FUTURE CHALLENGES OF PROVIDING HIGH-QUALITY WATER

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Contents

Summary

This contribution explores the globalization of issues and challenges pertaining to the provision of high quality water in future against the background of global climate change. It addresses the state of the globe's freshwater resources and availability and identifies a number of emergent patterns in this process. Globalization occurs in an era where the impact of climate change on water resources will severely impact on the future provision of this source. Various aspects of globalization such as floods, droughts, the role of El Niño, and the rise of sea level are addressed. Globalization and global

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climate change will alter water management in future. Ethical and demographic considerations in the provision of high quality water are also addressed.

1. Introduction

Water is life. Water is politics. Water is also scarce. Water is also a global issue. Globally water is abundant, but unevenly distributed in time and space. (See, for example, Table 1.) As a natural resource it shares a number of characteristics with other resources, yet not all resources share water's significance as the basis for all forms of life. Water is one of the few renewable resources, via the hydrological cycle. It is mobile, contributing to tensions pertaining to ownership and control. Water can be used in a number of ways, such as for agriculture, irrigation, industrial, and human consumption.

Continent	**Area (10^3 km^2)**	**Population (millions)**	**Runoff (km^3/year)**
Europe	10 500	498	3 210
Asia	43 475	3 108	14 410
Africa	30 120	648	4 570
North and Central America	24 200	426	8 200
South America	17 800	297	11 760
Oceania	8 950	26	2 388
Total	135 045	5 003	44 540

Source: Peter Gleick, "Coping with the global fresh water dilemma: the state, market forces and global governance", in Pamela Chasek, ed, *The global environment in the twenty fist century: prospects for international cooperation* (New York: United Nations University Press, 2000), p. 206.

Table 1. The global availability of freshwater by continent
Source: Gleick (2000), p. 206.

Water is a prominent commodity, needed not only for the physical survival of every organism on the planet but also for the economic prosperity of humans. It is needed in the domestic, industrial, and agricultural sectors. In fact, most of our economic activities and life sustaining needs are either directly or indirectly dependent on water resources. The demand for water increases as populations grow and socio-economic development expands. For instance, as a state and/or region's industrial development increases, so too does the demand for water. The same can be said of agricultural expansion and, underlying this, population growth. In tandem with the increase in the demand for water, the supply diminishes. Finding the correct balance between water supply and demand is the overriding challenge facing every society in the world. Population growth and socio-economic development along with the associated increase in demand and decrease in the supply of water are the direct and immediate challenges that face national, regional, and global water sectors. Yet a number of other problems also confront these water sectors. Some of the most important of these problems relate to global climate change, water scarcity, and water and international security. These challenges are formidable

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because they need different approaches in order to solve them. Global climate change, although better understood during the last couple of decades, seems to be one of the greatest uncertainties facing humanity and the freshwater resources we use.

As globalization intensifies, the power of national governments to address water issues declines. The challenge to provide high quality water for both human and industrial consumption will be increasingly daunting. The Westphalia order of the state is increasingly threatened. Some scholars suggest that we are already living in a post-Westphalia world order. Water issues, contradicting the Westphalia concept of the state as a fixed territorial space, are not limited to particular social and geopolitical boundaries. Furthermore, the issues of providing high quality water challenge another notion of the Westphalia state, namely that of the state's sovereignty. In some cases, states have waived their sovereignty in order to have sustainable water resources to provide high quality water. The provision of high quality water (as a political, economic, and developmental issue of who gets, what, where, when, and how) has since the 1960s become a trans-national issue. In this sense globalization has reconfigured the state and its power vis-à-vis the provision of high quality water (for example) in a number of ways. A state's territory, a major Westphalia hallmark, is increasingly becoming part of a world without borders. Water as a trans-border issue redefines geography, community, and power relations within and between states. Second, state sovereignty regarding water is increasingly eroded. New international rules and authorities govern water issues. Third, state autonomy on water provision is compromised. No state can act alone on the provision of high quality water. It has to consult with a number of actors within and outside its borders. Fourth, the question of citizens' allegiance to the state is challenged. New centers of public authority are created outside the state's jurisdiction. Citizens are more likely to align themselves with a transnational social movement on a particular issue than with a state. Lastly, the world is not an anarchy but rather a heterarchy, in other words, a system in which political authority is shared and divided between different layers of governance and in which various actors share in the governance of resources.

