Water and its Global Meaning

1

Andreas Haarstrick and Müfit Bahadir

Abstract

In times of climate change, the question of safe and sustainable use of freshwater resources is becoming increasingly urgent, and in some regions around the equator belt, even more urgent. It is imperative that water management is reformed towards sustainability and that the awareness of both the responsible governments and the population is raised even more than is the case at present. A "business as usual" attitude will even more jeopardise human lives and lead to environmental destruction than is already the case. We have the choice! It is evident that increasing water demand follows population growth, economic development and changing consumption patterns. Global water demand has increased by 600% over the past 100 years and will grow significantly over the next two decades in all the three components, industry, domestic, and agriculture. Industrial and domestic demand will grow faster than agricultural demand but demand for agriculture will remain the largest—Global water demand for all uses, presently about 4,600 km^3 per year, will increase by 20–30% by 2050, up to almost 5,500–6,000 km^3 per year. By 2040/50 the global population will increase to between 9.4 and 10.2 billion people and most of the population growth will occur in Africa. This chapter addresses the most pressing issues of water resource sustainability and puts a finger on the wound that, if left untreated, will become an uncontrollable inflammatory problem.

Keywords

Water crisis · Water management · Water scarcity

1.1 Water on Earth

About 4.5 billion years ago, our planet Earth was formed. Since then, natural forces have shaped our planet. Water became the most important factor of life. Not only the origin of life, but also the human civilization depends on water. The earliest ancient civilizations developed at river basins. Bricks were produced from water and soil for building homes. Distribution and consumption of water were the triggers of formation tribes and states. Settlements at oceans were able to

A. Haarstrick (✉)
Leichtweiss-Institut für Wasserbau, Exceed, Technische Universität Braunschweig, Braunschweig, Germany
e-mail: a.haarstrick@tu-bs.de

M. Bahadir
Institut für Ökologische und Nachhaltige Chemie, Technische Universität Braunschweig, Braunschweig, Germany

M. Bahadir and A. Haarstrick (eds.), *Water and Wastewater Management*, Water and Wastewater Management, https://doi.org/10.1007/978-3-030-95288-4_1

develop to world metropoles. But today, these metropoles are severely endangered due to sea level rise. Meanwhile, big cities are built in deserts. They can only exist due to water transported from long distances of hundreds of kilometers. Nowadays, water has become scarce and is going to be much scarcer with the growing world population. Human being shaped the earth that significantly calling the period "*Anthropocene*"—the age of men.

Water is a versatile stuff. The total amount of it on earth remains constant. It takes just different aggregate states like liquid, solid and vapor (gaseous). Due to this versatility, the hydrologic cycle is triggered, continuously generating freshwater. Each drop of freshwater we drink is recycled numerously over the time. To the best of our knowledge, our earth is the sole planet in the universe having liquid water. But it is still controversial, where the water on earth came from. Water is assumed to be imported from comets, consisting of frozen water and dust that hit our planet in earth history in great number.

Through solar irradiation water evaporates from water surfaces (oceans, lakes) and forms clouds in the atmosphere through condensation at deeper temperatures since cold air can store less amounts of water than warm air. It starts raining. The precipitation is taken up by plants and evaporated over the leaves again. The same with soil surfaces. The water cycle runs continuously. The large forest areas of equatorial belt in Latin America, Africa, South Asia, Oceania, etc. are called "rain forests", being mostly responsible for this phenomenon. Plants take up water from the soil through their roots, transport it through the stems to the leaves and evaporate it again—called evapotranspiration. The vapor condenses in the atmosphere forming clouds and raining and precipitating again. This way, the rain forests organize their water demand by them own. Without the plants, water would soak away to the aquifer or run off to the oceans.

The total volume of water on our planet remains always the same—about 1.4 billion km^3. This is a huge amount of water. But just less than 3% of it is non-saline (fresh) water that is needed for most living species. 2% of freshwater is stored in polar and glacier ice, which is not available for human consumption. Just less than 1% of the total water amount on earth can be used as drinking water and water for different human activities like agriculture, industry, and public water supply. Almost the half of this 1% of water is stored partly in deep aquifers and is renewed rather slowly. This groundwater is pumped to surface and available for human consumption. But at the same time, the groundwater reserves deplete. Today, roughly 2/3 of freshwater is used for irrigation in agriculture, followed by the industry and public supply (each approx. 1/6 of freshwater amount). Agriculture is the greatest consumer of freshwater worldwide. It is estimated that almost one billion people worldwide do not have access to clean drinking water, whilst around one third of mankind does not have suitable sanitary facilities or wastewater treatment. This situation becomes worsened through the future scenario of climate change particularly in already drought regions of our planet.

