

Chapter 6

Water as a Source of Conflict and Global Risk



It is clear that water has two fundamental functions namely being a prerequisite for life on Earth as well as being an economic resource or commodity for further development. These two roles are often in conflict all around the world mainly due to continued competition between different water usages, human livelihoods as well as the environment. The continued competition between water usages has consequently led to the exploitation of water through different human activities which has in turn increased the risk and placed great pressure specifically on aquatic ecosystems and the life which they support (Pimentel et al. 2010). Conflicts may therefore arise on various levels between agriculture, industrial and domestic water use sectors as well as the natural reserve due to increased water stress. Increased water stress may be caused by natural events such as droughts or by human activities which may include but not limited to overuse of surface or groundwater as well as water pollution which lessens the amount of usable water for different water uses and creates additional vulnerabilities and risks.

Different types of subnational as well as national conflicts may arise all over the world from water scarcity and be accompanied with immense environmental degradation, socio-economic consequences and risks. The chapter will evaluate water as a source of conflict with the use of current case studies. The chapter will also focus and conclude part one of the book by evaluating water as a global risk. Focus will be placed on the cost of current and predicted water-related problems such as water stress and water-related diseases which may pose significant risks for future environmental sustainability, environmental and human health as well as socio-economic growth.

6.1 Water as a Source of Conflict

The US Central Intelligence Agency issued a warning decades ago that many countries will experience water problems/shortages, poor water quality or floods which will risk instability, state failure and increase regional tensions. In 2001 the then UN

Secretary-General, Kofi Annan highlighted with concern that the fierce competition for freshwater resources may become a source of conflict and wars in future, however, he revised his statement a year later saying that water can rather be a “catalyst for cooperation”. After decades of “water wars” threats which never materialised, these conflicting statements emphasise the complexity of how water and conflict interact (Swanson 2014).

Some scholars highlight the ancient Babylonian conflict which occurred 4,500 years ago being the only true “water war” which has ever occurred. The fact that one-fifth of the world’s population face water scarcity and another 1.6 billion people live in countries whose infrastructure is too weak to get water where it is needed, it is surprising that major conflicts have not occurred.

Water as a prerequisite for life on Earth as well as being an economic resource or commodity for further development fulfils many roles in our environment and society. Water is a fundamental resource for drinking, food production, fisheries and transport, sanitation, it is a solvent and cooling agent and lastly has religious significance. Therefore, when you think of water and the management thereof, you also need to consider its role in various sectors as you are managing all of these factors or sectors as well. The following sections will evaluate the role of water stress in creating conflict, the relationships which exist between water stress and civil unrest or military conflict, how competing interests may contribute to water stress and ultimately tensions and lastly the role which climate change might play in creating future possible conflicts or tensions with the use of detailed case studies.

6.2 Role of Increased Water Stress in Creating Conflict

In 2012 an unclassified version of a USA National Intelligence Council report on Global Water Security was released which stated that, without more effective water resources management, between now and 2040, worldwide fresh water availability will not meet the demand. This report further indicated that “while wars over water are unlikely within the next 10 years, water challenges—shortages, poor water quality, floods—will likely increase the risk of instability and state failure, exacerbate regional tensions, and distract countries from working with the USA on important policy objectives” and that “water problems will hinder the ability of key countries to produce food and generate energy, posing a risk to global food markets and hobbling economic growth”. The concern related to the possible effects of global water shortages on political stability is therefore not new and have been receiving attention for the past three decades around the world (Intelligence Community Assessment 2012).

Approximately half of the world’s population, as well as a large number of ecosystems around the world, are affected by water problems which in turn create stresses influencing the stability of the affected communities and have the potential to exacerbate festering antagonisms and quarrels. Rapid urban developments which have resulted in numerous informal settlements, especially in the case of developing coun-

tries, have been accompanied by lack of domestic waste disposal, sanitation and sewage effluent systems and ultimately forces people to inhabit areas which have very limited sanitation and water supply. The world's poor population, particularly children, are especially negatively affected by unhygienic insufficient water. The situation is further exacerbated in communities where there exists a competition for adequate clean water supply and consequently leads to further public and private discord. Lack of clean and reliable water also ultimately affects food security as it is intimately linked with water. Serious problems which arise from inadequate water can last for generations and these externally imposed stresses such as these can ultimately lead to social unrest, political instability and in some cases even armed conflict.

Droughts or periods of drier than normal conditions also lead to water-related problems and increased water stress. In recent years multiple regions around the world have experienced droughts which in some cases have led to protests or conflicts within communities themselves and/or with other competing water sectors. The following case studies will look at the role of drought or declining water resources in creating different possible conflicts in both developed and developing countries.

6.2.1 Parched Western USA Region: Severe Drought, Water Rights and Societal Impacts

Developed countries such as the USA will be unable to avoid water supply problems and future instability due to consequences associated with climate change as well as the occurrence of more frequent extreme weather events. The western region of the USA is a leading example of how continued drought can attribute to various types of instabilities or possible conflicts within the region.

The drought has been described as the worst in history, has affected the local and national economy since 2012 and have cost various states millions of dollars. The persistent drought has also been accompanied with a series of legal and political battles over who controls the now precious water resources. Farmers which pumped water from the desiccated Brazos River were ordered to shut down their pumps due to the sprawling photochemical complex having more senior rights. This was implemented by the government to make up the deficit and gave cities and power plants along the river a pass on the basis of public health and safety overriding farmers own water rights. The farmers in the region have consequently taken the government to court over the issue and have been winning.

The population of the arid Western region has always argued over its water resources however the persistent drought has intensified these struggles and the continued growth and thirst of these western urban areas have raised the stakes to new levels. Some of these struggles have led to legal actions or stricter restrictions and have included the following:

- The state has cut off deliveries of river water to rice farmers along the Gulf coast southwest of Houston for 3 years to sustain reservoirs that supply the ever-expanding Austin urban region.
- Lawsuits have also been issued in Nevada to block a pipeline which would supply Las Vegas with groundwater from the aquifer straddling the Nevada-Utah border.
- Strict restrictions are being imposed in Colorado on requests to ship water across the Rocky Mountains to Denver and the rest of the state due to fear of their existence. Local water rights sales have consequently been blocked to Denver's fast-growing suburbs.
- Activists in Arizona are attempting to stop plans related to the pumping of groundwater used by a vast housing development which would reduce the water levels of a protected river. Kansas has accused Colorado and Nebraska of allowing farmers to divert Kansas' share of the Republican River. There is a similar dispute between Mexico and Texas (Wines 2014).

The Californian region has received most media attention due to the drought it has experienced the last couple of years. The drought has been attributed to unusually low snowfall which occurred across the state mainly due to increasing winter temperatures over the recent years and cost California US\$2.7 billion in 2015. Drier conditions have also led to larger and more frequent fires posing danger to people and property as well as other hazards such as landslides and floods (Poppick 2014; Aleem 2015; Kasler and Reese 2015). The drought has also led to the deposition of soil and heavy metals into the already strained water resources, increased turbidity and may have further financial implications in terms of increasing the water treatment costs. The agricultural sector has been the hardest hit as it is the biggest water user (80%) in the region. Farmers stand to lose US\$810 million from keeping fields fallow, a further US\$453 million on pumping groundwater and likely to lose 17,000 agricultural jobs due to the drought (Aleem 2015; Kasler and Reese 2015).

Societal impacts have included the loss of jobs especially within the agricultural sector and a rise in food prices. Political consequences have included that the government has had to request urban consumers to decrease water usage by 25%. Some inequality of access to water resources has arisen where 48% of wealthy homeowners with income above \$100,000 have stated that it would be too difficult to conserve water. This has consequently led to heated debates within society whereby rich people do not mind paying a \$100 fine for consuming too much and ordinary people are blamed for consuming too much. An increase in class inequality as well as differing perspectives on water consumption has occurred which has placed immense pressure on the government to manage this precarious situation with a state historically characterised by injustice and racism with the allocation of water during the Gold Rush eras in the region (Aleem 2015; Johnson 2015; Kasler and Reese 2015).

The main conflict is between farming and fishing industries and has been exacerbated by the drought causing the possible extinction of native fish species such as the delta smelt as well as threatening other native fish such as the longfin smelt, green sturgeon and winter-run Chinook salmon. Delta smelt populations have been declining for decades due to invasive predators, pollution, habitat loss and increased

water exports to farms and cities. The drought has worsened conditions by reducing freshwater flows and raising water temperatures and led to government regularly cutting water exports from the delta to protect the fish species and other threatened fish from being sucked into the giant pumps that send water south. Farmers are of the opinion that too much water has been wasted on these fish and scientists and environmentalists state that it needs protection due to it being an important indicator species for the delta's health. Some almond farmers have had to pull out some of their almond trees due to them not being able to obtain enough water for irrigation (Kahn 2015; Pedroncelli 2015).

The additional conflict between farmers and the urban population has been centred around government ordering urban areas to cut their water use by 25%. Urban residents have consequently developed the perception that the agricultural sector is getting off easier and that this sector should be subject to more regulations. However, it should be noted that due to the drought, farms have been allocated 0% share of the water from irrigation canals of the Central Valley Project and have led that half a million acres of farmland have had to be laid fallow in 2014 (Walker 2015).

