object of security – people, states, water itself – in order to ensure "security" one needs to establish benchmarks against which conditions and performance may be measured. Some of the relevant categories are highlighted in the definitions above, for example "tolerable risk to society", "enough", "affordable", "needed quantity and quality". Importantly, Van Hofwegen suggests that security is partly a perception as opposed to a fixed or empirically demonstrable condition. Similarly, "tolerability of risk" is related to what (a majority of) society believes is, or perceives as being, "enough" water of "acceptable quantity and quality". Norman et al. (2010) provide an extensive list of measures related to water security. Most of these are set at the country and/or region scale: for example, Falkenmark et al.'s (1989) water stress indicator; Gleick's (1990, 1996) vulnerability of water systems (watershed scale) and basic human needs index (country scale); or the OECD's (2001) index of water scarcity, to name a few of the more well-known measures.

Let us take, for example, Falkenmark et al.'s (1989) 'water crowding indicator' and its revised version (Falkenmark and Rockstrom 2004). The indicator in its original form divided annual freshwater availability (i.e. measurable, flowing surface and accessible groundwater) by the number of people in a sovereign state. The early rendering described 'flow units', that is, one million cubic metres per annum. Using a benchmark of 1700 m3/cap/annum as individual 'water security', the scarcity index then argued that where there were less than 600 people per flow unit, a country was water secure; from 600–1000 a country experienced water stress; from 1000–2000 a country suffered chronic water scarcity; and beyond 2000 people per flow unit, a country suffered absolute water scarcity. Falkenmark and Rockstrom (2004, p. 91) equated the original crowding indicator with per capita water accessibility as follows:

- \>600 persons per flow unit = <1700 m3 = water stress
- \>1000 persons per flow unit = <1000 m3 = chronic water scarcity
- \>2000 persons per flow unit = <500 m3 = beyond the water barrier.

In their 2004 study, Falkenmark and Rockstrom grouped the water crowding indicator with a technical water scarcity measure and described the two together as a refined measure of blue water scarcity. Blue water is defined as readily accessible surface and groundwater. Technical water stress is defined in the following way:

- <10% blue water withdrawn = low water stress
- 10–20% blue water withdrawn = medium low water stress
- 20–40% blue water withdrawn = medium high water stress
- \>40% blue water withdrawn = high water stress.

Their argument is that as increasing amounts of annual renewable freshwater as well as various forms of groundwater are utilized, eventually a state will reach financial and/or technical and/or physical water barriers beyond which they will have difficulty accessing any more water.

In addition, they developed a green water (meaning water that is directly absorbed from the soil – i.e. soil moisture – and then transpired by the plant or evaporated back to the atmosphere) scarcity indicator measured via an 'aridity index' which calculates evaporative demand at different scales (but is presented in their study as an average at both country and region level). By way of illustration, a country located in the tropics, while receiving an amount of rainfall equal to that received in a country in a temperate zone, will have less water available due to the high evaporative demand of a year-round hot climate. Taken together, the three measures give a good indication of existing water resource endowments, so presenting a benchmark against which to assess current and future water security.

There are persistent shortcomings to this revised measure, as well as important innovations. One of the problems with aggregate data at the country level is that it masks actually existing forms of use and the inequalities therein. As anyone knows, even in arid countries such as Yemen or in drought-ridden cities such as Cape Town, Sao Paulo and Chennai, and states such as California, a significant percentage of the population has more than enough water for their household, industrial and agricultural needs. A second problem with the water crowding indicator is in measuring individual need (i.e. 1700 m3/cap/annum) relative to freshwater availability. Elsewhere (Swatuk 2018) I have discussed this problem in relation to Southern Africa. In short, if an average of 60% of our food derives from rainfed agriculture (i.e. green water), then 60% of individual annual need is not subject to blue water availability. If a country, such as Botswana, has more than 3000 people per flow unit, one would expect widespread social unrest, yet there is none. There are three ways to explain the absence of conflict despite what the benchmark suggests would be the case. First is the fact that people get the majority of their food from rainfed farming: water that does not appear in flow measures such as annual freshwater availability. Second, a large percentage of people's staple foods are imported (in Botswana's case, from South Africa), so the water contained in their diet comes from elsewhere on the planet. Allan (2002) long ago argued that the Middle East must wake up to the fact that all countries in the region live beyond their natural water barriers and that there is no civil unrest tied to water only because of the widespread availability of imported affordable staple foods. Third, diets that are low in red meat have a significantly lower water footprint, so a rich society such as Japan, with a historically high fish-based diet, has about one-third the water footprint as does the United States of America.