Water is essential for all major socio-economic sectors, contributing to each of them in a different way. For instance, agriculture requires large quantities of water for irrigation and food production. Energy requires water for powering turbines, cooling power plants, and growing biofuels. Access to safe water supply and basic sanitation is necessary for maintaining public health. Water is needed to keep the ecosystems healthy, which in turn provide crucial environmental goods and services. The benefits from each of these sectors are provided through water. Managing water for all is not only a question of availability of resources and money, but equally a matter of public participation and good governance. Water is a local issue and involves numerous stakeholders at basin, municipal, regional, national, and international levels. If effective public governance is missed to manage interdependencies across policy areas and between levels of governmental bodies, policymakers will face obstacles designing and implementing measures for sustainable water management. Even mitigating the impacts of natural disasters through extreme events

following climate change like flash floods and inundations, recently occurring almost every year, is not only a problem of Developing Countries, but also of the developed world.

Many water resources have trans-boundary character. Rivers of Nile, Euphrates and Tigris, and Jordan in the Middle East, but also Rivers Elbe and Rhine in the heart of Europe deserve joint solutions of the riparian countries. Basin wide cooperation is essential for sustainable water management for prosperity and peace in the respective regions. Many projects in development cooperation fail for ignoring the importance of socio-cultural aspects, and solely concentrating on technological problems. The end of the active involvement of experts from industrialized countries often leads to failure in the implementation stage of projects. Especially, projects related to water supply and use gain little recognition if the various political, cultural, and social meanings of water in different regions are not considered.

1.2 The Presence and Future of Water

The next time one opens a bottle of water one should think about where the water used comes from and under what conditions it was extracted. Indian beverage cans contain treated rainwater, while the water for soft drinks in the Maldives is obtained from seawater. In most cases, however, drinking water is still obtained from surface and groundwater reservoirs. It should be emphasized, however, that the above examples are no longer exceptions, and more and more water has to come from different sources to meet demand. There is a reason for this: we are at the beginning of a global freshwater crisis.

Given that 70% of the Earth's surface is covered with water, and that volume remains constant (at 1,386,000,000 km^3; Fig. 1.1), how is a water shortage even possible? Well, it must be remembered that 97.5% of all water is seawater that is unsuitable for direct human consumption. And both populations and temperatures are ever rising, meaning that the freshwater we do have is under severe pressure.

Global water demand is expected to increase by 55% by 2050. Much of the demand will be used in agriculture. Demand accounts for more than 70% of global freshwater consumption. To feed the growing population, food production will have to increase by 69% by 2035. The same is true for water withdrawals for energy. Here, a decline of more than 20% is expected due to the likewise increasing demand [1]. With this development, it once again becomes quite clear that a global water crisis will certainly occur, if intelligent measures for the sustainable use of drinking water resources are not initiated as soon as possible.

Mexico City, which was built on old lake beds, is experiencing an average subsidence of 30–40 cm/a in some areas [2, 3]. The reason is that the aquifer beneath the city has been depleted. Once horizontal streets now consist of hills and valleys. Meanwhile, the city must import 40% of its fresh water from 2000 m lower regions (partly also from seawater desalination plants) and has become more extremely vulnerable than ever before [4].

This situation is also comparable to California (USA). The state experienced the most intense drought periods from 2012–2014 compared to those reconstructed over the past 1200 years according to the Palmer Drought Severity Index (PDSI). The large aquifer volumes declined at a rate of almost 20 bill. m^3/a during this time [5]. Even subsequent extreme precipitation was unable to fully recharge the reservoirs. Groundwater reservoirs generally have a regeneration time of up to 300 years.

What else could a global freshwater shortage lead to? One gloomy theory refers to the possibility of armed water conflicts. Particularly vulnerable regions in this respect are the Middle East and the Arabian Peninsula [6]. Another theory deals with climate change and the spread of deserts. Devastating examples of this can be found in north-eastern parts of China, in India and in Sub-Saharan Africa [6].

But it is worth looking at some bright spots. Some nations have found noteworthy solutions—Australia, for example. Australia survived a "millennium drought" that lasted from 1997 to

