

Freshwater Resource Exploitation: New Security Challenge For Africa

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ABSTRACT

Population growth and human activities such as freshwater resource exploitations continue to have shattering effects on ecological dynamics. These effects are likely not unrelated to issues emanating from climate change and global warming. There is adequate scientific evidence that supports shifting trends in the ecosystem and specifically relating to increased water use and loss of wetlands; that poses a new security challenge for Africa especially, and which without proper intervention, could be catastrophic; resulting in food shortage and profound implications on biodiversity conservation. Many measures have been put in place intended to arrest excessive water extraction; the measures include co-management, encouragement of local community adaptation methods, and good governance. It is unclear whether these methods can catch up with the speed of depletion of the water resources. There is fear that future scarcity in water resources could compound with other issues plaguing Africa to result in conflicts.

Key words: Africa, Bluewater, Ecosystem, Ecoregion, Freshwater, Global food supply, Greenwater, Planetary freshwater boundary, Water consumption Water crowding, Water resources, Water scarcity, Water Withdrawal.

INTRODUCTION

Rapid growth in world population and ever-increasing consumption of renewable and nonrenewable resources poses serious challenges for both future development prospects and the very existence of the resources. These challenges are not unrelated to those posed by *climate change*, *global warming*, and *climate variability*; and together have brought more awareness to food-energy-water-nexus (Hasan, Tarhule, Hong, & Moore III, 2019), hence creating a real perception of water scarcity and risks. Between 1970 - 2015 approximately 35% of the world's wetlands were lost and the loss rate has been accelerating annually since 2000 (United Nations Climate Change, 2018). Liu et al., explain that excessive groundwater exploitation for purposes of irrigation and farming in areas of slow recharge is the main reason for water depletion in Africa; hence the growing demand for water will continue to redirect reliance on unsustainable freshwater withdrawals (2017).

According to Schuol, *et al.* (2008) despite the general consciousness about insufficiency of water supply in Africa, information on freshwater availability and water scarcity is rather limited. There is extensive literature that addresses the problems related to freshwater exploitation globally, but

scantier on Africa specifically. However, literature is rich in content that discusses insecurities resulting from climate change, water variability, food shortage and hunger, and other challenges that have previously been described as security challenges for Africa. Available evidence suggests that about 50 percent of global wetlands have been lost (Anonymous, 2012) and more than 20 percent of the global known freshwater species are extinct or endangered by human arresting factors (UN Report, 2019) such as; pollution, excessive water usage, and farming activities. Estimates indicate that water use will see a 50 percent increase by 2032. Given such alarming trends and patterns, it is not at all surprising that two-thirds of the population of the world shall face water shortage (Manzoor, 2011) would be one of the significant security issues of the 21st century, especially in Africa where there is a combination of the lack of knowledge resources and political will to work towards arresting the situation.

Freshwater resource exploitation continues to have shattering effects on ecological dynamics, stability, and water resource quality on a global scale, especially in arid and semi-arid regions (Hambright, et al., 2008). Africa has approximately 87 different freshwater ecoregions grouped into 10 major habitat types and distributed among 5 regions. The diversity of freshwater habitats is high and covers a wide range; from the extreme wet conditions in the Congo to the dry conditions of the Sahara (Fouchy, McClain, Conallin, & O'Brien, 2019).

According to World Bank report estimates, more than 50 percent of the global population is concentrated in Africa, the Middle East, and South East Asia. This concentration of population in these regions signifies that the communities are at higher risk of facing severe water shortage by 2025 (Manzoor, 2011) if there is not a coordinated effort for intervention put in place to address the problem. The gravity of the problem is equally evident in other regions where water conflict and loss of freshwater ecosystems are looming. In almost three decades, there have been debates worldwide about how to manage African freshwater fisheries with a focus on co-management (Jul-Larsen & Dwieten, 2002).

RELATED BACKGROUND

There is no doubt that water is essential for planetary life support, and the insecurities associated with water deficiency must be addressed through socio-economic development processes (Falkenmark, 2013). While issues associated with freshwater exploitation are universal, Africa seems to be the most vulnerable because they lag in addressing freshwater exploitation and water scarcity issues, thus exposing the continent to security challenges and possible future conflicts. The most stressed areas related to freshwater exploitation according to Fouchy, *et al.* (2016) include temperate coastal rivers of northern Africa, tropical and subtropical floodplain rivers of western Africa, upland rivers of southern Africa, and the Great Lakes.