Water experts are well aware of the limitations associated with these measures of water (in)security and have worked to improve them. So, aridity indexes now benefit from Earth observation technologies capable of measuring soil moisture, i.e. green water available to plants. Falkenmark and Rockstrom (2004), themselves argue in support of a green water revolution. The greatest challenges to food security are to be found in the savannah zones, home to hundreds of millions of people, where rainfall is seasonal, often erratic, and subject to high evaporative demand. The important innovation in support of water security here is the idea that making more of the water "where the rainfall hits the soil", in support of not only food production but ecosystem health, may be a more cost effective, ecologically sustainable, and socially acceptable way to ensure water (for/in food) security as opposed to large-scale water transfer projects.

While Falkenmark and Rockstrom (2004) help us see that arid and semi-arid environments have enough water if well managed, policymakers seem wedded to the notion of scarcity as described by the water crowding index, and continue to pursue policies, programmes and projects designed to control nature – what Conca (2006) described as damming, diverting and draining natural watercourses.

4.   CHALLENGES TO WATER SECURITY

Water is a paradoxical resource. It is simultaneously scarce (in time and space) while ever-renewable and abundant. It cycles globally but manifests differently and is accessed, used and managed locally. It is needed by all living things, but in vastly different quantities, depending on the particular use to which it is put: from non-consumptive spiritual, health, sport and leisure related "uses" to vast quantities of consumption in agricultural production, mining, fracking and so on. The impacts of use vary dramatically, so much so that a safe supply for cities and industries may become a dire threat to the same groups of people through the introduction of toxins, bacteria and so on. Because water is fugitive, actions by people upstream directly affect people downstream. In the context of political boundaries (both intra-state and inter-state), the potential for conflicts seems acute. The challenges for achieving water security, therefore, are complex and myriad. In addition to the need for data, indicators and measures against which to judge performance, Van Hofwegen (2007) shows that water security is dependent upon an accurate understanding of (i) stakeholder needs; (ii) actors and their interests; (iii) the resource base itself (land and water); (iv) existing and planned infrastructure; and (v) the need to contemplate and plan for "outside issues" such as climate change, incentives and markets for crops and commodities, technical innovation and so on. In this section, I highlight a representative sample of challenges to water security.

The Past and the Future

In a recent paper, I describe water use through time and space (Swatuk 2019), drawing on the insights of, for example, Solomon (2010), Conca (2006), Allan (2003) and Wittfogel (1957). What these studies show, among other things, is the way in which powerful actors have deployed capital and technology to, paraphrasing Conca, 'push rivers around'. Historical practices continue to inspire and influence contemporary policies, particularly with regard to large-scale multi-purpose infrastructure projects (World Commission on Dams 2000). A significant debate exists with regard to the appropriate approach to achieving water security (Zeitoun et al. 2016). Grey et al. (2013) argue that ensuring efficient water-related services for nine billion people and managing water-related threats to society is a 'trillion dollar water security policy challenge' (p. 7). They argue in favour of improved science and knowledge generation and mobilization, citing positive examples initiated by Jay Famiglietti through National Geographic and the International Institute for Applied Systems Analysis. While I am supportive of this argument to a certain degree, it is worth considering that science and knowledge generation are not unbiased. Put differently, the uses to which capital and technology are put are determined by those with the capacity to act in service of their own interests. While there is ample evidence to show that big dams are not a one-off solution to water scarcity (and therefore achieving human and/or state security), particularly in an era of climate change,

nevertheless dam-building proceeds at a rapid pace and on a massive scale across the global South. As Tony Allan (2003) highlights, many states across the global South (e.g. India, China, Brazil, Ethiopia, Tajikistan), supported by national and global construction companies and financial institutions, are engaged in a 'hydraulic mission' to capture water on a large scale for integrated water, food and energy needs.