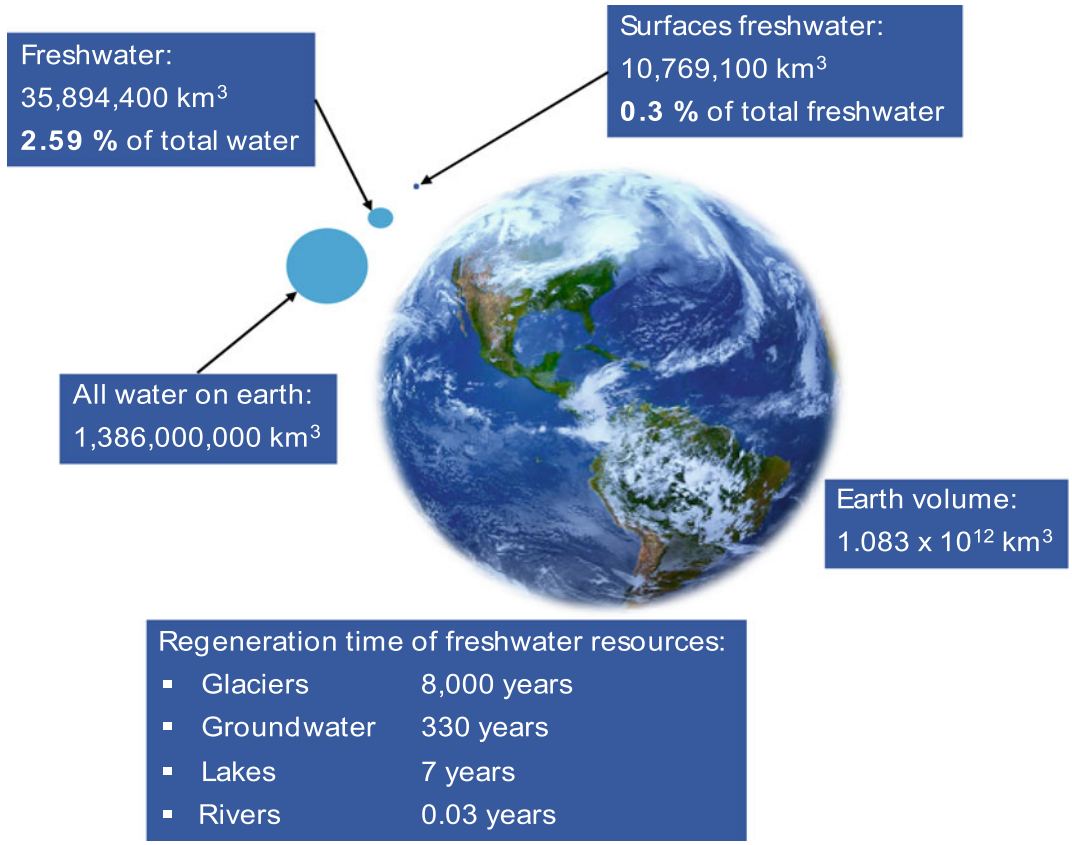

Fig. 1.1 Water on earth

2009. The response was a rapid implementation of measures that halved water consumption by businesses and households. This was achieved, among other things, by introducing a price for water that made it a tradable commodity [7]. This worked well, but one must not forget that water trading involves many dangers, especially on the stock exchange. Despite successful regulation of use through price, it must be ensured that fresh water supplies are subject to equitable distribution. The right to water must have a strong legal and ethical basis that is not negotiable.

Another notable example is Israel, which considers water availability a matter of national security. By recycling wastewater, including domestic sewage, the Shafdan Wastewater Treatment Facility near Tel Aviv, for example, provides about 140,000,000 m^3/a of water for agricultural use. Thus, over 87% of Israel's agricultural water needs are now met by wastewater [8]. Spain as one of the biggest European exporters of vegetables and fruits, for example, manages only 19%. However, it should be noted, that Israel is pursuing a conflict-laden policy in the Middle East regarding freshwater resources, which is one of the most controversial sets of issues in this region [9].

Can desalination of seawater be an effective solution to meet the growing demand for water in industry and agriculture and, moreover, avoid political crises? Currently, desalination via reverse osmosis is highly costly and maybe also for the next decades only a thinkable option for rich countries. The capital costs are presently going to be higher than a treatment plant to treat freshwater. However, the further development of renewable energy and related technologies may contribute to reduce those costs making

desalinated water affordable and contribute to ease political tensions.

A simpler, cheaper, and quick-to-implement solution is rainwater harvesting. In Melbourne, Australia, one of the largest rainwater harvesting tanks can hold four million liters [10]. Authorities such as Kerala, Bermuda and the Virgin Islands have mandated that all new buildings be equipped with a rainwater harvesting system. For Malaysia/Singapore, it has been calculated that up to 75% of domestic water demand can be met by rainwater harvesting [11].

As earlier mentioned, around the world, more than 70% of freshwater is used for irrigation. Moreover, in many cases, the agricultural irrigation techniques are inefficient. Further, with respect to excessive freshwater use, thermal power plants (nuclear, coal, natural gas) require vast amounts of water for cooling. Renewables for the most part—solar and wind—do not! The faltering shift to renewables has much to do with heavy-handed, lobby-driven government policies. Bold and consistent action is needed to incentivize society and the economy and to support smart investments.

To achieve water-efficient societies, there are undoubtedly many ways, in which this can be done. In fact, it should be quite simple, either by increasing the efficiency, with which every drop of water is used, or simply by moving away from water-intensive uses and increasing the use of appropriate environmental technologies with sustainability credentials.