Globalization, a highly contested concept, is one of the driving forces determining future challenges of providing high quality water. Globalization is here described as "processes whereby social relations acquire relatively distanceless and borderless qualities." (Paradoxically, this process does not mean the end of fixed territorial geography.) Although elements of globalization have been witnessed previously in history, it has unfolded to an unprecedented extent since the 1960s. It is a process that has touched the lives of almost every human being on the globe. Yet the trend has spread unequally in different parts of the world, adding to the challenges of providing high quality water.

This theme paper examines some aspects of globalization and how it relates to water and the challenges of providing high quality water. The future challenges relate to meeting basic human needs and human health, the link between water and food security, the link between water and ecosystems, and water as a national security issue. Added to this are issues relating to water access, quality, quantity, and management, along with the development, control and allocation of water resources. The issue also includes

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concerns over global and regional food security and sufficiency, as well as the role of women and the link between water and health.

This theme will look at some of these challenges in a broad sense, in that it supplies the student and practitioner with useful information regarding the various facets of the challenges ecosystems and humans face regarding freshwater resources. In the first part, we will be looking at the global and regional freshwater resource balance. In this section a number of topics will be discussed, including the hydrological cycle, the amount of water in the earth/atmosphere environment, the distribution of water across time and space, and the impact of anthropogenic activities on freshwater resources. Global climate change and its various impacts on freshwater resources will be presented in the second part. The different impact thereof on the climate, freshwater resources, sea-level rise, the El Niño phenomenon, the ethics and politics surrounding the mitigating activities to counter this futuristic threat, and how it can be viewed from a broader societal perspective are shortly discussed. Demographics and water availability and demand will be examined in the third part of the theme.

There are a number of ways in which water issues can be said to have become globalized. Some water issues are inherently global and intrinsically transnational. There are, for example, about 250 international watersheds covering more than 50 percent of the land surface of the globe, an area that includes more than 40 percent of its population. This links to the second point: some water issues relate to the exploitation of the so-called global commons. As water is intimately linked with all aspects of the natural environment and most human activities, it is a valuable resource linked to disparities in power, wealth, and health. Water is the basis for all forms of life. It is also the basis for development in industrialized societies as well as agrarian economies. Water scarcity remains one of the most fundamental development constraints in developing countries. Moreover, water issues are often local in their occurrence and scale, but global in their impact.

The globalization of water issues is manifested in, *inter alia*, global awareness, the number of multilateral organizations and agreements addressing water and related issues, the expansion of International Law to deal with these, and the increase in the number of global non-governmental organizations and social movements involved in addressing the future challenges of providing high quality water.

2. Global and Regional Freshwater Resources

One of the most fundamental challenges with respect to freshwater resources is that of the quantitative assessment of global and regional freshwater inventories. The reason for this fundamental challenge is that freshwater is the most important resource for environmental and societal purposes, within the ambit of rational use and protection of water resources. This is one of the most important and complex scientific and technical problems facing humanity. Such problems are to a large extent becoming national, regional, and global in nature. Deficiencies of freshwater and the progressive pollution of water resources are increasingly constraining factors in the socio-economic development of many countries within the developed and developing world. Knowing how much water the global and regional environments contain is very important, for

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water is a critical element in ecological cycles, of which humans are also a part, and it is essential to ascertain where, when, how, and how much water will be needed in future. We need it in order to drive our industries, to supply energy, and to produce food. For these purposes huge amounts of freshwater are required, and they must be drawn from the environment, with its intricate water cycle and distribution of freshwater around the globe and among regions.

Not only that, water is also central to the mythical, religious, and political interpretation of humans' existence on the living planet. The Greek philosopher Thales, for instance, who lived in the early sixth century B.C. in Miletus, believed that all things are made of water. In relation to this, Thales also believed that everythin g started in and from water and comes to an end or dies into water. He accepted that the entirety of things on earth consists of water. Thales also had the mythical belief that the earth rested on a bed of water, which he borrowed from Egyptian and/or Babylonian creation legends. Accordingly, the earth was created from water by one or more gods. Water was a divine entity for Thales, and consequently possessed a soul. He contended that in this sense water could be considered as divine. He therefore deduced that, because everything consisted of water, and water had a soul, so everything contained a soul and was divine. In Thales' terms, water is central to every ecosystem in the biosphere, something that was realized over 2,500 years ago.