Schuol, et al., (2008) created a model for Africa using mostly freely available public global information; due to the unevenly distributed weather stations within the continent. Accordingly, the outcome of this analysis could be used in national and global water planning and management.

ARTICULATION OF THE PROBLEM

The problem discussed herein is not confined to freshwater; saltwater regions display a similar bleak picture. More than 75 percent of the world's population will likely reside within 50 miles of

the sea by 2025; thus, exerting pressure on the coastal ecosystem and may lead to further depletion of flora and fauna. Freshwater - lakes, rivers, wetlands, and underground aquifers - provide a broad array of services, including flood control, fish production water purification, portable water supply, recycling, and transportation as well as protection of biodiversity. Despite the significant role water plays in our daily lives, many of its ecosystems are being destroyed by excessive uses via water withdrawal, introduction of alien ecosystems and invasive species of flora and fauna. It is estimated that more than 60 percent of fisheries are exploited at or beyond the acceptable sustainable levels, and more than 50 percent of the world's coral reef are likely to die by 2030.

While over 70 percent of water is consumed by agriculture, humans are still the biggest users of water resources. Humans around the globe consume more than 90 percent of all water resources. Water use has generally been on the rise with increase in economic activities, especially for industrial and municipal arenas. Industries need water for cooling, power generation, and washing. Among the industries that consume most of the water resource are the Iron and steel industries, petrochemical, and paper. People also require water for drinking, food preparation, and sanitation. The World Bank asserts that given the present levels of human activities, there is a greater likelihood that more than 60 percent of coral reefs and 34 percent of fisheries may be at risk.

Given the magnitude and gravity of the problem; immediate and coordinated action is required to address the problem and to ensure sustainable and efficient use of water. It is against this backdrop that one of the central issues on the agenda of the 2002 summit of global sustainable development focused on Freshwater. There is substantial evidence to demonstrate that there is a direct correlation between the health of the environment and that of humans. In developing countries communicable diseases are the leading causes of deaths. Lack of clean water and sanitation cause diarrhea. In 1999, 1.7 million children died of diarrhea that resulted from contaminated foods and water, and poor sanitation. Additionally, indoor pollution causes respiratory diseases. These diseases are preventable if policymakers decide to employ simple and inexpensive technologies such as water purification and proper ventilation, respectively.

In recent years, strides have been made toward the supply of clean drinking water. During the 1990s, more than 15 billion dollars were invested in drinking water and sanitation in Africa, Asia, and Latin America. It was just a small amount geared toward addressing a very serious problem. This investment, however, did not mitigate the gravity of the problem. Majority of the more than six billion people in the world live in Africa and Asia. These two regions do not have access to safe drinking water. Consequently, people are compelled to drink dirty water or resort to armed conflict over water. Improved access to drinking water will go a long way towards improving the health of children. Additionally, women's health will improve and instead of carrying out the responsibility of fetching water for domestic use, these women would better use their time for more productive purposes including education and income-earning activities. These investments have been largely carried out in urban areas and very little attention has been given to rural development.

WATER SCARCITY GEOGRAPHY

Productive and social potential of water meets human society in two ways: "bluewater"—the liquid used to meet hygienic, health and economic requirements such as irrigation. "Greenwater" on the other hand is rainwater that has infiltrated the soil that operates production of food and biomass (Falkenmark, 2013). The term water scarcity according to Hasan, et al. (2019) is "a gap between

available freshwater supply and demand under prevailing institutional arrangements and infrastructural conditions.” Discussions relating to water scarcity as previously mentioned cannot in principle be isolated from issues surrounding climate change and global warming.

A standard of measure for water loss and scarcity was developed to continue to monitor *water stress* (water extraction and replenishment) levels. Freshwater exploitation can be estimated using "the exploitation index" defined as withdrawal of conventional freshwater resources (surface and groundwater) over total renewable resources (expressed in %). The more widely used indicator of freshwater exploitation is based on water scarcity developed by Falkenmark in 1989—the Water Stress Index (WSI) expressed as follows:

$$\text{WSI} = \frac{\text{Renewable water resources}}{\text{Population}}$$

The renewable water resources represent flow in units (where 1 flow unit = 1,000m³) available to a country from all sources. This indicator established four thresholds: 1) occasional/local water stress, 2) regular water stress, 3) chronic water shortage, and 4) absolute water scarcity of renewable water resources vulnerability or stress.