Closely linked with the question of the future fate of freshwater resources is the debate on sustainability. In 1987, Gro Harlem Brundtland (former Norwegian Prime Minister) in her report popularized the term "sustainability" by referencing critical environmental and development problems on global level. In this context, she stressed the following items [12]:

- Establishment of a way of acting that considers the needs of current and future generations without any compromises;
- Equal distribution of natural resources amongst users in an area shall not only spatially happen but also be temporally during the time of usage.

This approach sounds like a "wonderful" idea. But is it realistic? In this debate, one has to consider three main issues. The first one is an inherent problem that deals with the implementation of conceptual ideas and acceptance by majority society. The second issue raises the question how it could become successful. The answer may only result from changes, which must be obtained in a way that the total dependence on earth's resources deeply penetrate human consciousness. The third issue relates to basic requirements: An all-over accepted definition and manifestation of what is really needed, and an adaptation to sustainable action in daily routine.

The World Water Council says: "*There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people—and the environment—suffer badly.*" [13]. It is still possible to take corrective measures to prevent the water crisis from worsening. However, what is depressing and sad is that despite the growing awareness that our freshwater resources are limited and need to be protected in terms of both quantity and quality, nothing significant is changing.

Regardless of the use of freshwater (agriculture, industry, household), huge water savings and improved water management are possible. Water is wasted almost everywhere, and if people do not face water scarcity, they take access to water for granted and as a natural thing. With population growth, urbanization and advancing industrialization, water consumption is bound to increase. In order not to fall further into a massive crisis, several measures need to be taken to increase the proportion of people with sustainable access to safe drinking water and sanitation:

- Guarantee the right to water;
- Decentralize the responsibility for water;
- Develop know-how at local level;
- Increase and improve financing;
- Evaluate and monitor water resources.

Urgent action needs to be taken about agriculture, transboundary cooperation, resource conservation, and ecological diversity. The increasing demand for water by humans not only reduces the amount of fresh water, but also has a profound impact on aquatic ecosystems and the species that depend on them. There is a danger that ecological balances will be massively disturbed and thus no longer be able to serve their regulating role.

The UN Water Report 2019 [6] says that global water demand is expected to continue increasing at a similar rate until 2050, accounting for an increase of 20–30% above the current level of water use, mainly due to rising demand in the industrial and domestic sectors. Over 2 billion people live in countries experiencing high water stress, and about 4 billion people experience severe water scarcity during at least one month a year. Stress levels will continue to increase as demand for water grows and the effects of climate change intensify. Moreover, these processes are intensified by changing climate conditions and the increase of extreme weather events (Table 1.1).

Water-related natural hazards such as floods and droughts affect already water supply and sanitation infrastructure, leading to significant economic and social losses and impacts. It can already be observed that such hazards are increasing in frequency and intensity because of climate change. Short- and long-term impacts of water-related extreme events also include the spread of communicable diseases, disruptions to water and food supplies, and the damage to financial assets and social disruption.

1.3 Water and Wastewater Management in the Context of Sustainable Development Goals

The Agenda 2030 of the United Nations established 17 Sustainable Development Goals (SDGs) and 169 global targets, related to development outcomes and means of implementation for the period 2015–2030. The SDGs were designed to be integrated and indivisible to balance the social, economic, and environmental dimensions of sustainable development [14].

The anchoring of SDG 6 in the 2030 Agenda, "*Ensure availability and sustainable management of water and sanitation for all*", reflects the most pressing issues in water and sanitation. The Agenda addresses rising inequalities, depletion of natural resources, environmental degradation and climate change as the greatest challenges of the present. It points out that social development and economic prosperity depend on sustainable management of freshwater resources and ecosystems, and it emphasizes the integrated nature of the SDGs.

Water-related ecosystems and the environment have always provided natural sites for human settlements and civilizations, bringing benefits such as transportation, natural purification, irrigation, flood protection and habitats for

Table 1.1 Average annual impacts of inadequate drinking water and sanitation services, water-related disasters, epidemics, earthquakes, and conflicts

	Water-related			Others	
	Inadequate water and sanitation	Drought	Flooding	Earthquakes and epidemics	Conflicts
People affected during a period of emergency	No data	55 million	106 million	6 million	65 million
People killed	780,000 by infection deseases	1100	6000	56,000	75,000 war deaths
Economic damage	No data	5.4 billion USD	31.4 billion USD	30 billion USD	No data

biodiversity. However, population growth, agricultural intensification, urbanization, industrial production and pollution, and climate change are already overwhelming and undermining nature's ability to provide key functions and services. Consequently, poor, and marginalized populations will be disproportionately affected, further exacerbating rising inequalities.

The use of freshwater in agriculture, industry and households produces highly polluted wastewater that pollutes freshwater resources. In many countries, much of this wastewater is still discharged into natural waters and freshwater areas without any treatment.