The mystical value of water, then, was recognized by the ancient Greeks in the distant past. At the end of the twentieth century, however, our understanding of global and regional freshwater resources is still to a large extent defective. For instance, we still do not understand the dynamics of the flows of water between the continents and oceans, the volumes of water contained in the earth/atmosphere environment, and the state of the environment's freshwater reserves. Yet during the 1960s, known in the water sector as the International Hydrological Decade, which was co-ordinated by the United Nations Educational, Scientific and Cultural Organization (UNESCO), we made a giant leap forward in broadening our understanding of the many unfamiliar elements of the global hydrologic cycle. Many references on global and regional freshwater resources cited in 2001 date from that period. Since then, however, there has been little follow-up on our comprehension and knowledge of how to solve problems of the world's most critical resource, except for the United Nations International Drinking Water Supply and Sanitation Decade from 1981 to 1990. Over the past twenty to twenty-five years, scientists from around the world have composed and presented appraisals of global water reserves and the use thereof. These publications contain material and data on water resources and the water balance, water utilization, and the effect of economic activities on water resources.

Within the earth/atmosphere environment water is an ever-present resource. It is contained within the atmosphere as moisture and on land in river and streams, aquifers, ice sheets, and glaciers, wetlands and bogs, and in the oceans as salt water and icebergs. In fact the oceans around the world form the largest reservoir of water on the planet. Of all the water on earth, 97 percent is saltwater. This huge volume is unfortunately unsuitable for drinking purposes or the production of food for the ever-growing world population. The other 3 percent is freshwater. The total volume of this tiny amount is in the order of about 35 million cubic kilometers (km^3). Nevertheless, almost all of this

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freshwater is contained in the ice caps of Antarctica and Greenland and within deep sub-surface aquifers. This water is technically and economically out of reach of human purposes, for the time being. Just 0.3 percent, or 100,000 km^3, of all freshwater resources on our planet is found in rivers and lakes. This volume of water makes up the total of our available water supply.

Dependable assessments of global and regional freshwater resources, stockpiled in a manifold of water bodies and in diverse physical states are highly important in understanding how humans affect water resources and the hydrologic cycle. We should be mindful of the fact that the information concerning the volume of water on earth is not an accurate presentation of the actual global water reserve. Such data are only approximations of the actual values of water contained in the earth/atmosphere environment. For instance, the information on water contained in sub-surface ice in permafrost regions, the amount of soil moisture, and water stored in marshes and bogs is based on rather rugged, and sometimes crude, approximations. On the other hand, more reliable calculations are now, after years of research, at hand regarding water contained in the oceans, reservoirs and lakes, in polar ice caps and sheets, and glaciers, and volumes of fresh and brackish ground water. The reasons for these disparities in the data on different water resources seems to be that such data are derived computationally and cannot therefore be very reliable in the case of sub-surface ice, soil moisture and water contained in marshes and bogs. Another reason could be that the other water resources in the oceans, glaciers, rivers, lakes, and so on are to some extent—depending on the type of water resource—more accessible to humans for different purposes. For instance, groundwater resources play a very important part in the water supply and demand of many Middle Eastern and North Africa countries, while rivers and streams are utilized to a large extent in other parts of the world such as Southern Africa, Latin America, Europe, Asia, Australia, and North America. Therefore, what seems to drive the gathering of water data is the economic value attached to the commodity.

As we have noted, the total amount of freshwater is about 35 million km^3. This volume represents just 2.5 percent of the total water reserve contained in the hydrosphere. A fairly large portion of the freshwater, about 24 million km^3, or 68.7 percent, is in the form of ice and/or permanent snow cover in the Arctic and Antarctic. On average around 90,000 km^3 (90.26 percent of total global freshwater resources) is contained in rivers and lakes, on which humans depend for their main freshwater needs. Every type of water is interdependent and interacts intimately as water is transformed from one form to another, and advances from the oceans to land surfaces and back under the power of solar energy and the earth's gravitational pull. This cycle is called the hydrologic cycle.