This type of path-dependent policy and practice raises the question: Whose security will be ensured from these activities? There is an extensive literature on "benefit sharing" (e.g. Sadoff and Grey 2005) that is particularly appealing in the transboundary context of water access, use and management. For example, the Nile Basin Initiative is facilitating a number of hydro-power projects whereby states in the basin can share energy and revenue. But there is an equally extensive literature on the social, economic, ecological and political costs of the same types of projects (e.g. Shiva 2002). Enlightened and progressive policy announcements and improved science do not erase the high politics of decision-making about water use (as well as the use of other natural resources).

Back in 2000, at the 2nd World Water Forum at The Hague, the Netherlands' then Crown Prince William sought to inject space for political discussion regarding water security by declaring that the world's water crisis was a crisis of governance, not of absolute resource scarcity. The intention was to raise awareness that the structures, organizations and institutions created to harness water for human uses reflected past historical notions (e.g. "man over nature", "control", sectoral organizations, hyper-masculine decision spaces) and practices (e.g. big infrastructure, economic gains privileged against environmental losses). A new discourse of "good governance" was introduced alongside Integrated Water Resources Management (IWRM) to address these political problems and highly politicized issues (Woodhouse and Muller 2017). Each concept engendered massive literatures so will not be discussed here. Suffice to say that from the liberal standpoint, water security can be achieved through better institutions characterized by benchmarks and incentives for rooting out corrupt, unaccountable and non-transparent practices, while simultaneously building improved pathways for stakeholder engagement and inclusive forms of decision-making and action (e.g. Butterworth et al. 2010; UNDP 2013; Woodhouse and Muller 2017).[12] From a critical perspective, however, decisions around water (and land) will always generate winners and losers based on unequal social, political and economic power dynamics (Swyngedouw 2004; Linton and Budds 2014). In consequence, those most negatively impacted by current and planned water resource use decisions must organize and mobilize against dominant political forces (e.g. Patel 2008; Marcatelli and Buscher 2019). Given that (i) institutions reflect the past, rather than anticipate the future, (ii) water is embedded in all aspects of human behaviour, (iii) guaranteed access to water is a measure of political, social and economic power (Solomon 2010), and (iv) resource use paradigms change only very slowly (Allan 2003), it is understandable that institutional approaches to achieving society-wide water security continue to yield uneven outcomes.

How Much Is Enough?

As with shifting tectonic plates, a dramatic break with the apartheid past combined with a variety of complementary global and regional factors to facilitate meaningful change in water law, policy and practice in South(ern) Africa (Swatuk 2002, 2010). While things have settled down, there continues to be a variety of aftershocks both positive and negative (Von Schnitzler 2008; Bond 2017). At its peak, the South African government introduced a "hier-

archy of need" to guide policy and practice. At the apex was "free basic water" equal to 6000 litres per household per month – a modest amount at best, but in line with WHO guidelines at the time. Next was "environmental flow", the need to establish the baseline flow of South African rivers to ensure continuity and in some cases recovery of natural ecosystems. Once these two baselines were established, all remaining water would be available based partly on market principles and partly on historical practices. The important innovation was to be household and ecosystem security above all else. Actual performance notwithstanding, the South African government showed quite clearly that household and ecosystem security was prized above all else.

Delivering on promises is another matter and is subject to all of the political and economic pressures highlighted above. Nevertheless, a reasonable benchmark was set in line with stated global best practice (the WHO guideline) to help align stakeholder interests (including the state itself) with resource endowments, and to guide financial and infrastructure planning in support of water (and ultimately, food and energy) security.