Against this background, the accomplishment of SDG 6 is highly challenging. The challenge is seen above all in the governments' decision-making and prioritisation processes. Each government must decide how to incorporate them into national planning processes, policies and strategies based on national realities, capacities, levels of development and priorities. In best case, they should cover the entire water cycle including provision of drinking water (SDG target 6.1), sanitation and hygiene services (6.2), treatment and reuse of wastewater and ambient water quality (6.3), water-use efficiency and scarcity (6.4), Integrated Water Resources Management (IWRM) also through transboundary cooperation (6.5), protecting and restoring water-related ecosystems (6.6), international cooperation and capacity-building (6.a), and participation in water and sanitation management (6.b). The sub-targets mentioned here, and indicators linked to them are far from perfect. However, they provide an unprecedented basis for working systematically on the future of water security worldwide [15].

The implementation of good water governance and sustainable water management depends on the participation of a range of stakeholders that includes local communities. Governments have responsibility for many governance functions, such as formulating policy, developing legal frameworks, planning, coordination, funding and financing, capacity development, data acquisition and monitoring, and regulation. Good water governance comprises many elements, but it principally includes effective, responsive, and accountable state institutions that respond to change, openness and transparency providing stakeholders with information, and giving citizens and communities a say and role in decision-making. At this point, the participation and multi-stakeholder engagement are important parts of policy processes, although measuring their effectiveness is still in its infancy. The importance of having a transparent, universal, and neutral platform for government and citizen groups in place to mobilize available resources and to seek alternative means of ensuring improved water services has proven to be essential and complementary to local government support.

It should also be kept in mind that for reliable water management data acquisition and monitoring plays an important role. Data underpin the governance elements of accountability, transparency, and participation. They enable progress to be monitored and service providers, governments, and development partners to be held accountable. Many developing and emerging countries lack the financial, institutional, and human resources to acquire and to analyse data to support governance. Less than half of developing countries have comparable data available on progress towards meeting each of the global SDG 6 targets. Further, data acquisition and monitoring require political commitment to transparency that includes efforts related to accessibility and sharing of data. Increased utilization of the latest Earth observations, citizen science and private sector data should be incorporated into data-monitoring systems to complement existing data-collection efforts.

All the considerations and reminded measures are ultimately of little use if the capacity development leaves far behind. Unfortunately, an acute lack of capacity is constraining water resources development and management in all its facets across most developing countries, particularly in Sub-Saharan Africa and South and South-Eastern Asia. Human resource shortages are reported in all key areas, including agriculture and irrigated farming, water-related risk management, water and sanitation services, wastewater treatment, recycling and reuse

technologies, and desalination. This is not a new phenomenon and has been a leading concern and constraint on water-related development for many decades. If the respective developing countries, but also the development policy strategies of the rich industrial nations do not change their direction towards immense education and capacity building measures, then all efforts and invested money will continue to be wasted, and many of the SDGs will fail. So, this is no news to say that education, further education, and training are essential for achieving SDG 6. SDG 4.c supports this by calling for "*substantially increasing the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least-developed countries and small-island developing states*" [16].

Unfortunately, reality shows something else, e.g., Fig. 1.2 provides an indication of the numbers of students enrolled in tertiary education in 2015 in various regions, though it was not disaggregated into sectors. There were notable low numbers in Sub-Saharan Africa, which has a population of about one billion. In 2015, however, only 3.5% of students enrolled in tertiary education [17].

Several developing countries have basic education institutional structures in place, but they are too often in need of strengthening and funding. There may be options for regional training, where concerned countries share facilities and costs. However, this is not easy to implement unless countries and their schools, training centres and universities plan, fund and implement capacity development programmes that meet the expectations of national development plans.

In his speech about research in Africa 2004, the UN Secretary General Kofi Annan highlighted: "*The knowledge required for Sub-Saharan Africa to achieve its own green revolution is not lacking. What is lacking as ever, is the will to turn knowledge into practice.*" [18]. This sentence was not meant to criticise the quality of research in Africa, but to urge the focus of research and the effectiveness of the pathway from research to policy and practice. Thus, in many cases, this kind of effectiveness would contribute to a significant and visible improvement in sustainable water management and people's daily lives.