Main critiques have been aimed at almond farmers who have continued to plant almond and other nut trees which require annual watering. California grows 80% of the world's almonds and is by far the biggest exporter of processed fruit and nuts. State officials have had to defend the agricultural industry and invoked globalisation for the root cause as more than two-thirds of almond crop is exported, much of it to China (Walker 2015). This has also raised the debate of water efficiency in different farming sectors especially between almonds and beef or dairy production whereby it has been emphasised that it takes more than 380 L of water to produce a 28 g of beef, compared with less than 190 L for 28 g of almonds. The decrease in water use in the almond farming sector is mainly due to advances in irrigation technology which have lowered their water demand by a third. The conflict has extended to that opprobrium ought instead to be heaped on alfalfa hay, a low-value crop sold as feed to dairies overseas, which takes up even more of the state's agricultural water supply than do almonds, 15% in recent years. Almond farmers further defend their stance by suggesting that almonds generate more jobs for the state economy per unit of water consumed than alfalfa, rice, beans or corn (Kahn 2015; Walker 2015).

Different types conflicts have therefore risen from the persistent drought and these conflicts and debates will continue within the region and increase in intensity with the continuation of the drought as well as the persistent and increased impacts of water stress, changes in climate and the insatiable societal demands while trying to ensure a healthy environment. A positive outcome is that the drought has forced farmers to adopt more efficient water management technologies and practices that helped boost the revenue within the limited available water and urban consumers have also been requested to cut their water use down by 25% by the government (Cooley et al. 2015; Johnson 2015). The adaptations made have consequently buffered the region's economy and job levels. Some of these adaptations and responses will build resilience, while others will have lasting and damaging consequences to the region's population, its ecosystems and future generations.

6.2.2 Possible Future Water Conflicts in India: Persistent Drought and Continued Poor Water Management

India has been facing one of its most serious droughts and it has been estimated that around 330 million people are likely to be affected by acute water shortages. It has consequently placed the country's available water resources high on the public agenda. Four of the ten drought-hit states within the country face chronic conflicts due to poor water management and the diversion of water to urban areas. Even though the country receives considerable rainfall most years through the annual monsoon, the rainfall falls in particular areas, for a short period of time. This consequently leads to distress in terms of flooding due to the drought (Vira 2016).

The drought has forced the Indian government to resurrect plans to attempt and link major river basins through the Interlinking of Rivers project. Critics have however suggested that it will most probably be unsuccessful and lead to ecological and social disruptions. The continued inadequate rainfall in the country has led to the drying up of reservoirs and village water bodies especially in the grain-growing regions of southern India. The country is experiencing the worst drought in 140 years and has led to people having to leave villages and move to urban areas, people not having food or water and no fodder for livestock. The Cauvery River, which was once an 800-km river on which millions of farmers depend, has become dust tracts in several sections. This has also led to soil erosion and further reduction in rainfall. The removal of the natural storage of monsoon rainfall has consequently led to floods and further drought. This in combination with the over-extraction beyond the river's capacity has left the river dry and placed numerous people's livelihoods in jeopardy (Vira 2016).

The assumption of having larger cities by diverting water from hundreds of miles away may kill all rivers in the country if all rivers are diverted to urban and industrial areas. Other effects of the damming of rivers may include coastal erosion, deforestation as well as the displacement of already vulnerable people and exacerbate possible impacts of climate change. Centralised irrigation systems and large dams which have been introduced have led to immense soil erosion and over-extraction of underground aquifers have depleted the water table. Bauxite mining has also contributed to the collapse of groundwater levels and has left hills bare and arid.

This water crisis has led to the failure of crops and has caused desperate farmers to obtain loans with exorbitant interest rates to purchase food, seeds, fertiliser and equipment. Drought-hit farmers from Tamil Nadu consequently protested for farm loan waivers but few state governments have conceded. Furthermore, upstream states like Karnataka have refused to share the Cauvery River's water with neighbouring or downstream villages which will cause crops to fail and could transform them into deserts. Violence in the streets broke out after Karnataka decided not to comply with the supreme court ruling of releasing more water. The drying up of the Cauvery River could be India's greatest human catastrophe ever if these issues are not resolved and local water preservation and community-driven water management systems are not considered and implemented (Ng and Mukherjee 2017).

The management of water demands has not been prioritised within the country and water-thirsty crops still dominate the dry regions of the country. Farmers receive energy subsidies which allow them to over-pump already depleted aquifers. Distributional equity issues are also prominent within the country where the poor in urban contexts pay more per litre for erratic and unreliable water while richer neighbours have the luxury of definite water supply.

The water conflict possibility lies within the context of the transboundary nature of the water issues within the Hindu Kush Himalayan region which spans across eight countries, supports ten major river systems and potentially affecting 1.5 billion people. Transboundary cooperation is therefore vital to manage fragile resources which are further threatened by uncertain impacts of climate change. Despite three major wars since India's independence, India and Pakistan have managed to maintain some cooperation however it has been suggested that regional conflict over water resources will worsen. The possibility of worsened regional conflicts is much dependent on China as it is the dominant upstream water controller in the region. India will, therefore, have to focus more attention on its already fragile water resources as these issues span over social and economic life. An integrated water management approach will be required to address sustainability, land use management, agricultural strategies, improved demand management as well as distribution and pricing of water especially with the growing pressures accompanied with climate change and the constant migration and population growth (Vira 2016).

6.3 Water Stress and Civil Unrest or Military Conflict

Water resources have rarely been the sole source of violent conflict or war, however, there are complex and real links between water and conflict. There is a long history of tensions and violence over access to water resources, attacks on water systems as well as the use of water systems as weapons during war. Water has played different roles throughout human history in terms of creating unrest and in terms of military conflict. During major global conflicts, clean water supplies served as direct military targets or military tools. In modern times which have lacked all-out global war, regional or local battles for economic and social development has dominated along with terrorist activities which have centred around controlling local water supplies to promote their ideological religious or ethnic factions.

While future large-scale wars over water are not anticipated, water scarcity has been deemed as a factor which can increase regional conflicts and tensions, encourage border disputes and possibly be a focus of terrorism, local tribal and ethnic warfare as well as political disputes in terms of competing economic developments. Water disputes which have occurred in the past decade have not produced large-scale global war, however, regional conflicts and local wars have often used water as part of a ploy to advance political goals. The following case studies will look at the role of increased water stress in combination with civil unrest or military conflicts.

6.3.1 East Africa Water Wars and Prolonged Civil Unrest in Sudan, Darfur

The East African region has been plagued by rising temperatures, droughts and increased water scarcity. This in combination with growing populations especially where rivers are shared by more than one country, constant fight for water usage rights and continued water shortages have led to multiple examples of water conflicts in the region. Water has consequently been used as a weapon to obtain either political or socio-economic goals.

The drought between 2004 and 2006 over the East African region affected approximately 11 million people, killed large numbers of livestock in the region and forced the Kenyan and Ethiopian governments to intervene in numerous skirmishes over water in their countries. Military forces and police needed to intervene in some cases to pacify battles specifically around wells. Significant fighting over groundwater resources occurred within Ethiopia during this period. Conflict developed between two clans and gave rise to “well warlords” and “well warriors”. The extensive violence was labelled as the “war of the well” and led to the death of 250 people and many injured.

The history of Sudan especially the Darfur region has been characterised by civil war, famine, coups as well as tyranny. Years of civil unrest in the Darfur region has been dominated by the intentional bombing of wells around villages such as Tina and contaminated in Khasan Basao in 2003 and 2004. The previous stance for the main cause for the prolonged conflict was solely placed civil unrest, on the Muslim government in the north which has been engaging in civil war with rebels in the Christian or animist south as well as genocide against ethnic groups. This view has however changed in recent times with the sharing of new data as well as increased focus on declining water resources and arable land within the region (Muhammad 2010; Schlein 2011).

The region has faced immense ecological crises which predominantly include water scarcity and desertification, displacing rural populations through changing landscapes and lack of agricultural production. The livelihoods of the country’s population are dependent on agricultural production as the sector accounts for 97% of water use. Farming practices have however degraded the environment, reduced arable soil and have caused desertification to spread. The possible causes for the continued conflict in the Darfur region have been attributed to the following:

- Spread of deserts southwards by an average of 100 km over the past four decades;
- Overgrazing of fragile soils causing widespread land degradation;
- The “deforestation crisis” which has led to 12% loss of the country’s forest cover in just over 15 years;
- Declining and highly irregular patterns of rainfall particularly over the Darfur and Kordofan states. The rainfall in the Northern Darfur region has decreased by a third over the last 80 years (Worldwatch Institute 2018).