Many Challenges to Ensuring Water Security

Despite these important legal and practical innovations, South Africa, like the rest of the world, exhibits ongoing "water apartheid". The levels of insecurity are most acutely felt, within South Africa but also across the global South, as follows:

- Lack of access to improved water supply among the urban and rural poor
- Lack of access to improved sanitation services among the urban and rural poor
- Badly polluted waterways (including groundwater contamination) affecting everyone
- Urban vulnerability due to limited and ageing infrastructure, inadequate finance, and changing hydrological cycles
- Urban vulnerability due to high population growth rates (linked in part to rural vulnerabilities leading to rural-to-urban migration) outstripping existing service delivery capacities
- Flash flooding during heavy rains due to widespread impervious surfaces
- Water shortages resulting from urban expansion, impervious surfaces and high rates of runoff and evaporation (due to land-use change and/or land degradation)
- Increased instances of waterborne disease during rainy season(s)
- Rural food insecurity due to rainfed agriculture on poor soils, lack of access to supplemental irrigation and limited state extension services and support
- Rural household insecurity due to loss of common lands through expansion of large commercial farms and economies of scale.

South Africa is heavily dependent on coal for energy generation. The Southern African Power Pool (SAPP) was established more than 20 years ago to create a regional energy grid so that during the rainy season, South Africa can buy hydropower from its relatively water-rich neighbours (Angola, Democratic Republic of Congo, Mozambique, Zambia, Zimbabwe), while during the dry, low-flow season, it can sell thermal power to the region. Attempts to ensure energy security and lower regional carbon footprints are negatively impacted by financial, technical and social limits to dam building, as well as abiding scepticism regarding the feasibility of borrowing vast amounts of capital to build large dams that may not be useful under a climate change-affected hydrological regime. This is a common concern across the tropics, the region of the world estimated to be most severely impacted by climate change.

None of these problems is new or unknown. The UNDP (2006) devoted its entire 2006 Human Development Report to water security. Since 2003, UN-Water has produced ten World Water Development Reports, the first four of which are comprehensive overviews of the state of water in the world. Since 2014, reports have appeared annually with the latest entitled 'Leaving No One Behind' (UN-Water 2019). The World Bank and the FAO have extensive commitments to improving global water practice, as do all regional organizations. Yet it is clear that hundreds of millions of people suffer not merely water insecurity, but livelihood insecurity linked to their inability to access water of an appropriate quantity and quality when and where they need it (UNDP 2006; UN-Water 2019).

5.   WHAT IS TO BE DONE?

The UN's Agenda 2030 established SDG 6, water and sanitation for all. Within SDG 6 are a number of targets including 6.5 which aims to have all countries operationalizing IWRM by 2030. This is a noble, albeit idealistic, goal. Given what has been said and shown in this chapter, it seems to me that a more realistic approach to achieving 'some water for all forever', as goes the mantra of the South African Department of Water Affairs, is a pragmatic, practical approach that adopts what Moriarty et al. label 'IWRM light'. In their words:

> In situations where the kind of over-arching legal and institutional frameworks for river basin planning and allocation of water resources … are either missing or ineffective, then 'light' IWRM based on the application of key principles to sub-sectoral activities (such as [Water and Sanitation] WATSAN) provides an alternative approach. 'Light' approaches aim to develop guidelines, based on the application of IWRM principles at all stages of the project cycle. The idea behind the 'light' approach, is that if all sub-sector actors try to apply good IWRM practice at their own level, in their own work, this will in turn lead to the emergence of better local level water resource management, and will be an important first step in the process of IWRM. (Moriarty et al. 2004, p. 22)

The authors highlight three critical issues related to water security: scale; boundaries; and temporal variability (Moriarty et al. 2004). In terms of scale, water use is highly localized. Human communities tend to cluster around water sources due to the fact that water is non-substitutable and bulky (Savenije 2002). Large-scale water storage and transfer projects such as the Central Arizona Project in the USA, the Grand Anatolia Project in Turkey, the Grand Ethiopian Renaissance Dam in Ethiopia, and the Three Gorges Dam in China show that on many occasions state interests can greatly magnify the scale of intervention as well as its impact.

This raises the question of boundaries. Savenije (2002) describes water as essential, non-substitutable and fugitive. Hence the tension between leaving the water to flow, ensuring a healthy ecosystem, and impounding it, to guarantee its presence when needed by (some) humans. In the context of states, water is power; it is the fluid backbone of economies (Swatuk 2018). In terms of temporal variability, it is clearly not always where we humans need it when we want it. This is particularly the case in the drier parts of the world and in monsoon-dependent regions where an entire year's precipitation falls in highly concentrated form over a limited number of hours.