UN-Water/Africa (2006) indicated that Africa on annual basis has abundant water resources, but the high spatial temporal variability within and between countries and river basins poses a problem of possible shortage. This shortage is an underlying reasons for these conflicts between nations because it results in include 1) low rainfall, inadequate water supply, and dependency on one major water source; 2) high population growth and rapid urbanization; 3) modernization and industrialization; and 4) a history of armed combat and poor relations between countries. Below is an effort to discuss issues of water scarcity looking at the two components of freshwater.

Bluewater scarcity

To understand issues related conversations about “bluewater” scarcity, one must consider the following: (i) water crowding, (ii) water stress or use-to-availability, and (iii) combined water scarcity predicament studies. Attention has been drawn to implications of population growth in water-poor areas since the 1970s (Falkenmark, 2013). Water crowding looks at the phenomenon associated with water competition levels and is a phenomenon that is recent; post-World War II, in response to continued population growth. Use-to-availability, also known as water stress, is a measure of water exploitation levels sometimes referred to as demand-driven scarcity that explains management of water resource and the need to include infrastructure investment in national economic planning to arrest the rising levels of water use (Falkenmark, 2013). According to Tatlock (2005), Sub-Saharan Africa suffers from greater levels of water stress than many other regions in the world.

Greenwater scarcity

Agricultural water security is highly susceptible to “greenwater” scarcity. “Greenwater” can be scarce for several reasons. Some reasons are climate- and soil related, whereas others are related to people’s activities. In cases where “greenwater” is deficient, “bluewater” is added through irrigation as a means of achieving “greenwater” security. During crop growing season, “bluewater” accounts for only 16% of global consumptive water use. The framework for discussion of

“greenwater” scarcity includes (i) dry climate, (ii) droughts, and (iii) dry spells, and (iv) man-made scarcity. Irrigation is used to compliment yields, without which yields would fluctuate between total crop failure during drought years and good yields in years of plenty of rain (Falkenmark, 2013).

BIODIVERSITY CONSERVATION AND FOOD SECURITY ISSUES

Global strategies implemented for environmental conservation generally aim at protecting both biodiversity and ecosystem services (McIntyre, Reidy Liermann, & Revenga, 2016). There are profound implications of freshwater resource depletion or overexploitation for biodiversity conservation as evidenced mainly by the positive relationship between species richness and capture fisheries in the world’s rivers. Patterns of threat and fish catch demonstrate bewildering parallels in eastern and southern Asia, as well as western Africa, southern North America, and parts of southern Europe.

Data used to substantiate much of the discussions bordering freshwater exploitation and biodiversity conservation in general come from the Food and Agricultural Organization (FAO). Since freshwater fisheries catch statistics are submitted voluntarily to FAO by governments, the outcomes result in biases and underreporting of data related to large rivers, population centers, and commercial fisheries (McIntyre, *et al.* 2016). In the same vein, Hasan, et al., (2019) indicated that accurate assessment of “available water” is difficult, especially in data-scarce regions, such as Africa. In order to obtain somewhat useful data, Hasan, et al., (2019) introduced a satellite-based indicator—Potential Available Water Storage (PAWS); which integrates Gravity Recovery and Climate Experiment (GRACE) satellite Total Water Storage (TWS) measurements with precipitation estimates between 2002 and 2016 from Tropical Rainfall Measuring Mission (TRMM).

With projected increase in world population, it is expected that there will be a corresponding increase in food demand; and thus, will have a direct impact on agricultural water usage (Mancosu, Snyder, Kyriakakis & Spano, 2015). Water shortage has a significant impact on crop yield. According to McIntyre, *et al.* (2015), about 158 million people worldwide depend on fish derived through freshwater aqua-culture, wild-caught marine, and wild-caught freshwater. Accordingly, “...eighty-one percent of nutritional dependence on freshwater fisheries occurs in nations below global median gross domestic product (GDP) (<\$4,800 purchasing power per capita annually...where alternative animal protein sources may be largely unaffordable” (p. 12882).