The conflict over arable land and declining water resources have consequently contributed to instability within the region. It has been linked to a breakdown of law and order, associated flow of weaponry and the overflow of conflict from neighbouring countries, mainly Chad, and ultimately continued civil unrest within the region. In some cases, water resources have been specifically targeted and ultimately used as a weapon to obtain either political or socio-economic goals. The prolonged drought of 1983, the famine of 1984–1985 and the creation of severe water scarcity in the Darfur region has however been labelled as the root cause for the conflict in the region. Farmers and Arabic nomads have long been competing for limited water resources and grazing land due to the ever-expanding Sahara Desert which has also contributed to ongoing conflict (Polgreen 2007).

Water resources have therefore not always been the main target but rather the main contributing cause for conflict in the region. The perceived misallocation and unavailability of water in the region have instigated clashes which have been labelled as development disputes.

Due to water being labelled as being the main root cause of these conflicts, a need has risen to address this issue as people believe that water can consequently be used as an instrument for peace. The implementation of well managed and equitably distributed water resources has been given as possible instrument for sustainable peace within the region. These steps can however not be taken in isolation.

It needs to be highlighted that the conflicts experienced within the region is multifaceted and cannot be solved by just addressing current water stress. Civil unrest as well as instability, increased desertification, the associated decrease of arable land which threatens most of the region's population's livelihoods as well as the future effects of climate change on the region also needs to be considered and included as these factors also play a significant role which can not be ignored.

6.3.2 Syria: A Country Unravelling

Syria is one of the driest countries in the world receiving less than 250 mm rainfall annually and is a water scarce country. Pressures on the country's water resources have been increasing over the past couple of decades. Approximately 60% of its renewable surface and groundwater resources originate outside of Syria's borders (Frenken 2009) and all of its major rivers are shared with neighbouring countries. Tensions have occurred between Jordan and Syria since 1990 over the construction of Syrian dams. Turkey and Syria also have long-standing disputes over the management of the Euphrates River and these tensions have worsened over the past decades with the completion of the Ataturk Dam and a decrease in rainfall in the region. Population dynamics have also played a major role as the population has increased from 3 million in 1950s to 22 million 2012 which has decreased the country's total per capita renewable water availability to under 760 m³ to a level categorised as scarce (Gleick 2014).

In addition to having little overall freshwater in proportion to demands, the region also experiences high natural hydrologic variability. Syria has experienced six significant droughts between 1900 and 2005 where five lasted for only one season and the sixth lasted two seasons (Mohtadi 2013). Syria experienced a multi-season, multi-year period of extreme drought from 2006 to 2011 which led to agricultural failures, economic dislocations as well as population displacement. The current civil war has been attributed to the drought including agricultural failures, water shortages as well as water mismanagement which contributed to deterioration of social structures and spurring violence (FAO 2012; Femia and Werrell 2013; Mhanna 2013).

The persistent and severe drought has been combined with multiyear crop failures and related economic deterioration has led to significant dislocation and migration of rural communities to urban areas which further contributed to urban unemployment as well as economic dislocations and social unrest. These impacts have been described as the “perfect storm” when combined with other economic and social pressures. The return of the drought in 2011 worsened the situation even further and drove millions of people into food insecurity and forced more than 1.5 million people (mostly agricultural workers and family farmers) to migrate from rural land to cities and camps on the outskirts of the country’s major cities. Poverty and food insecurity still increased and conditions worsened due to poor water management decisions, poor planning and policy errors. Most of Syria’s irrigation still relies on highly inefficient flood irrigation which still needs to be modernised and half of all irrigation is dependent on groundwater which is also overpumped (78% of groundwater withdrawals are unsustainable) and have led to the dropping of groundwater levels and increased production costs. These additional factors to the drought added to further economic and political uncertainty (Gleick 2014).

The failure to implement economic measures to combat or address the effects of the drought as well as the associated economic and environmental conditions were all drivers for massive mobilisations of dissent and subsequent political unrest (Saleeby 2012). The extensive exploitation of groundwater has also contributed to the problem as it has led to substantial drops in water levels and in some cases contamination by salts and nitrates, making wells unfit for human use.

The development of unrest in Syria was accompanied by worsened violence. In 2011, Syria experienced disruption in a wave of political unrest over North Africa and the Middle East due to dramatic changes in the availability and cost of food (Arab Spring). It was dominated by religious differences, failure of the ruling regime to address increasing unemployment and social injustice contributed to further social unrest. Impacts on urban water distribution systems were reported with intentional attacks on water systems due to their strategic value. Many of the reservoirs have been intensely fought over and reservoirs under rebel control are badly managed as they lack proper skills or staff to operate them properly. The civil unrest has created millions of people to become refugees. The deterioration of water security in Syria may cause increasing disease and fuel migration which may consequently deepen pollution and water scarcity in neighbouring countries such as Jordan (Jones 2017).

6.3.3 *Yemen: Humanitarian Crisis and a Non-existent State*

Yemen is located in the Arabian Peninsula and is the poorest country in the Middle East. The southern region is characterised by expanding deserts, being the driest and have been plagued by persistent conflict since decolonisation. The country's human population has grown exponentially since 1980 from 8 million to over 27 million people and consequently placed great strain on the already stressed water resources. Approximately 50% of the country's population struggle to access or purchase enough clean water for drinking and food production. Consequently, 14.7 million people in the country depend on humanitarian aid (Cruickshank 2013; Whitehead 2015).

The change to a global trade/cash economy together with farmers changing to cash crops which use large amounts of water and the production of a stimulant drug called "qat" at the cost for food for the average citizen have also increased water use. New drilling techniques were introduced to try and tap into its fossil water reserves and led to unsustainable extraction from these aquifers, drills having to go deeper and deeper and water prices increasing. The abandonment of traditional irrigation methods to favouring the pumping of groundwater has caused aquifers to become depleted at a very fast rate. Yemen has always been a water-stressed country, however, the vast expansion in its human population and poor water management has exacerbated the problem (Cruickshank 2013; Whitehead 2015).

The country has further also been plagued by persistent drought which is being exacerbated by climate change. Water and food have consequently become scarce and have led to the displacement of populations and violence. Some experts have warned that Yemen might be the first modern country to run out of usable water and that it can occur within the next decade.

Tensions over strained water resources have reached extreme levels and led to the fracture of Yemen along sectarian and regional lines. Protests over rising petrol prices and rising prices of water transported by trucks started in 2014 by the Houthi minority and led to a revolution against the sitting government which fled south and formed an Arab Coalition with Saudi Arabia. The country has been in the midst of a major civil war after the Arab Spring uprisings in 2012. A Saudi-led coalition has started an aerial campaign and will continue air strikes till they have achieved their objective of saving the ousted president Abd-Rabbu Mansour Hadi's government (Whitehead 2015; Lopour 2016, 2017).

The civil war has exacerbated the country's water problems and has placed more people in needing humanitarian aid than any other country in the world. Water has become a weapon of war as millions of people rely on humanitarian aid to meet basic water needs and fuel shortages have led to people relying on water truck deliveries as they are unable to pump water. There have been reports of children being bombed or shot while waiting in line for water cans. The civil unrest has also delayed and restricted trucks carrying humanitarian aid through naval blockades administered by the Arab Coalition. A substantial portion of the country's infrastructure has been destroyed. Key strategic dams, viaducts and water treatment plants have been

destroyed by the persistent conflict initiating unprecedented water scarcity levels (Whitehead 2015; Lopour 2016, 2017).

The country's health system has also collapsed and unsafe drinking water has put its population at high risk for communicable diseases such as cholera and dysentery. The country has consequently been experiencing an outbreak of cholera since October 2016 as many hospitals and clinics have been destroyed or shuttered and its damaged critical water, sanitation and hygiene infrastructure has been exacerbating the problem.

Even though warring political factions may reach a political solution in the near term, the underlying factors of the country's water crisis is not set to improve due to a weak to non-existent state. The lack of governance and mismanagement will restrict necessary maintenance of infrastructure and conflict resolutions. Additionally, the impacts of climate change will also intensify water problems in the coming years as the warmer climate and increased evaporation will reduce the overall water reaching the country's rivers and aquifers. Immense assistance will be required to try and meet the population's basic needs as the country is continued to be withered by war, water shortages, government mismanagement and climate change. Solutions which have been suggested to be implemented once political stability has been achieved include the treatment of shallow coastal wells to make these drinkable and safe and starting with rainwater harvesting in mountain areas as a starting point however the government will have a major job on their hands to try and address the country's immense water problems (Whitehead 2015; Lopour 2016, 2017).

The humanitarian crisis has been described as worse than Syria and has not received as much attention. Several other countries in the Middle East region are also experiencing water shortages making the issues within Yemen critical for regional stability.

6.4 Water Stress and Competing Interests

Water stress combined with competing interests for limited resources can lead to political turmoil on a regional, national and in some cases even international levels. Conflict may arise when water resources such as rivers are used as a political instrument or as potential threat. There are numerous regional cases where rivers flow through several adjacent nations. The strengths, weaknesses and absences of existing treaties between these political entities may in some cases create tensions. Three case studies will now be discussed as examples of disputes or possible transboundary conflicts over surface water.