Water in the oceans and other surface reservoirs on land, such as dams and lakes, is heated and vaporized by solar radiation. It is estimated that an enormous volume of water, in the region of about 505,000 cm^3, evaporates on a yearly basis from ocean surfaces. The total evaporation of water over the oceans is about six times greater than that over land. The reason for this is that the oceans cover most of the planet's surface and land areas are not always wet enough to produce much evaporated water. The vapor accumulates in the atmosphere where it is condensed to fall to earth and the oceans as rain, hail, or snow. Precipitation over the oceans is almost four times greater than that

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over land. Almost 90 percent or 458,000 km^3 of water precipitated over the ocean returns in various forms back to the ocean. The precipitation over land, 10 percent or 50,500 km^3 of water, is collected in rivers and streams, lakes, wetlands, groundwater aquifers, glaciers, and ice caps. Of the total, precipitation that falls on dry land and supplying all types of water resources is in the order of 119,000 km^3. Gravity transports these different forms of water to inland water reservoirs or the oceans. Of the 119,000 km^3 of water that falls over land surfaces, about 47,000 km^3 per year (35 percent) is returned through various runoff systems back to the ocean. Solar radiation can also evaporate it while on land or in the oceans, and the cycle begins anew. The hydrological cycle is in a state of constant movement that never comes to an end. Because precipitation over the earth's terrestrial surface is more that the evaporation, water runs off the land and into the oceans. Evaporation, precipitation, and runoff are known as pathways for water in its various facets. These pathways are interconnected in a closed matter flow system. Within the hydrological cycle water is also always in a constant state of change.

The pathways of water form a highly complex interdependent system. The patterns of precipitation in the form of rain will shed some light on this closely linked system. Precipitation in general is the world's most important source of water. The agricultural sectors of societies, in some parts of the world, depend largely on rain as a source of water. In Southern Africa for instance dry-land farming, with its associated subsistence and commercial farming components, relies almost exclusively on rain as a source of water. The three principal parameters of precipitation include volume, intensity, and frequency, which vary with respect to place, time, and season throughout the year. Knowledge of these characteristics is essential in the planning of water projects for different uses in society. The routes of rainwater make up the process of the hydrological cycle and are quite complex. Even before rain reaches the surface, some of it is evaporated into the air, at a rate that depends on the temperature of the air and its humidity content. The evaporation cannot be measured, but is made manifest by lower air temperature and an increase in humidity levels. If a saturation point is reached, rain will fall to the ground. However, the world water balance may be considered as a closed system. There is at the moment no information to confirm a one-way flow of water from the earth's atmosphere back into outer space, and no data to suggest that water is coming from outer space and into the earth/atmosphere environment to alter the balance to any significant extent, apart from the occasional meteor containing some small amount of water moisture.

Although the earth/atmosphere environment contains a huge amount of water in all its facets, in different forms and types of water bodies, it is well known that water is distributed over time and space in a highly irregular fashion. This is clearly shown by comparing the runoff of freshwater by continent, which is as follows: Africa 4,600 km^3, Antarctica 2,310 km^3, Asia 14,100 km^3, Australia and Oceania 2,510 km^3, Europe 2,970 km^3, North America 8,180 km^3 and South America 12,200 km^3. From this it is evident that more than half of the freshwater global runoff occurs in Asia and South America (31 percent and 25 percent respectively). Africa, Australia, Oceania, and Europe account for 9.7 percent, 5.3 percent and 6.3 percent respectively. There is therefore a huge disparity among regions with respect to the freshwater resources available for socio-economic development. Most the runoff, over 80 percent, is concentrated in the

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northern and equatorial zones of the world, with fairly small populations. In temperate zones, on the other hand, freshwater resources are exceedingly limited. These zones include the southern forest, the forest-steppe, and steppe zones. These areas are also more suitable for human life and a host of activities, especially the production of food. Freshwater resources are even more unevenly distributed over the continents and large portions of the earth's land surface. There are enormous regions with arid and semi-arid climates and regions with limited water resources. Such territories occupy 33 percent of Europe, 60 percent of Asia, a large portion of Africa, the southwestern parts of North America, around 30 percent of South America, and the largest part of Australia. There are also wet regions within these territories that have abundant water resources.