Policy, Law, Institution

As highlighted throughout this chapter, there has been a concerted effort by the world's water experts to draw representatives from all stakeholder groups (states, civil society, private sector) into a conversation regarding water security.[13] This global conversation has been ongoing since the early 1970s and perhaps reached its zenith in the decade near to the end of the 20th century, when the Dublin Principles were agreed to in 1992,[14] the Global Water Partnership was created in 1996, and the first World Water Forum was held in Marrakech in 1997 (Conca 2006). Through SDG 6, states around the world have committed to operationalizing IWRM by 2030. Many states in the global South have taken the lead from the European Union's Water Framework Directive to begin to align national policies through regional cooperation. Numerous inter-governmental organizations, international financial institutions, policy-oriented think tanks, civil society groups and companies have been involved in updating and harmonizing state and regional organizational policies, laws and institutions. For Moriarty et al. (2004), these are the necessary macro-level steps that must be taken in the process of achieving IWRM and better water governance.

Transboundary Cooperation

Much has been made of macro-level alignment within the context of shared river basins (e.g. Swain 2004; Swatuk and Wirkus 2009; Earle et al. 2015; Movik et al. 2016). States have been tasked with ensuring water security for their citizens. According to Gupta (2016, p. 118), 'more than 250 river basins are transboundary and they are subject to hundreds of agreements'. Data from the United Nations shows that 148 countries include territory within one or more transboundary river basin; 39 countries have more than 90% of their territory within one or more transboundary river basin; and 21 countries lie entirely within one or more of these watersheds.[15] In transboundary basins, the trend over time has been to enter into bilateral agreements on either single use or multi-purpose water projects, primarily pipelines and dams. The Nile Basin Initiative, for example, has initiated a series of fast-track hydro-power projects among Eastern Nile states in support of inter-state cooperation for energy security. These types of cooperative agreements have been modelled around the world, increasingly being spun as "green energy" projects in support of carbon reduction (Swatuk and Wirkus 2018). They have generated as many social and environmental problems as they have contributed to national and regional water, energy and food "security" (Shiva 2002). In some cases, inter-state cooperation masks intra-state low-level conflict and insecurity (Wolf et al. 2005) and/or existing inter-state inequalities, a situation Zeitoun and Warner (2006) label 'hydro-hegemony'. In their particular case, they refer to the Middle East and Israel's dominant position, but the same may be said for a number of cases involving shared rivers: South Africa and Lesotho on the Orange/Senqu River; South Africa and Namibia on the lower Orange River; Uzbekistan and Tajikistan on the Amu Darya and Syr Darya rivers; India and both Nepal and Bangladesh on the Ganges–Brahmaputra rivers. In each case, peaceful relations mask underlying tensions resulting from the preponderance of political, economic and military power of one state in the basin (Toset et al. 2000; Gleditsch et al. 2006; Mirumachi 2015).

Achieving Water Security in Parts

As major players struggle with macro-frameworks for national/regional water security, Moriarty et al. (2004) and Butterworth et al. (2010) suggest that strides toward society-wide water security can be achieved piece by piece at micro-levels, meaning that project managers can seize opportunities when and where they arise, while keeping the overall ideal of basin-wide IWRM firmly in mind. There are many examples of improved water security at sub-national scales in urban and rural settings. For example:

● Low-impact development (LID) and the "sponge city" (greening urban spaces and replacing impervious surfaces with permeable ones enables cities to make more use of the water to which they already have access)
● Development of multiple-use systems in rural areas (increasing the ability of small communities to share water with commercial enterprises)
● Water demand management including putting an end to unaccounted-for water (including appropriate tariff structures; leak detection and repair)
● Creation of source water protection zones (limiting development in headwaters while afforesting degraded areas with indigenous flora)
● Improved stormwater management including artificial groundwater recharge (redirecting the vast amounts of stormwater that either flow across or evaporate from hard surfaces into natural and/or artificial – e.g. disused mineshafts – underground storage)
● The introduction of micro-hydro, and small-scale solar and wind power (making low impact interventions that avoid the high sunk costs and environmental and social upheaval associated with large-scale hydro-power projects)
● Desalination plants for coastal cities (which are increasingly affordable as a supplement to existing systems)
● Improved land management in rural areas (including the reintroduction of traditional farming practices, creation of small dams, appropriate crop choice, and the use of cell phone technology for information pertaining to markets, prices and weather).