6.4.1 The Brahmaputra River: Sinking of China and India Relations

The Brahmaputra River originates in Tibet and flows through India before merging with the Ganges and draining into the Bay of Bengal in Bangladesh. The river is an important water resource for China as it provides hydroelectricity and it is a key agricultural lifeline for India and Bangladesh within a region characterised by overpopulation and aridity. It is mainly important for the agricultural industry in India's Assam Plains and concerns have been raised regarding multiple hydrological plants which China is in various stages of construction on its Tibetan plateau as it is believed by some that these projects may reduce flow of the river in India which can compound the already fragile water situation in the affected areas (Ramachandran 2015).

Potential conflict in the southern Asia region is particularly focussed on the borders of India, Pakistan and China. Tensions are rising over rivers which run cross-border such as the Indus River (flowing from India to Pakistan) and the Tsango/Brahmaputra River system (flowing from China to India). In terms of India and Pakistan, an Indus Water Treaty was developed in 1960 when Pakistan was concerned over existing and planned Indian dams which can potentially limit water in critical growing seasons. In 2011 an editorial in a Pakistan Newspaper *Nawa-i-Waqt* stated "Pakistan should convey to India that a war is possible on the issue of water and this time the war will be a nuclear one". The statement is primarily based on the fear that India can "switch off" the Indus to make Pakistan solely dependent on India which is considered as a possible "water bomb" (Ramachandran 2015).

On the other side of the spectrum, India claims that China will divert the Brahmaputra River and place millions of livelihoods in jeopardy. Recent years have seen the two governments deciding to tame the river by building hydropower dams in an effort to try and support their ever-growing energy requirements and over 160 memoranda of understanding have been signed between the Arunachal Pradesh state government and private and public dam-building companies to build medium and large dams in the state. The size and scale of these proposed developments are unprecedented in the history of northeast India and indigenous communities within the affected region are concerned that they will face major social and economic upheaval with the approval of all these projects. India's policy of pursuing hydropower development in the region could also have negative impacts on bilateral relations (Patranobis 2016).

China's plans to divert the river have also set off anxiety in the lower riparian states of India and Bangladesh as it will have repercussions for water flow but also agriculture, ecology, lives and livelihoods downstream and undermine Sino-Indian relations. China maintains that all their proposed hydropower projects are run-of-the-river projects which involve no storage or diversion, however, others are less optimistic and still consider these projects of utmost concern as they will influence lower riparian countries negatively. India's damming of the Ganges River which has reduced river flow to Bangladesh has also contributed to tensions (Lumaye et al. 2016).

China is also planning the northward rerouting of the river's waters at the Great Bend which can result in a significant decrease in the river's water level as it enters India and has serious impacts on agriculture and fishing in downstream areas and increase salinity. However, others are still of the opinion that the impact of the diversion will not be severe. Analysts in the region have warned that "water wars" can break out between India and China as upstream dams, barrages, canals and irrigation systems may fashion water into a political weapon or subtly in peacemaking to show dissatisfaction with a co-riparian state (Ramachandran 2015).

China has however announced in late 2016 that it will block a tributary (Xaibuqu River) of the river to construct one of the country's most expensive hydroelectric projects. The impact, if any, of the blocking is not immediately clear. The Xaibuqu River is not a trans-border one and does not fall under the bilateral mechanism between China and India (Ramachandran 2015).

China's proposed dams are key to national economic and energy development priorities and have placed less emphasis on international ramifications of planned diversions. Even though there is no comprehensive bilateral treaty in place for the sustainable management of the river, an information sharing agreement for hydrological data has at least been agreed upon between the two governments. This will hopefully improve communication on the issue and lessen suspicion and tension between the riparian states. Cooperation has therefore been expanded between Beijing and New Delhi with this agreement of sharing hydrological/flood data during the flood season after a decade of negotiations. India has officially accepted that China's dams do not pose danger to downstream water flows and have consequently created a nexus between hydrological and geopolitical worries. However, the Brahmaputra River will remain a potential source of friction between these preeminent rising powers as India remains sensitive to its control and development of its restive northeast region through which the river runs. Multilateral cooperation between the riparian states, therefore, needs to become entrenched to ensure that the region does not move slowly closer to "water wars" (Ramachandran 2015; Wuthnow 2016).

6.4.2 The Renaissance Dam and Nile River: Ethiopia and Egypt

The Ethiopian government announced in 2011 that they are planning to build the "Grand Ethiopian Renaissance Dam". The dam will predominantly be used for hydroelectricity, have a capacity of 6,000 MW and cost approximately \$4.1 billion. The hydroelectric dam will be constructed on the Blue Nile near the border with Sudan and is meant to capitalise on the country's considerable hydroelectric potential as well as provide electricity for themselves and surrounding regional populations (Michel 2013).

The construction of the dam has however angered Egyptian authorities who claim that it may limit their water supply and decrease their farmland by approximately

25%. There are also fears that Ethiopia will trade one problem for another as it may jeopardise its own water security by increasing the volatility of a river which has a history of being difficult to predict.

The potential impacts of the construction of the Renaissance Dam will particularly be on downstream water supplies which is a grave concern for Egypt who has consistently opposed the construction since it was proposed. Egypt's legal argument concedes to treaties from 1929 and 1959 which guarantee it two-thirds of the Nile's water along with veto rights on any upstream projects. Ethiopia ignored this right when they unilaterally proceeded with the construction. Ethiopia has partially diverted the course of the Blue Nile and initial filling has started in 2017 with the completion of construction (Michel 2013; Whittington 2016).

The building of the dam raises existential alarms for Egypt as the country receives almost no rainfall and depends on it for 97% of its renewable water resources. The Nile also depends on Ethiopia as more than four-fifths of the river's water falls as rain in the Ethiopian highlands.

The development of a multilateral approach to develop the Nile has failed thus far. The failure was especially evident in the 2010 Cooperative Framework Agreement where upriver countries joined together against downriver countries which refuse to give up their historical rights even though economic power and dynamics have changed in the region. Ethiopia maintains that the Renaissance Dam will not have a significant impact on its neighbouring countries however Egypt fears that it might diminish its vital water supplies. Despite constant disputes it has been stated that there is little chance that the two countries might clash swords over the Nile as both stand to lose too much from war. Even though the chances of conflict might be low, the jarring demands on the Nile's shared waters are real and symptomatic of other similar conflicting claims over scarce water resources in other regions as well (Whittington 2016).

6.4.3 Ilisu Dam and the Tigris River: The Case of Turkey and Iraq

Water has started to play a vital role and has been described as the main cause of disputes between Middle Eastern countries in recent years as evident in some of the previous case studies. Multiple years of war, thoughtless water supply management, unchecked population growth, misguided agricultural policies as well as the supporting of consumption have led to a growing water crisis in the region. Most of these countries are also comparatively downstream riparian countries which lack water resources and has led to a natural convergence of states which like to hold power and authority on limited available water resources in the region (Bari 2016). The case of Turkey and Iraq is an example of these growing conflicts within the region.

The headwaters of the Tigris and Euphrates Rivers begin in Turkey and Syria and flow into Iraq. The control of these rivers is dependent on the release of water

from upstream dams such as the Atatürk Dam which is the centrepiece of 22 Turkish dams. A concern has been raised recently that these dams in Turkey have not conformed to “international guidelines designed to prevent human rights violations through development and infrastructure projects” and a UN report notes with alarm that “the Turkish government has performed no assessment of the environmental and social impacts of these dams, perhaps because they would mostly impinge on already marginalised groups such as the rural poor, nomads, the Alevi, and the Kurds in violation of Article 2.2 of the International Covenant on Economic, Social and Cultural Rights (United Nations High Commissioner for Human Rights 1966)”.

This is a major concern for downstream riparian countries but more specifically for Iraq which is facing significant threat of water shortages attributed to internal and external challenges. These challenges include poor water management, internal political conflicts as well as unstable relationships with neighbouring countries which include Turkey, Iran and Syria. Increased water shortages can severely impair Iraq’s economy and may pose unforeseen environmental issues. Water has become a key factor in the creation of either peace or war within the region. Iraq, therefore, needs to prioritise the development of strict hydro-policies to try and mitigate increasing risks (Al-Muqdadı et al. 2016).

The Erdogan government has been keen to approve the final part of the South eastern Anatolian Project which includes the Ilisu Dam on the Tigris River located near the Syrian border. The Ilisu Dam is the most recent of many Turkish projects aimed at obtaining the hydroelectric potential of both the Tigris and Euphrates rivers. The Ilisu Dam will generate 1,200 MW or approximately 2% of Turkey’s energy needs (Bari 2016).

Iraq will be the most affected by Turkey’s upstream activities and Syria to a lesser extent. Iraq has always historically relished on most of the share of these rivers which have supplied seasonal marshlands which are used to grow food. These waters have however receded over the past decade even before the completion of the Ilisu Dam. Currently, northern Iraq and Syria are experiencing extended droughts and some analysts have mentioned that this could possibly have contributed to the rise of Islamic State of Iraq and Syria or ISIS in the region. Some extreme projections have shown that the combination of climate change as well as upstream dam activity in the region will lead to the Tigris and Euphrates rivers not having enough water to reach the ocean as early as 2040. This has consequently further raised concerns and uncertainty within Iraq regarding its future water resources (Al-Muqdadı et al. 2016; Bari 2016).