On top of this, we do not always receive the necessary freshwater from the hydrologic cycle when we need it most. Some places may receive gigantic volumes of freshwater, while others get almost none. Some of the driest places on earth can go years with not a drop of water, or at best very small volumes. This is the case with the Atacama, Namib, and Sahara Deserts in Chile, Namibia, and North Africa respectively. On an annual basis these places may not receive any rain, with rain gauges showing zero measurements throughout the year. Other places may receive huge amounts of freshwater. For instance, Mount Waialeale, on the island of Kauai, Hawaii has received more than 11.5 meters (m) of rainfall in one year. Some regions across the globe may have average and above rainfall for a long period of time, while at other times they may suffer severe drought. This was the case with large parts of Southern Africa during 1982–3 and 1990–5, when drought had a crippling effect on the ecosystems, populations, and economics of most of the states in the region.

Runoff is therefore unevenly distributed throughout the year within different regions of the world. Most of it, between 60 percent and 70 percent, occurs in the flood period. Total river and stream flows contrast significantly for the continents as whole. Most of the runoff in Europe (48 percent) takes place between April and July. In Asia, 80 percent of the runoff occurs during the period May to October. In Africa, more than 74 percent, takes place from January to June. May to August is the time for largest volume (54 percent) runoff in North America. In South America it takes place from March to September, with a runoff of 70 percent, and in Australia it is 68 percent in January through March.

The challenge of studying water resources includes the appraisal not only of the regional and periodical distribution of freshwater resources, but also the impacts of human actions on freshwater reserves. Significant impacts on the natural variation of river and stream flow and the condition of global and regional freshwater resources have over the past decades and even century been influenced by a number of factors. (These elements do not impact on the amount of global and regional freshwater resources. They do not increase or lessen the volume of freshwater, since the amount available to humans has not changed to any significant degree since the time of the Roman Empire.) Over the past decades intensive development of industries and the agricultural sector across the globe, population growth, the expansion of humans into vast tracks of virgin territories, ever increasing withdrawals of freshwater on all continents and from various sources, and policies of forest clearing have been among the most notable impacts on the natural state of freshwater reserves. These activities

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have had a profound impact on river and streams. Many rivers and streams are no longer in a pristine state, due to economic and other societal practices such as forest clearing within their basins. Many aquatic ecosystems have collapsed due to an ever-increasing withdrawal of water for socio-economic development. The Aral Sea in Central Asia is a case in point, where much of the surface of this inland lake has been reduced to desert by the abstraction of increasing volumes water for the production of cotton during the heyday of the Soviet Empire.

Studying and increasing knowledge about the vast volumes of water contained in the earth/atmosphere environment is one of the most important contemporary challenges facing humanity. In future, we will be faced by another challenge that could have severe impacts (to varying degrees, some positive and some negative), not only on freshwater life support systems but also on the economic activities of humans: global climate change.

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Biographical Sketches

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Hannatjie Jacobs is an independent research consultant based in Stellenbosch, South Africa. After obtaining her first degree from the University of the Free State, and her second degree at the University of Port Elizabeth, she completed an M.A. in Political Sciences at the University of Stellenbosch before completing an M.B.A. at the University of Stellenbosch's Graduate School of Business. Ms Jacobs gained distinctions for her two dissertations. She has received various academic awards. Apart from her extensive media experience, she has published on various aspects of Africa's position in the global political economy for more than two years in her weekly column, "In Africa," in a South African newspaper. She is currently involved in a project focusing on leadership development, HIV/AIDS and education in Africa under the auspices of the University of Stellenbosch's Network for African Congregational Theology (NetAct).

Richard Meissner received his training as a political scientist at the Rand Afrikaans University (RAU) in Johannesburg. He obtained an M.A. in Political Studies from the same university in 1999 and is currently busy with a D.Phil. in International Relations at the University of Pretoria (UP). He was one of the first students in South Africa to complete a Master's thesis on water politics.

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Research Unit (AWIRU), which he joined in 1999. He was involved in a number of studies regarding the management of national and international water resources in Southern Africa and the Middle East. He has also written a number of articles for accredited journals. His scope of interest lies within the field of water politics and particularly the interaction of divers actors within the domestic and international domains regarding water resource issues. Richard Meissner is a member of the South African Political Studies Association and the South African Institute of International Affairs.

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