SECURITY IMPLICATIONS

There is relatively little evidence that supports the argument that climate change leads to state security and conflict (Brown, Hammill, & McLeman, 2007). Public policy at different time intervals has identified different issues in Africa that make it a hotbed for possible conflict or heightened security risks (Mallon, et al., 2015). While there are many threats faced by Africa including; poverty, poor education, ill-health, violence, hunger, sustainable agriculture, nutrition, and food security, limited access to finance, slow economic growth rate; and articulated by Brown *et al.* (2007) as follows:

“Climate change represents the latest in a series of environmental drivers of human conflict that have been identified in recent decades, following others including drought, desertification, land degradation, failing water supplies, deforestation, fisheries depletion, and even ozone depletion; “(p.1)

not all the threats have been raised to the bar of security challenges. Some of the issues that have been elevated to security challenges include HIV and AIDS, climate change, and now, freshwater resource exploitation.

Climate change has been described by Brown, et al. (2007) as the 'mother of all security problems,' where security analysts and academics have warned that changes in climate threaten both water and food security and scarcity could result in forced migrations and trigger conflict, with Africa being the region to most likely suffer the worse effects. At a 2007 debate at the UN Security Council, on the subject of climate change, energy supplies and security, South Africa and Egypt objected to the appropriateness of this venue for discussions relating to greenhouse gas emissions (GHG), and Congo-Brazzaville, on her part remarked on the irony that Africa being the least contributor to GHG is likely to be the worst affected region (Brown, et al., 2007). Clearly, African nations contribute very insignificantly to emissions, both in absolute and per capita terms.

An example of a conflict in Africa that is directly linked to environmental degradation resulting from changes in climatic conditions is the Darfur conflict which resulted in tensions between farmers and herders over disappearing pasture and declining waterholes (Brown, et al., 2007), and continues to threaten the peace deal between the north and south Sudan. It was projected that annual rainfall in most of Africa (with exception of eastern Africa) would likely decrease and more warming is expected throughout this century. It is projected that rainfall shall be 10 percent less annually by 2050 (Nyong, 2005).

Adaptation is a concept born from both natural and social sciences that suggests a process of adjustment to continues change for survival. With this, Africa is seen as a region that deserves adaptation funding and cited as such since it is vulnerable to adverse effects of climate change. This is evidenced in the centuries of adaptation by African populations despite the tremendous number of vulnerabilities they have faced; employing sophisticated and evolving processes and practices (Brown, et al., 2007). What is at issue currently is whether African populations have the matching capacity to sufficiently respond to the quick changes. The productive landscape, rainfall, water availability, food production, and population distribution are in general the future challenges that the continent will have to grapple with; and with scarcity in resources, there is a fear of possible breakout of conflicts if governments and communities do not manage these shifts properly. Sasson (2012) confirmed that "climate change and global warming are considered the two major threats to agriculture and food production" (p.6) in Africa. Over-exploitation of water resources, mainly for agriculture has, created environmental disasters.

CONSERVING FRESHWATER AND WATER MARKET

The focus to seeking solutions to freshwater exploitation to overexploitation has mostly been on seeking humanitarian funds with the goal of improving access to quality water in the long-term (Tatlock, 2005). As with many other challenges related to Africa, the initial emphasis is on donations, in this case, on water development. Global environmental challenges overshadow issues of water development, specifically in Africa.

Since sub-Saharan Africa is subject to more extreme climate variability than other regions, it needs improved water storage capacity. According to Tatlock (2005), even though some experts disagree that construction of large dams could offer a more sustainable reserve of water resources as a way

of combatting the burden of climate fluctuations; citing the harmful environmental impact of large dams, others have a variant view.

Some experts are considering political approaches to the problem such as the signing of water treaties to minimize the possibility of conflict. According to Tatlock (2006) transboundary water agreements have led to international collaboration; hence have undermined the probability of future conflicts.

Africans as previously discussed have been able to survive and thrive through adaptation. To boost this ability to adapt, small-scale agricultural improvements could offer contributory solutions to water stress. Some of the improvements consists of crop drip irrigation, shallow well harvest, pump usage, and implementation of other technological innovations. In this instance, the focus is on “greenwater” rather than “bluewater”. Farmers specifically, can access “greenwater” in one of three ways, drip irrigation, rainwater harvesting, and supplemental irrigation. Crops can grow poorly even during periods of rainfall, and most farms in Africa suffer from nitrogen and phosphorus depletion in soil. One way to assuage water stress in terms of food scarcity is to increase water-holding capacity with organic fertilizers that would increase availability and efficacy of “greenwater”.