Iraq has accused Turkey of having a hidden hydro-political agenda and Turkey complain that Iraq’s claims are legally unfounded due to these rivers originating on Turkish soil. These two countries have failed to reach a consensus, Turkey has continued with its plans while Iraq has lost time as well as resources.

Assumptions have been made that Turkey is aiming to accomplish two goals at once. These goals include first to gain control of water courses which belong to Syria and Iraq and second to restrict water shares of these downstream countries to such an extent that they are forced to depend on them politically. Turkey will gain long-term advantages and could assist them in overcoming energy shortages and ultimately

establish them as a key player in Middle East politics. Turkey has justified their actions through the following arguments:

- Downstream countries do not have proper water management of their water resources and most freshwater is wasted. These countries will benefit from the project as it will prevent floods as well as water waste.
- Turkey has the right to control rivers' flow as 90% of Euphrates' and 50% of Tigris' total annual flow originates on Turkish soil.
- The UN Convention does not have binding legal status and additionally, all natural resources should be shared if the convention was to be followed literally.
- Iraq should have a lower share of water as irrigable land within the Euphrates basin does not exceed 1.95 million hectares. Moreover, most of this river basin is infertile and it would be useless to expend more water for them.
- Turkey has proposed that water from the Tigris and Euphrates Rivers should be allocated for the purpose of alleviating water shortages but this was rejected by Iraq.
- Lastly, Turkey uses these dams for community development, power generation as well as the management of demographic changes within the country and not for hydro-political gain. The dams would therefore not pose a potential threat to these downstream countries (Al-Muqdadi et al. 2016).

The Economic Commission for Europe's (ECE) Convention on the Protection and Use of Transboundary Watercourses and International Lakes entered into force in 2013 and Iraq signed this convention in June 2015. The signing of the convention may strengthen the legality of Iraq's claims and give a possibility of a win-win position. This will, however, require the establishment of a healthy negotiating environment and a change in the prevailing discourse from a political to a scientific level. Turkey has also shown legal concerns over water resource management and Iraq has not adequately managed its water resources. The arguments given above by Turkey would appear valid under the assumption that it does not operate with political motives however many indicators support the view that Turkey is acting with hydro-political motives which have led to conflicts between the two countries (Al-Masri 2014; Al-Muqdadi et al. 2016).

The dam construction site was militarised in December 2014 which led to further political tensions and human right violation despite the predicted dramatic social, cultural and ecological impacts in the affected downstream regions. The dam construction site was militarised after construction halted from August 2014 due to the resignation of workers. Workers resigned due to the kidnapping of subcontractors by guerrilla forces of the People's Defending Forces. Approximately 80% of construction was completed at this time but the hydroelectric power plant had not been constructed. Turkish people indicated that they did not want to work on the Ilisu Dam construction site as it is a threat to their lives and subcontractors consequently employed workers mainly from non-Kurdish provinces within the Republic of Turkey (Al-Masri 2014; Ayboga 2015).

Syria and Iraq already went to war with Turkey twice during the period of 1975–1991 with military action and have gone to war once over waters of Tigris

and Euphrates Rivers and it seems like this might occur again. The current wars in Syria and Iraq have intensified the situation as water networks and infrastructure have been targeted and in some cases destroyed. Some of these affected water networks have also now come under the control of ISIS and Kurdish separatists have threatened Turkey by stating that they will attack its dams as a means of retaliation over clashes (Ayboga 2015).

These occurrences have underlined forecasts that the Ilisu Dam would militarise and lead to human rights violations. The Turkish state has been called to accept responsibility however they have insisted on going forward with the project. The economic and political implications for Iraq need to be highlighted as it is dependent on the affected Tigris River and the ongoing war within the country has also shown that large water infrastructures intensify existing conflicts. The establishment of a healthy negotiating environment is therefore of prime importance and scientific discourses needs to be implemented on all levels to make sure that another war is averted within the region.

6.5 Future Climate Change and Water Conflicts

As discussed in previous chapters, global climate change may lead to negative changes in international water security in certain regions. Current climate change projections indicate an increase in droughts in certain regions of the world and increase in floods in others. The world will also experience accelerating variability in terms of timing, amount and aerial distribution of rainfall. These associated stressors with climate change may cause or worsen local violence and political actions related to securing water for their growing populations and economies as well as ensuring suitable food supply especially crops dependant on irrigation.

The warming of the world will drive conflict and instability on local, regional and global scales. Climate and environmental change have consequently been labelled as clear threats to global security which cannot be ignored. The most likely regions to suffer from water-related security conflicts have been identified as Central and South Asia due to the unique combination of rural economies which are dependent on single annual weather events such as monsoons, numerous cross-boundary/border rivers which flow from tropical glaciers in the Himalayas as well as the continued rapidly growing human population. Environmental pressures are layered in regions who have characterised borders, extended national antagonisms as well as open conflict. Other regions over the world will also likely suffer from water stress related to climate change, however, Central and South Asia are the only regions with the combination of these mentioned factors (Bhalla 2018).

As shown in previous case studies, major rivers which flow through arid regions hold an increased risk for interstate conflict between upstream and downstream states. Upstream countries which control headwaters are motivated to store water as a scarce and valuable resource while downstream countries have incentives to enforce their agenda on weaker neighbours. The Nile, Tigris, Euphrates, Mekong and the Indus

Rivers all meet the set criteria, have been identified as possible areas of conflict and in some cases conflict has already been ongoing. The case studies provided in previous sections have clearly shown that these rivers are indeed regions of conflict which may intensify with continued political instability or differences as well as stressors accompanied by climate change. Climate change will heighten the pressure on disputes and it is therefore of great importance that governments seek mutual cooperation and international institutions support cooperation (UNEP 2008; McKie 2015).

The combination of water insecurity and urbanisation, migration, pollution as well as radicalisation and proliferation of small arms may easily result in conflict. Examples of areas characterised by high vulnerability which has descended into regional conflicts include Darfur, Yemen, Ethiopia and Burkina Faso as well as Afghanistan and Pakistan. Water may not be the sole cause of conflict as the socio-economic conditions, water shortages or imbalances of water distribution are also drivers for conflict especially in marginalised societies.

“Water wars” which are defined by conflicts which are driven by water issues alone are considered to be unlikely but water disputes are already a reality across the globe especially in arid regions. Water disputes or water riots are therefore a more appropriate term than “water wars”. Small-scale riots have occurred among farmers in China, Ethiopia and Egypt as well as Central America and have been similar to food-related riots which erupted around the world in 2008. Regions which are of significant risk are those who are characterised by strong ethnic or tribal divisions. Water riots may consequently drive towards the marginalisation of parts of society away from water stress. This migration will not just be limited to poor countries. The desertification of Mexico and Central America which has placed increased pressure along the USA-Mexican border clearly shows that developed countries will also be affected (Munguía 2006; Kreamer 2012; McKie 2015).

An indirect link, therefore, exists between climate change impacts on the environment and migration. Impacts of climate change may initially cause violent conflict and consequently force affected people to flee due to violence. Conflict will then further deteriorate the environment and accelerate environmental degradation in the region which will lead to further migration. Drought has considered to be one of the climate change impacts which could trigger these conflicts. A potential for conflict therefore exists when a population experiences social discrimination in terms of access to safe and clean water and when water scarcity contributes to distributional conflict.

The impacts of water scarcity and soil degradation on food security have mainly led to migration instead of violent conflict. Migration has consequently also been labelled as one of the most distressing effects of climate change (Campbell et al. 2007). Migration in combination with politicisation of ethnicity, financial effects of displacement as well as expanding of conflicts could worsen current conflicts. Migration will also place increased pressure on the environment where they relocate due to a sudden increase in demand for resources such as water and food. The resultant competition between groups over limited resources may cause conflict if there is a history of tension between these groups due to social and cultural differences (Hermans 2012).

Climate-induced water stress is and will become an increased prime challenge in the twenty-first century. A comprehensive approach will be needed as climate change is intertwined with numerous factors as mentioned previously in this chapter. Current treaties need to be designed better and be more flexible to ensure that the different levels of water insecurity or stress as well as specific needs are considered for individual countries. It should also be a mechanism to protect weaker countries which lack leverage to deal with hegemony directly. A win–win situation, therefore, should be created for all riparian states and leadership needs to be encouraged in regions of high risks of water conflicts or disputes.

6.6 Water as a Global Risk

The previous sections clearly indicated and emphasised the role of increased water stress, continued civil unrest, competing interests as well as future climate change in the creation of water disputes as well as environmental refugees. Water can, therefore, be deemed to be a risk on all levels, i.e. local, regional and global if risks and vulnerabilities are not identified together with the implementation of adaptations and responses to build resilience.

Failure to implement environmental, social and economic measures to try and combat effects of water stress, continued droughts, as well as future impacts of climate change, will lead to further environmental degradation, drive possible mobilisations of dissent between water users and cause subsequent political unrest in extreme cases. This will in turn also lead to the creation of environmental refugees which will place further strain on neighbouring countries by deepening water pollution and scarcity. Continued poor water management practices as well as ill-maintained water infrastructure will exacerbate water scarcity problems even further and increase water-related risks in all sectors.