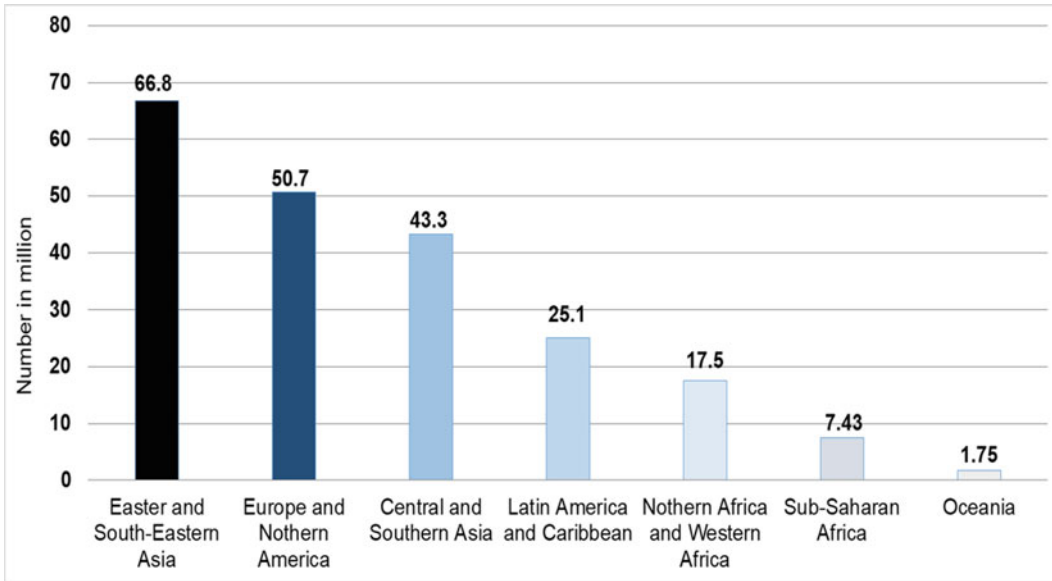

Fig. 1.2 Students enrolled in tertiary education in SDG world regions in 2015 [17]

1.4 Future Perspectives and Challenges of Sustainable Water Management in Water-Scarce Developing Countries

The most severe water problems are found in countries located in the Middle East-North Africa (MENA), South-East Asia (SEA), and Sub-Saharan Africa (SSA) regions. These different regions individually face challenges in providing safe, affordable, and sustainable water and sanitation for all. The challenges could not be more different, just as the regions themselves are different.

The **MENA region** is the most water scarce region in the world. According to FAO the "water poverty/scarcity" threshold of renewable water resources is 1,000 m^3 per capita per year, while there is in average less than 200 m^3 per capita per year in the MENA region [19]. It is already clear that water scarcity on a per capita basis is increasing and will continue to increase due to population growth and climate change. The result will be a rapid increase in groundwater demand. Impacts on agriculture, such as the loss of arable land and consequently decline in agricultural production, also contribute to increasing numbers of people migrating from rural to urban areas or fleeing to other countries. According to WHO, some 51 million people (or 9% of the total population) lacked a basic drinking water service in 2015 in the entirety of the MENA region [6]. Besides climate change and population growth, another problem is that if armed and religious conflicts continue in the region, hopes for consistent sustainable water management, access to water services for all and the establishment of safe water infrastructure are illusory. Already today, natural disasters linked to climate change impacts have resulted in the displacement of over 2,400,000 people across the Arab Region in 2016, many of them being in the Arab Least Developed Countries (LDCs) (98%): 1,230,000 in Sudan, 810,000 in Somalia, and 360,000 in Yemen [6]. The international community would do well to make every effort to end these conflicts. But the parties and governments in the region must also work resolutely to achieve this. Peaceful and free access to water and the intelligent use of resources are indeed a challenge, but only a certain prosperity can grow in the region and inspire hope for a future and secure water supply, infrastructure, and sanitation.

The **SEA region** is mostly affected by flood and drought disasters. The Asian Development Bank (ADB) reported in 2016 that 48 countries in the region are classified as water insecure regions due to low water availability and unsustainable groundwater extraction. For reasons like those in the MENA region, the need for agricultural irrigation has also steadily increased in the region. The consequence here, too, is disproportionate decreases in groundwater levels and thus a significant increase in water stress. This development is particularly evident in the North China Plain and in northwest India. In addition, high levels of water pollution are worsening the situation in terms of drinking water availability, caused by alarming rates of untreated sewage discharged into surface waters. The situation is exacerbated by high levels of chemical pollution in runoff water [20]. In the Ganges and Mekong basins, high concentrations of arsenic compounds are increasingly endangering groundwater quality. Arsenic comes from the erosion of pyrite minerals on high Mount Everest and run off into the Everest originated river systems, being transported over long distances till the Gulf of Bengal and Mekong Delta in South Vietnam. The challenges for sustainable water management are huge. This becomes clear, when one looks at the rapid growth of the region's urban population in most Asian countries, which has more than doubled since 1950, and so the problem cities face with developing adequate infrastructure are a task of the century to keep pace with rising water and sanitation needs. Looking at the rural areas in the Asian Regions with long time unsustainable practices and unequal access to irrigation water, the impact on agricultural productivity and poverty alleviation is devastating and leads more and more to loss of livelihoods, while most rural poor people are dependent on agriculture. Accordingly, the

concept of water security is gaining importance not only in Asia. The concept contributes to improving the resilience of water and sanitation services and is the key to optimizing and securing access to clean water in a climatically uncertain future, while at the same time providing governmental authorities with realistic information to take tailored measures.