According to Jul-Larsen and Zwieten, long-term changes in water levels that are a direct or indirect result of climate change are also important in explaining the changes in food stock. Management systems in Africa have generally been styled after the post-colonial systems focused on the relationship between fishing effort and biological productivity (2002). Despite these post-colonial systems styled in the failed top-down approach, co-management has been proposed as an alternative to management (Jul-Larsen & Zwieten, 2002) for fisheries. This approach empowers communities to employ local methods that lead to cheaper and better solutions.

In water conservation, it is said that if water reuse substitutes for existing use, then freshwater is saved; while other additional economic benefits may be generated from finding new uses for treated wastewater even though it does not translate into water savings (Scott, Darghouth, and Dinar, 2013). On world stage, solutions to ecosystem conservation, especially improvement of drinking water supply, pose huge prospects for business. Potential areas of sound investments to address water scarcity and shortage include:

- Construction of new and rehabilitation of existing wastewater treatment plants implementing new and improved technology,
- Surface storage reservoirs for reclaimed water,
- Separate sewer systems for municipal and industrial wastewater, and

Water shortage, specifically, drinking water scarcity is on the decrease owing to a rise in population. This reduction in water resources opened opportunities for businesses in an industry that offers \$287 billion worldwide (Manzoor, 2011), which represents about 40% of the oil industry. Multinational corporations such as Coca-Cola and PepsiCo entered the drinking water market, and this has led to over exploitation of natural water resources.

Scott, Darghouth, and Dinar project that since most of the population growth in developing nations shall occur in urban areas, investments in urban water supply and sewage treatment shall be on the

rise; however, to achieve adequate water/sewage treatment for reuse in the agricultural sector in a manner that shall undermine risks associated with the environment and human health, governments shall need to invest further (2013).

CONCLUSION

Frameworks for conservation implemented around the world could assist in the formulation and development of policies that could address water related problems generally around the world, but specifically in Africa. Most efforts to ensure security and to reduce potentials for conflict are focused on food production augmentation. It should however be noted that achieving food security continues to be a challenge globally, not just for Africa (Mwaniki, 2006). The summits of August and September 2002 in Johannesburg, South Africa on Sustainable Development *may* have laid the foundation for a quick and sustainable approach toward addressing the problem. The conference called for an agreement among nations on how to formulate and implement practical policies that could assist mankind improve the wellbeing of people around the world. Among the serious concerns raised by delegates was the problem of environmental degradation. The more than 60,000 delegates from 174 countries in attendance, discussed among other issues, attempts to halt greedy and wild consumption of nonrenewable resources. They asserted that if the present consumption pattern is not arrested the resultant might be exhaustion of the resources. Participants at the conference also agreed that environmental and social issues pose a serious risk to sustainable development.

Now is the time for prompt action. The world cannot afford to standby and witness a problem that can be averted through concerted international action reach crisis-pitch. The foregoing supports the assertion that water is the most important international problem of the 21st century. Its role in our daily lives and sustainable development cannot be overemphasized. Policy makers must have the courage to stand up against transnational and other polluters and invest more in technologies that curb the emission of GHG into the atmosphere. Fouchy et al. (2019) added that improved scientific knowledge and monitoring programs, strong and effective natural resource management and ecosystem protections are needed to face this security challenge. Above all, the governments of African nations must be willing partners to curb this crisis-level challenge. According to Manzoor (2011): “

Public controls...97% of water distribution in...poor countries and private investments in water supply in these countries can have a negative impact on...living status of poor people. Thus...experts foresee that [the] war of the next century will be fought over water and not...oil” (p. 41).

Abbreviations

AIDS: Acquired Immune Deficiency Syndrome, FAO: Food and Agricultural Organization, GDP: Gross Domestic Product, GHG: Greenhouse Gas, GRACE: Gravity Recovery and Climate Experiment, HIV: Human Immuno-Deficiency Syndrome, UN: United Nations, TRMM: Tropical Rainfall Measuring Mission, TWS: Total Water Storage, WSI: Water Stress Test.

Definition of Terms

Below are definitions of terminologies used in this article that could provide additional context and understanding.

Bluewater is liquid water found above and below the ground, such as rivers, lakes, and groundwater.

Freshwater is any naturally occurring water other than seawater and brackish water.

Freshwater exploitation refers to the extraction of water for irrigation and human consumption.

Greenwater is soil water in unsaturated zone derived from precipitation.

Water withdrawal describes the total amount of water withdrawn from surface water or groundwater sources.

Water consumption is the portion of the withdrawn water permanently lost from its source.

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