Current water-related problems, therefore, need to be identified to establish the costs thereof for the environment, social and economic spheres. The future impacts of climate change also need to be considered as this will also play a major role in the creation or deepening of vulnerabilities as well as risks within regions. The following sections will look at the current water-related risks as well as their costs to evaluate water as a global risk.

6.6.1 Costs of Lack of Clean and Reliable Water

It is estimated that approximately 900 million people around the world do not have access to improved sources of clean drinking water and that 2.6 billion of the world's population do not have access to improved sanitation. Access to water, sanitation and hygiene is a human right, yet billions are still faced with daily challenges accessing even the most basic of services.

Without any intervention, by the year 2025, as much as two-thirds of the world's population will be living under serious water shortage conditions and one-third of the population will be living in regions experiencing water scarcities. The year 2050 will see half of the world's population living in conditions of absolute water scarcity (Curry 2010; Ribolzi et al. 2011). Numerous countries are either suffering from intense water shortages or running the risk of being added to the water scarcity statistics. Water scarcity is, therefore, a major global risk as indicated in this and previous chapters and requires attention on all scales and in all water use sectors.

Rapid urban development especially within the developing world has resulted in many informal settlements which lack domestic waste disposal, sanitation as well as sewerage/effluent systems and limited water supply. People are continued to be forced to live in areas of inadequate access to sanitation and have forced them to obtain water from very limited areas. The surface water bodies within most of these areas are highly impacted and shallow wells are often near pit latrines. More than 80% of sewage waste in developing countries are estimated to be discharged untreated into water bodies which affect not only drinking water but also ecosystems which can not survive in eutrophic conditions. Continued urbanisation which is driven by a combination of external factors will therefore lead to continued water degradation and ultimately increased water scarcity within these regions as water will be unsuitable for use. It, therefore, needs to be noted that continued rapid urban development needs to be properly managed to reduce the risk of increasing water stress.

The poor population, particularly children, are mostly hurt or affected by unhygienic and insufficient water and it is estimated that every year inadequate sanitation with the lack of hygiene have claimed the lives of 2.2 million children under the age of five and is an equivalent to 6,000 deaths per day. The impact of diarrheal diseases in children under the age of 15 is greater than the combined impact of HIV/AIDS, malaria and tuberculosis. Additional global statistics related to access to clean water and water-related diseases include the following. Approximately 2.6 billion people have gained access since 1990 however 663 million are still without access to improved drinking water resources. A minimum of 1.8 billion people around the world drink from water sources which are faecally contaminated. Lastly, the proportion of the global population using improved drinking water resources increased from 76% in 1990 to 91% in 2015. Water degradation, therefore, has immense socio-economic costs as it increases health risks and costs as a whole placing strain on developing countries' and/or region's current and future economic development.

The investment in the improvement of water supply, sanitation, hygiene and water management practices can reduce the world's disease burden by approximately 10%.

Increased good hygiene behaviours can be used to combat ill effects of diseases caused by poor personal hygiene and skin or eye contact with contaminated water. Organisations attempt to address these issues by combining improved sanitation facilities with hygiene education on schools. SuperAmma is a good example of such a programme which has been successfully implemented in rural India where instead of using health messaging, emotional motivators were used to improve hand-washing behaviours. The campaign increased hand washing with soap by 31%.

For regions or countries to be able to achieve the set SDGs, proper water and sanitation will be the key foundation. Improved water and sanitation also serves as a basis for achieving gender equality as well as good health in regions. Sustainable water management practices will enable the improved management of food and energy production and ultimately contribute to further economic growth. Likewise, water ecosystems will also be preserved together with their biodiversity and action can be taken on future climate change by building resilience to future changes.

Ignoring the need for improved infrastructure and sustainable water management practices will lead to the continued death of millions of people per year, further losses in biodiversity and ecosystem resilience and ultimately undermine success and a sustainable future. Governments should therefore keep on being held accountable by civil society organisations and investments need to be made into water research and development. The inclusion of women, youth and indigenous communities in water resource governance should be encouraged. Lastly, awareness needs to be generated of these roles and turn them into actions which lead to win-win results as well as improved sustainability and integrity for human and ecological systems.

6.6.2 Costs of Insufficient Supply and Future Water Scarcity

Water scarcity affects more than 40% of the global population and approximately 1.7 billion people live in river basins where water use exceeds recharge and these statistics are projected to rise. Additionally, the world's freshwater supplies are deteriorating at a rapid rate accompanied with numerous threats to maintaining supplies for the rapidly increasing human population.

Both fresh surface water and groundwater resources are increasingly being depleted by mismanagement and by over-tapping, especially in countries where the natural water supply stores are less than the demand for water. Water degradation through numerous different pollution sources are also contributing to the depletion of freshwater supplies, with this problem being the greatest in countries where water regulations or enforcement is absent. The pollution of both surface and groundwater, limits the quality of water, especially in developing countries where approximately 95% of all untreated urban sewage is discharged directly into surface water bodies. The dumping of untreated urban sewage is not only occurring in developing countries. Some well-developed countries such as the USA are also guilty of this charge. Approximately 37% of all lakes in the USA are unfit for swimming as a result of this type of pollution (UN 2003; Cassardo and Jones 2011; Ribolzi et al. 2011).

Human wastes, fertilisers, pesticides, eroded soil sediments, as well as untreated waste water from industries, are among the greatest sources of pollution. The pollution of surface water results not only in the water being unsuitable for human consumption but is also applicable to crops. By ignoring these problems and not addressing them, water shortages could be aggravated, humans and ecosystems be threatened and the levels of rivers and lakes could drop significantly, not only in developing countries but also in countries across the world (UN 2003; Cassardo and Jones 2011).

A significant cost of a lack of clean and reliable water supply due to increased water scarcity or pollution is related to food security. Food security is closely linked with water as global agricultural water use accounts for 70% of all water consumption compared to 20% for industry and 10% of domestic use and many forms of energy production also requires reliable water resources. The competition for adequate supply of clean water within communities have as a result also exacerbated public and private discord and have in some cases led to increased water disputes in many regions across the world.

Scarce water resources also have an impact in terms of day-to-day cost on a personal human level mainly in the form of time spent collecting water. Millions of children, especially girls, spend several hours a day collecting water causing them not to be able to attend school. It is estimated that an additional 443 million school days are lost per annum from water-related illnesses and the associated economic losses are linked to increased health expenses, absenteeism and decline in productivity. The world's poorest countries are the hardest hit with Sub-Saharan Africa estimated to have lost 5% of its GDP in 2003 or approximately \$28.4 billion annually to water-related diseases which account for more than the total debt relief and aid to the region within that year. The World Bank estimates that 6.4% of India's GDP is lost due to adverse economic impacts and costs of inadequate sanitation.

Serious problems which arise from inadequate water supply can continue for generations. An example of this has been the estimated 100,000–250,000 human deaths and the perish of millions of herd animals during the drought of 1968–1975 in Sub-Saharan Africa which resulted in societal upheaval, significant shifts in population (displacement of 5.5 million), many children suffering from brain damage due to inadequate nutrition and the economy of eight countries devastated for decades after.

Furthermore, 20% of the world's potable water is lost from distribution pipes on account of inefficiencies (e.g. leaking pipes). Countries such as Bulgaria and Hungary have unacceptably large numbers as they lose 50 and 35% of potable water through pipe inefficiencies respectively. The Indian city of Bangalore loses approximately half of its pumped water even before it reaches the city's distribution systems. However, it is not only the developing nations that are feeling the effects of water shortages. Continued development and the intensification of the urbanisation process in developing countries, as well as the overall increase in the world's population, will cause a dramatic increase in water usage (Sikdar 2007; Ribolzi et al. 2011).

There is no substitute for water as it is an essential element for the survival of human beings and the environment. Industries and national economies are all dependent on this resource. The demand for already overcommitted national and inter-

national water resources in numerous countries has rapidly increased, especially in many of the world's largest cities. The result has been the ripple effect of disputes among riparian communities which eventually escalates into serious regional and international security issues (Shen et al. 2008; Frederiksen 2009). The increase in the world's human population is therefore not the only cause of water scarcity. Political power, policies and socio-economic relations can also induce water scarcities as a result of unbalanced power relations, poverty and inequalities (Kummu et al. 2010; UNDP 2006). Political conflicts over water especially in the Middle East have strained international relations amongst these already water-starved nations and the combination of political conflicts and the continuous increase in population will exacerbate and possibly spread these problems pertaining to water even further (O'Brian and Leichenko 2003; Cassardo and Jones 2011).

Furthermore, increasing scarcities owing to climate change, population growth, industrialisation, inefficient agricultural practices, and the degradation and maldistribution of water resources, could also compound already tense interstate relations and could cause mass migrations of environmental refugees (Guslits 2011). These mass migrations will place immense strain on the water resources within these affected regions or countries and might lead to social conflict and disputes, increased pressure on food security and place pressure on future economic growth as a result of increased competition between the human population and primary water use sectors.