In the **Sub-Saharan Africa** region, periodic and chronic water scarcity represents a major challenge to Africa's path to development and prosperity. The lack of water management infrastructure both in terms of storage and supply as well as of improving drinking water provision and sewage disposal are decisive factors that are responsible for the hardly changing poverty [6].

Climate change processes that negatively affect rainfall and temperature trends threaten water availability, agricultural productivity, and ecosystem balance in almost all regions of Sub-Saharan Africa. Additional challenges for sustainable water management arise from the growing population, which is expected to reach 1.3 billion out of 2.2 billion people worldwide by 2050. An additional aspect, which is linked to the mentioned challenge, relates the education sector. While it is estimated that 85% of primary school teachers worldwide were trained in 2016, the proportion for Sub-Saharan Africa was only 61% [17]. If equal opportunities, adequate education and training of young women and men are ensured, the intellectual contribution from these segments of the population could help Africa on its way to achieving SDG 6. Besides the academic elite, a broad and good education is a basic prerequisite for economic and political stabilization and for overcoming mass poverty. If governments continue to ignore this and do not bring about any concrete changes, the disastrous situation of many states in Sub-Saharan Africa will not change.

And yet, contrary to all the current negative signs, governments and humanity still have it in their hands to realize a positive turnaround. Only the honest and firm will must reign to bring about the positive turnaround. In all the regions discussed, there were positive initiatives and promising solutions, especially in the water sector. Countries like Cost Rica, Rwanda, Kenya, South Africa, Thailand, and Vietnam are just few examples. Perhaps the changes in one or another developing country were also based on participatory processes that brought in new and diverse voices and ideas, so that people could influence decisions as rights holders and deeply rooted and unconscious prejudices and discrimination could be overridden by changing attitudes and norms within water institutions at all levels. This is the only way to achieve sustainable water management and thus sustainable development.

1.5 The Way Forward

Water availability can be seen as a function of two distinct but inseparable characteristics. The first relates to water supply, which is the amount of water that can be sustainably drawn from surface, underground and unconventional sources. These include desalination of seawater, reuse of treated wastewater, and collection of rainwater and fog. Increasing water use efficiency in all major water use sectors (agriculture, energy, industry, and municipalities/households) can also go a long way towards reducing overall demand, freeing up water supplies for other users, including ecosystems. The second characteristic relates to access to freshwater, which means that water must be transported from the source and made available to the various users in sufficient quantity and suitable quality for the intended uses.

The need to improve and to secure water resource management is particularly critical for areas suffering from chronic or recurrent water scarcity, where demand exceeds sustainable supply, or where supply is affected by pollution, land degradation or other phenomena. The need to technically improve and sustainably optimize access to freshwater exists in all types of hydrological regimes, even in places with relative water abundance. Barriers to improved accessibility and sustainable use are often social, political, and economic. Against this background, sustainable governance structures are indispensable. Such structures must guarantee

fair and equitable and sustainable use of water resources for all. It is a high priority to ensure that sufficient water of suitable quality is available to meet the basic needs of all people, both for domestic use and subsistence. However, very often, links between water and broader decisions regarding food and energy security, humanitarian crises, economic development, and environmental sustainability often remain unrecognized or poorly understood. Worsening extreme events, environmental degradation, declining water availability and quality, population growth, rapid urbanization, unsustainable and inequitable patterns of production and consumption within and between countries, current and potential conflicts, and unprecedented migration flows are among the interconnected pressures facing mankind, which through their impact on water often hit those in vulnerable situations the hardest.

Moving forward while making progress requires a renegotiation of power relations at all levels, equitable participation and representation of all groups, and new partnerships to transform the economic, social, and political processes that guide water resource management and drive the provision of safe and affordable water and sanitation. In this context, the right priorities of the government and its active support, as well as shared awareness in the majority society are the basis for real change and improvement of living conditions.

However, given the complexity of this issue, other aspects need to be added, such as the role of society and the state. It is not enough to look at the tools available to water managers to solve the problems, but the commitment of society and the state is needed.

Water governance thus steps out of the traditional context, which was primarily about the question of supply and demand. Here, formal, and informal structures, procedures and processes operate in an integrated way at the national level. However, good water governance must also be considered globally. Global cooperation is essential in this regard. Without this cooperation, many strategies and national solutions will fail sooner or later. Neglecting the global dimension of water management carries the risk that too much national development outside the field of water management will overshadow and possibly even nullify good intentions.