Given that water is in everything, the potential for improved water security is vast. The bullet points above are merely a partial list, with each one deserving its own 10,000 words. The point to be reiterated here is that achieving water security at whatever scale will not result from a one-off big technology, big capital and big infrastructure project. As we have recently seen, wealthy cities such as Cape Town, Sao Paulo and Chennai stand at the brink of running out of water despite the fact that the water that falls and flows should be more than enough for everyone. The resource has been captured over time and put to a variety of often questionable uses. One gets the feeling that big infrastructure is the intervention of choice not only because it generates a great deal of wealth for those involved in the project, but, more importantly, it excuses those in political power from engaging meaningfully with the citizens on whose behalf they are supposed to govern. Achieving water security, in my view, requires a combination of pursuing IWRM-sensitive projects wherever they arise and directly engaging those at the commanding heights of national, regional and global political economies with empirically sound arguments in support of meaningful change. There is a case to be made for socially just, environmentally sustainable and economically viable approaches to water security. There are also many allies to be found across states, communities, civil societies and the private sector.

The Psychology of Consumption

At the same time, we would do well to remember that many of the water problems we encounter are a consequence of demands for the resource (or for the use of the resource in some form of production). Many of these demands, moreover, are rooted in the psychology of consumption (Dauvergne 2008). While IWRM-light is necessary, possible and hopeful, much of the world's water crisis is a consequence not of too little water (i.e. physical water scarcity), but dreams of "development" and possibilities for profit. One example will suffice: the growing dominance across the world of the Western diet heavy in factory-farmed beef, which has an extremely large water footprint. The Western diet, regarded by many around the world as a mark of wealth and development, is displacing traditional fish-based and vegetarian diets in Asia, whose water footprint is in the vicinity of one-third that of the Western, meat-based diet. Canadian beef producers in Alberta are eager to tap into global markets in Asia. Southern Alberta near the city of Lethbridge is commonly called "feedlot alley", where an otherwise arid environment is fed by glacial-melt rivers to enable extensive agriculture in growing alfalfa as feed for beef cows. In the context of climate change one wonders if this is the best use for glacial-melt water. But how to change practice ahead of a looming crisis? There are no easy answers, but it is imperative that alongside better science and policy-making there must be public engagement, meaning that academics must also be activists and public intellectuals (Postel 2017).

6.　　CONCLUSION

Humanity is wholly unprepared for life in the Anthropocene. Political leaders entrusted to take decisions in the interest of the whole are divided by self-interest, made manifest through the sovereign state. As a result, they have quibbled over facts and metrics and, at best, nibbled around the edges of meaningful climate action. Since the enlightenment in Europe, 'Man' has sought to distinguish himself from chaotic nature, and to stand over it in the interest of 'order' and 'dominance' (Crosby 1986).[16] Security rests on an ability to predict what will happen tomorrow based on what happened today. Societies around the world developed a symbiotic relationship with their environment, achieving a sense of security, of being a constituent part of their natural world. In Hulme's (2015) words, culture is climate, meaning that the diversity of cultures around the world reflected demonstrated human adaptive capacity in different regional and local biomes across the entirety of the Holocene era up to the time of the European voyages of discovery. European hubris and greed deemed non-European cultures backward and in need of change. Thus began the grand experiment of homogenizing social organization despite broad variance of weather and climate. Alongside European architecture came the concerted attempt to transplant temperate zone flora and fauna and to mimic European physical environments through a flattening of the hydrograph. What this means is that in places prone to wet/dry cycles and high variability, dams were built, wetlands were drained, canals were dug and eventually borewells were sunk to create neo-Europes (Crosby 1986; Ponting 1991). The "logic" of the dam, it seems to me, grows only more compelling to policymakers, engineers and financiers in the era of climate change.