It is therefore very clear and definite that these externally imposed stresses can lead to social unrest and disputes, political instability and in some cases as indicated previously armed conflict. Global estimates of the number of people living in areas with water stress therefore differ significantly between studies (Vörösmarty et al. 2000; Alcamo et al. 2003, 2007; Arnell 2004). Climate change is only one of many factors that influence future water stress; demographic, socio-economic and technological changes possibly play more important roles in most regions. The number of people living in water-stressed river basins would increase significantly mainly due to population growth projections.

6.7 Managing Water Tensions, Risks and Conclusions

It was estimated in 2010 that approximately 80% of the world's population were living in areas where water supply was not secure with leakages in the water supply system being a predominant vulnerability in both developing and developed countries. The contamination of drinking water or sabotage of distribution chains has also been regarded as likely terrorist acts even though the quantity of toxic chemical needed to contaminate municipal water supply is hard to define. Most biological pathogens fail to survive in water as a contaminant in the developed world due to standard water treatment practices however the vulnerability of water supply post-treatment has increased in risk. Consequently, some developed nations such as the USA have started to develop new safety measures such as remote monitoring technologies as

well as critical system redundancies and have adopted new protocols to fortify water supplies and to decrease these vulnerabilities and risks.

Conflicts over water resources have been described to be more complicated than a direct parallel to other resources. Various distinctions should be made between the types of resources and the paths by which they might contribute to possible conflict. The complication nature of water conflicts is further emphasised by water not being lootable like other conflict resources such as diamonds, not being geographically fixed as well as being intimately linked to livelihoods, local cohesion as well as political tensions.

The continued disputes between India and Pakistan have become an example of how listed water disputes serve as an impediment to cooperation between countries. India's growing energy needs for continued economic growth have increasingly clashed with the farmers in Pakistan who are dependent on shared waters. India's continued construction of several dams in the Indus River basin has led to Pakistani military and jihadi groups identifying water disputes as a core issue which needs to be resolved for the relations between these two countries to normalise.

The monitoring and assessment of the globe's water quality have been described as an essential part in trying to understand the intensity and scope of the world's water quality challenge. The coverage of data is however inadequate in many parts of the world and an urgent venture focussed upon the expansion of water quality data collection, distribution and analysis will be needed to try and identify hot spot areas of water pollution which can be deemed as high-risk areas.

The present situation regarding water planning and management holds many challenges. The future thereof will become even more challenging as a result of an increase in the demands of the world's population and the increased impacts that will be associated with climate change. It is estimated that the world's population will increase by 2.5 billion people in 2050 to bring the world's total population to 9.2 billion. This increase in population is equivalent to the total number of people that were in the world in 1950. Most of the growth in population will occur in the less-developed regions. Most of these regions are already the most severely affected by the lack of sanitation and drinking water services so that an increase in population will only aggravate the situation.

Growing population pressures, unsustainable consumption as well as accompanied escalating environmental stresses have led to the escalation of strains on fresh-water resources around the globe. The case studies included in this chapter are prime examples of how these pressures have put mounting strains on the environment but also on affected human populations and political relations.

Many river basins around the world are increasingly considered closed, meaning that the renewable water within the basin has already been allocated to various water sectors and the environment itself with little or no spare capacity. Examples of such river basins include from the Nile to the Tigris-Euphrates to the Indus as well as the Colorado River (USA) and the Yellow River (China). Closed river basins and rivers are not able to absorb new water demands or buffer fluctuations in supply. Changes in water use in one part of the system will therefore echo to users elsewhere in the basin, increasing pressure on consumers, the environment and policy makers.

It is estimated that more than 1.4 billion people currently live within closed river basins. The constant increase in water demands of primary water sectors will continue to increase the number of closed basins around the world and risk outrunning sustainable supplies in many more regions. Currently, projections show that the world's water requirements will exceed renewable resources by 40% in 2030 if we do not consider and implement extensive efficiency gains as well as policy improvements. China's water supplies are estimated to only fulfil three-quarters of its demand and India only half by 2030.

Global climate change will further aggravate these challenges by shifting rainfall patterns threatening to reduce water availability in some regions on the one hand and inflicting extreme weather events such as stronger storms in others and increasing potential droughts and floods on the other. The populations within regions experiencing drought will migrate to wherever resources are and as a consequence often triggers conflict. With the constant increase of water scarcity around the world, conflicts over resources have become common and water-related conflicts will definitely increase.

For the world to meet its growing water needs it will require more effective use of available water resources and ultimately enhanced collaboration between water use sectors and communities within nations as well as between countries in international basins. Water policy changes made by one user can ultimately affect the timing, location and amount of available water to other users as consumers are intimately linked by these shared water resources. As shown in the Nile confrontation case study, confrontation is not a productive way to navigate trade-offs as conflict can not assist in meeting increased water demands. Due to the indistinguishable ties between various water users in shared basins, only cooperation between nations and water users will be able to achieve the identification and implementation of necessary trade-offs and assist in meeting rising water demands. Water resources ignore political boundaries and water managers will need to learn how to manage shared water supplies as allies instead of rivals or more and more regions will suffer from increased water shortages. Increased water scarcity around the globe will cause politics to play a very powerful role in deciding water allocations across and within borders. Strong institutions will therefore be needed which should include equitable economic reallocation schemes, communication management as well as legislation to manage water tensions. The history of cooperation does not show much promise for the future and more focus needs to be put on water disputes which are not bothered by international borders or diplomacy. The establishment of a healthy negotiating environment and a change in the prevailing discourse from a political to a scientific level will be required on all scales to ensure the development of adaptations and responses which improve resilience and minimise of vulnerabilities.

References

- Alcamo J, Doll P, Henrichs T, Kaspar F, Lehner B, Rosch T, Siebert S (2003) Global estimates of water withdrawals and availability under current and future “business-as-usual” conditions. *Hydrol Sci* 48:339–348
- Alcamo J, Florke M, Marker M (2007) Future long-term changes in global water resources driven by socio-economic and climatic changes. *Hydrol Sci J* 52:247–275
- Aleem Z (2015) Why water shortages are the greatest threats to global security. Available via <http://mic.com/articles/111644/whywatershortagesarethegreatestthreattoglobalsecurity#.dBjhX1ok5>. Accessed on 26 Feb 2018
- Al-Masri A (2014) Water wars directed against Syria and Iraq: Turkey’s control of the euphrates river. Available via <https://www.globalresearch.ca/water-wars-directed-against-syria-and-iraq-turkeys-control-of-the-euphrates-river/5389357>. Accessed on 26 Feb 2018
- Al-Muqdad SW, Omer MF, Abo R, Naghshineh A (2016) Dispute over water resource management—Iraq and Turkey. *J Environ Prot* 7:1096–1103
- Arnell N (2004) Climate change and global water resources. *SRES emissions and socio-economic scenarios*. *Global Environ Change* 14:31–52
- Ayboga E (2015) Ilisu Dam construction site militarized. Available via <http://www.hasankeygirisimi.net/?p=41>. Accessed on 26 Feb 2018
- Bari SA (2016) The water crises in Turkey, Syria and Iraq. Available via <https://www.pakistantoday.com.pk/2016/07/17/the-water-crises-in-turkey-syria-and-iraq/>. Accessed on 26 Feb 2018
- Bhalla N (2018) World has not woken up to water crisis caused by climate change. Available via <https://www.scientificamerican.com/article/world-has-not-woken-up-to-water-crisis-caused-by-climate-change/>. Accessed on 26 Feb 2018
- Campbell K et al (2007) The age of consequences: the foreign policy and national security implications of global climate change. Centre for Strategic and International Studies (CSIS) and Centre for a New American Security (CNAS). Available via http://csis.org/files/media/csis/pubs/071105_ageofconsequences.pdf
- Cassarido C, Jones JAA (2011) Managing water in a changing world. *Water* 3:618–628
- Cooley H, Donnolly K, Phunisamban R, Subramanian M (2015) Impacts of California’s ongoing drought: agriculture. Available via <http://pacinst.org/publication/impactsocaliforniasongoingdroughtagriculture/>. Accessed on 26 Feb 2018
- Cruikshank M (2013) Yemen is on the verge of running out of water. Available via <https://thinkprogress.org/yemen-humanitarian-crisis-water-54a9c0b52831/>. Accessed on 26 Feb 2018
- Curry E (2010) Water scarcity and the recognition of the human right to safe freshwater. *North-western J Int Hum Rights* 9:103–121
- FAO (Food and Agriculture Organisation) (2012) Syrian Arab Republic Joint Rapid Food Security Needs Assessment (JRFSNA). FAO Report, 26 pp. Available online at http://www.fao.org/giews/english/otherpub/JRFSNA_Syrian2012.pdf
- Femia F, Werrell C (2013) Syria: climate change, drought, and social unrest. The Center for Climate and Security. Available online at <http://climateandsecurity.org/2012/02/29/syria-climate-change-drought-and-social-unrest/>
- Frederiksen HD (2009) The world water crisis and international security. *Middle East Policy* 16:76–89
- Frenken K (2009) Irrigation in the Middle East region in figures: AQUASTAT survey—2008. FAO Water Report, 34, 402 pp. Available online at <http://www.fao.org/docrep/012/i0936e/i0936e00.htm>
- Gleick P (2014) Water, drought, climate change, and conflict in Syria. *Am Meteorol Soc* 6:331–340
- Guslits B (2011) The war on water: international water security. Political Science Department. University of Western Ontario
- Hermans L (2012) Climate change, water stress, conflict and migration. International Hydrological Programme of UNESCO. Available via https://www.unesco.nl/sites/default/files/dossier/climate_change_water_stress_conflict_and_migration_0.pdf. Accessed on 26 Feb 2018