After all, it is evident that according to UN-Water 2 billion people today do not have access to safely managed drinking water and wastewater, and 1.7 billion people do not have access to safely managed sanitation services [21]. The question of why this is so, and in many cases in developing countries, can be answered in large part by the prevalence in these countries of political systems composed of extractive political institutions and extractive economic action. However, the scarcely practiced resource conservation to be considered in this context can also be traced back to industrialized countries. The currently prevailing economic and political action does not prioritize sustainability and resources conservation on the agenda.

Good water governance comprises many elements, but it essentially includes effective, responsive, and accountable government institutions that respond to change, openness and transparency that provide information to stakeholders and give citizens and communities a voice and role in decision-making. This is the framework of an inclusive political and economic system. The importance of having a transparent, universal, and neutral platform for government and citizen groups to mobilize available resources and to seek alternative ways to ensure improved water and sanitation management has been demonstrated as well as the importance of complementing local government support is proven.

Let's not fool ourselves, the genuine will alone to do this is ultimately the driving force. Basically, we have no choice but to want positive change.

References

1. Burek P, Satoh Y, Fischer G, Kahil MT, Scherzer A, Tramberend S, Nava LF, Wada Y, Eisner S, Flörke M, Hanasaki N, Magnuszewski P, Cosgrove B, Wiberg D. Water futures and solution: fast track initiative (Final Report). In: IIASA working paper. Laxenburg, Austria, International Institute for Applied Systems Analysis (IIASA); 2016. pure.iiasa.ac.at/13008/.
2. Avilés J, Pérez Rocha L. Regional subsidence of Mexico City and its effects on seismic response. Soil Dyn Earthq Eng. 2010;30:981–9.
3. Gutierrez J. Water scarcity and supply challenges in Mexico City's informal settlements. Penn Institute for Urban Research 2; 2019.
4. Kimmelman M. Mexico City, parched and sinking, faces a water crisis. New York Times—Climate; 2017. https://www.nytimes.com/interactive/2017/02/17/world/americas/mexico-city-sinking.html.
5. Griffin D, Anchukaitis KJ. How unusual is the 2012–2014 California drought? Geogr Res Lett. 2014;41(24):9017.
6. WWAP (UNESCO World Water Assessment Programme). The United Nations world water development report: leaving no one behind. Paris: UNESCO; 2019.
7. Australian Government, Bureau of Meteorology. Australian water markets report 2017–18: national overview section; 2019. ISSN 2207-1733.
8. Marin P, Tal S, Yeres J, Ringskog K. Water management in Israel key innovations and lessons learned for water-scarce countries: World Bank—Water global practice. 2017;18–21
9. Fröhlich CJ. Security and discourse: the Israeli–Palestinian water conflict. Conflict Secur Dev. 2012;12(2):123–48. https://doi.org/10.1080/14678802.2012.688290.
10. Imteaz MA, Shanableh A, Rahman A, Ahsan A. Optimisation of rainwater tank design from large roofs: A case study in Melbourne, Australia. Resour Conserv Recycl. 2011;55(11):1022–29.
11. Hafizi Md Lani N, Yusop Z, Syafiuddin A. A review of rainwater harvesting in Malaysia: prospects and challenges water. 2018;10(506). https://doi.org/10.3390/w10040506.
12. Keeble BR. The Brundtland report: our common future. Med War. 1988;4(1):17–25.
13. World Water Council. 2020. https://www.worldwatercouncil.org/en/water-crisis.
14. Scharlemann JPW, Brock RC, Balfour N, Brown C, Burgess ND, Guth MK, Ingram DJ, Lane R, Martin JGC, Wicander S, Kapos V. Towards understanding interactions between sustainable development goals: the role of environment–human linkages. Sustain Sci. 2020;15:1573–84.
15. Guppy L, Mehta P, Qadir M. Sustainable development goal 6: two gaps in the race for indicators. Sustain Sci. 2019;14:501–13.
16. Isgida Y. How does the newly added DAC evaluation criterion "coherence" contribute to achieving the SDG target 4c for teachers? J Int Coop Educ. 2020;22(2)/23(2):15–29.
17. Renata A, Ortigara C, Kay M, Uhlenbrook S. A review of the SDG 6 synthesis report 2018 from an education, training, and research perspective. Water. 2018;10:1353. https://doi.org/10.3390/w10101353.
18. Kofi Annan. 2004. https://www.un.org/press/en/2004/sgsm9405.doc.htm.
19. Mualla W. Water demand management is a must in MENA countries... But is it enough? J Geol Resour Eng. 2018;6:59–64.
20. UN ESCAP. Paths to 2015—MDG priorities in Asia and the Pacific. Asia-Pacific MDG Report; 2010/11.
21. UN-Water. Summary Progress Update 2021—SDG 6—water and sanitation for all. Version: July 2021. Geneva, Switzerland; 2021.