These processes worked fairly well across the temperate zones, yielding what Grey et al. (2013) identify as high water security within low hydrological complexity, but worked very

poorly over much of the rest of the colonized world. Western "success" has come at a high cost, however. Elaborate systems of water delivery put in place during an era of state-directed development in the interest of inter-state competition (i.e. the late 18th century to the mid-20th century; see Tilly 1990; Allan 2003) are today not only ageing and expensive to maintain, but inadequate to deal with the increasing variability and extreme weather events that are now commonplace across the global North. Meanwhile, colonialism and imperialism rooted out historically developed adaptive capacity across the global South, replacing it with modified models of European modernity. This suggests that, in terms of adapting to extreme events, the global North has much to learn from social histories in the global South. It also suggests, however, that water delivery systems in neither North nor South are "fit for purpose" in the Anthropocene. Moreover, far from learning lessons from the past, it appears that powerful actors in the global political economy are content to double down on capital and technology – an understandable response from a narrow segment of the global population that perceives itself to be water secure. But wholly unacceptable to the hundreds of millions faced with water, food, energy and livelihood insecurities.

NOTES

1. Available at http://www.oxforddictionaries.com/definition/english/secure (accessed 19 April 2020).
2. Available at https://dictionary.cambridge.org/dictionary/english/development (accessed 19 April 2020).
3. See https://www.undp.org/content/undp/en/home/sustainable-development-goals.html and http://www.un.org/millenniumgoals/.
4. See https://www.who.int/sustainable-development/housing/health-risks/waterborne-disease/en/.
5. See https://www.wri.org/aqueduct.
6. See e.g. https://earthobservatory.nasa.gov/features/Water/page1.php.
7. See http://watershedreports.wwf.ca/#ws-17/by/health-overall/profile.
8. See http://hdr.undp.org/sites/default/files/reports/267/hdr06-complete.pdf.
9. See https://www.worldbank.org/en/topic/water.
10. See https://data.unicef.org/topic/water-and-sanitation/drinking-water/. UNICEF presents all of its data in terms of state performance. In comparison, the UN, on its SDG knowledge platform, states: 'In 2015, 29 per cent of the global population lacked safely managed drinking water supplies, and 61 per cent were without safely managed sanitation services. In 2015, 892 million people continued to practise open defecation' (see https://sustainabledevelopment.un.org/sdg6).
11. See https://sustainabledevelopment.un.org/sdg6.
12. According to Moriarty et al. (2004, p. 3):
    IWRM is about integrated and 'joined-up' management. It is about promoting integration across sectors, applications, groups in society and time based upon an agreed set of principles. IWRM is a global movement driven by a perception of crisis, both current and future. The so-called global water crisis is underlain by a mixture of largely unavoidable development factors (population growth, increasing wealth and demand). However, it is increasingly realised that the heart of the water crisis is poor management or governance. With careful management and wise selection of priorities there is no reason that even in the driest parts of the world there should not be sufficient water to go around, and viable solutions exist to many of the problems faced. IWRM seeks to tackle some of the root causes of the management crisis, namely the inefficiencies and conflicts that arise from un-coordinated development and use of water resources.
13. See, for example, https://en.unesco.org/themes/water-security.
14. Principle 1: Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. Principle 2: Water development and management should be based on a participatory approach, involving users, planners, and policy-makers at all levels. Principle 3: Women play a central part in the provision, management and safeguarding of water. Principle 4: Water is a public good and has a social and economic value in all its competing uses. The principles were

agreed to at the International Conference on Water and the Environment, 26–31 January 1992; and presented at the Rio Earth Summit in June of the same year. See The Dublin Statement on Water and Sustainable Development (1992, p. 2), available at http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html (accessed 19 April 2020).
15. See https://www.un.org/waterforlifedecade/transboundary_waters.shtml.
16. I am using 'Man' in a dual sense: in the sense of a collective noun, i.e. "all of humanity"; but, more importantly, in a gendered sense where European men made 'Man' and included women and non-European men as part of unruly nature that was to be tamed.

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