- Intelligence Community Assessment (2012) Global water security. ICA 2012–08. Available via https://www.dni.gov/files/documents/Special%20Report_ICA%20Global%20Water%20Security.pdf. Accessed on 26 Feb 2018
- Johnson R (2015) California's drought and the politics of inequality. Available via <http://www.truth-out.org/news/item/32143-california-s-drought-and-the-politics-of-inequality>. Accessed on 26 Feb 2018
- Jones A (2017) Food security: how drought and rising prices led to conflict in Syria. Available via <https://theconversation.com/food-security-how-drought-and-rising-prices-led-to-conflict-in-syria-71539>. Accessed on 26 Feb 2018
- Kahn D (2015) Drought: political temperatures rise over conflicts between urban and rural water use in California. Available via <http://www.eenews.net/stories/1060016956>. Accessed on 26 Feb 2018
- Kasler D, Reese P (2015) California drought impact pegged at \$2.7 billion. Available via <http://www.sacbee.com/news/state/california/wateranddrought/article31396805.html>. Accessed on 26 Feb 2018
- Kreamer DK (2012) The past, present, and future of water conflict and international security. *J Contemp Water Res Educ* 149:87–95
- Kummu M, Ward PJ, de Moel H, Varls O (2010) Is physical water scarcity a new phenomenon? Global assessment of water shortage over the last two millennia. *Environ Res Lett* 5:1–10
- Lopour J (2016) Yemen, water and conflict. Available via <https://www.cigionline.org/articles/yemen-water-and-conflict>. Accessed on 26 Feb 2018
- Lopour J (2017) Yemen, water, conflict and cholera. Available via <https://reliefweb.int/report/yemen/yemen-water-conflict-and-cholera>. Accessed on 26 Feb 2018
- Lumaye S, Wuthnow J, Samaranyake N (2016) China and India's slow-moving path to 'Water Wars'. Available via <http://nationalinterest.org/feature/china-indias-slow-moving-path-water-wars-18254>. Accessed on 26 Feb 2018
- McKie R (2015) Why fresh water shortages will cause the next great global crisis. Available via <https://www.theguardian.com/environment/2015/mar/08/how-water-shortages-lead-food-crises-conflicts>. Accessed on 26 Feb 2018
- Mhanna W (2013) Syria's climate crisis. Available via <http://www.al-monitor.com/pulse/politics/2013/12/syriandrought-and-politics.html#>. Accessed on 26 Feb 2018
- Michel D (2013) Egypt, Ethiopia water dispute threatens nations. Available via <http://www.ibtimes.com/egypt-ethiopia-water-dispute-threatens-nations-1324189>. Accessed on 26 Feb 2018
- Mohtadi S (2013) Climate change and the Syrian uprising. Available via <http://thebulletin.org/web-edition/features/climate-change-and-the-syrian-uprising>. Accessed on 26 Feb 2018
- Muhammad J (2010) Scarce water the root cause of Darfur conflict? Available via http://www.finalcall.com/artman/publish/World_News_3/article_6808.shtml. Accessed on 26 Feb 2018
- Munguía VS (2006) Water conflict between the US and Mexico: lining of the All-American Canal. Human Development Report 2006, UNDP
- Ng D, Mukherjee T (2017) As a river dies: India could be facing its 'greatest human catastrophe' ever. Available via <https://www.channelnewsasia.com/news/cnainsider/as-a-river-dies-india-could-be-facing-its-greatest-human-9060070>. Accessed on 26 Feb 2018
- O'Brian KI, Leichenko RL (2003) Winners and losers in the context of global change. *Ann Assoc Am Geogr* 93:89–103
- Patranobis S (2016) China blocks Brahmaputra tributary, impact on water flow in India not clear. Available via <https://www.hindustantimes.com/india-news/china-blocks-brahmaputra-tributary-impact-on-water-flow-in-india-not-clear/story-QVAYbO2iOBFUSynwpyneN.html> Accessed on 26 Feb 2018
- Pedroncelli R (2015) Tiny endangered fish highlights California drought conflicts. Available via <http://www.cbsnews.com/news/tinyendangeredfishhighlightscaliforniadroughtconflicts/>. Accessed on 26 Feb 2018

- Pimentel D, Whitecraft M, Scott ZR, Zhao L, Satkiewicz P, Scott TJ, Phillips J, Szimák D, Singh G, Gonzalez DO, Moe TL (2010) Will limited land, water, and energy control human population numbers in the future? *Hum Ecol* 38:599–611
- Polgreen L (2007) A godsend for Darfur, or a curse? Available via <http://www.nytimes.com/2007/07/22/news/22iht-22polgreen.6764928.html>. Accessed on 26 Feb 2018
- Poppick L (2014) California droughts could have dangerous ripple effects. Available via <http://www.livescience.com/49287californiadroughtsrippleeffects.html>. Accessed on 26 Feb 2018
- Ramachandran S (2015) Water wars: China, India and the Great Dam Rush. Available via <https://thediplomat.com/2015/04/water-wars-china-india-and-the-great-dam-rush/>. Accessed on 26 Feb 2018
- Ribolzi O, Cuny J, Sengsoulichanh P, Mousque's C, Souleleuth B, Pierret A, Huon S, Sengtaheuanghoung O (2011) Land use and water quality along a Mekong tributary in Northern Lao P.D.R. *Environ Manag* 47:291–302
- Saleeby S (2012) Sowing the seeds of dissent: economic grievances and the Syrian social contract's unraveling. Available via http://www.jadaliyya.com/pages/index/4383/sowing-the-seeds-of-dissent_economic-grievances-an. Accessed on 26 Feb 2018
- Schlein L (2011) Water scarcity root of Darfur conflict. Available via <https://www.voanews.com/a/water-scarcity-root-of-darfur-conflict-123688459/158292.html>. Accessed on 26 Feb 2018
- Shen Y, Oki T, Utsumi N, Kanae S, Hanasaki N (2008) Projection of future world water resources under SRES scenarios: water withdrawal. *Hydrol Sci* 53:11–33
- Sikdar SK (2007) Water, water everywhere, not a drop to drink. *Clean Technol Environ Policy* 9:1–2
- Swanson D (2014) Water and conflict. Available via <http://www.irinnews.org/analysis/2014/04/22/water-and-conflict>. Accessed on 26 Feb 2018
- UN (United Nations) (2003) The United Nations Development Report: water for people, water for life. Executive Summary, UN
- UNDP (United Nations Development Programme) (2006) Human development report 2006: beyond scarcity: power, poverty and the global water crisis. United Nations Development Programme, New York
- UNEP (United Nations Environmental Programme) (2008) Vital water graphics: an overview of the state of the world's fresh and marine waters, 2nd edn. UNEP/GRID-ARENDAL
- Vira B (2016) Droughts and floods: India's water crises demand more than grand project. Available via <https://theconversation.com/droughts-and-floods-indias-water-crises-demand-more-than-grand-projects-60206>. Accessed on 26 Feb 2018
- Vörösmarty CJ, Green P, Salisbury J, Lammers RB (2000) Global water resources: vulnerability from climate change and population growth. *Science* 289:284–288
- Walker T (2015) California drought: almond growers fight back over reports they are causing chronic water shortages. Available via <http://www.independent.co.uk/news/world/americas/california-drought-almond-growers-fight-back-over-reports-they-are-causing-chronic-water-shortages-10224339.html>. Accessed on 26 Feb 2018
- Whitehead F (2015) Water scarcity in Yemen: the country's forgotten conflict. Available via <https://www.theguardian.com/global-development-professionals-network/2015/apr/02/water-scarcity-yemen-conflict>. Accessed on 26 Feb 2018
- Whittington D (2016) Nile valley water conflict: can Egypt live with Ethiopia's grand renaissance dam? Available via <https://www.juancole.com/2016/06/conflict-ethiopian-renaissance.html>. Accessed on 26 Feb 2018
- Wines M (2014) West's drought and growth intensify conflict over water rights. Available via <https://www.nytimes.com/2014/03/17/us/wests-drought-and-growth-intensify-conflict-over-water-rights.html>. Accessed on 26 Feb 2018
- Worldwatch Institute (2018) Desertification as a source of conflict in Darfur. Available via <http://www.worldwatch.org/node/5173>. Accessed on 26 Feb 2018
- Wuthnow J (2016) Water war: this river could sink China-India relations. Available via <http://nationalinterest.org/feature/water-war-river-could-sink-china-india-relations-15829>. Accessed on 26 Feb 2018