SUSTAINABILITY IMPLICATIONS OF NIGERIA'S WATER USE PATTERNS

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Abstract

Nigeria has significant renewable water resources; however, the current reality is that most of it is poorly utilized and managed, thus raising important sustainability questions. There are several concerns associated with the water situation in the country such as pollution, flooding, poor drainage infrastructure, etc. All these have dire water-poverty, socio-economic, health and livelihood implications for Nigerians. This discussion paper identifies the absence of a properly functioning regulatory regime in Nigeria's Water Resources sector - with the ensuing pattern of open access water use in the country - as a fundamental issue that needs to be addressed. It briefly maps out some specifics of the current situation within Nigeria's Water Resources sector. Utilising a simple steady-state economic framework that shows the implications of open access use of natural resources, it goes on to explain the sustainability implications of the current water resource use-patterns in Nigeria. Drawing on the points raised, the paper concludes with a few high-level recommendations for water sustainability in Nigeria.

KEYWORDS: Open Access, Water Resource, Sustainability, Steady-state

1. BACKGROUND

Nigeria has enormous water resources, and in fact, many of its 36 states are named after rivers. These water resources are however unevenly distributed among the various hydrological areas in the country. The Niger Delta and tropical rainforest areas in the South, for instance, have as much as 3000 mm of rainfall per year, lasting up to eight months; while the North-Eastern Sahel region has precipitation values as low as 500 mm per year, spanning 3 - 4 months (Idu, 2015). Regardless, compared to several other countries in Sub-Saharan Africa (SSA), this is a fair amount of water resource.

The Food and Agriculture Organisation of the United Nations (FAO, 2016a) uses the phrase Renewable Internal Freshwater Resources Flows to refer to internal river flows and groundwater from rainfall in a country. In this context, Nigeria has about 221 billion cubic meters (m^3) of renewable internal freshwater resources. Neighbouring Chad, Niger, and Benin have 15, 3.5, and 10.5 respectively; and South Africa has 44.8 billion m^3 of renewable internal freshwater resources.

However, Nigeria still faces significant challenges in the use of its water resources - specifically in its inability to properly manage, use and protect these resources for socio-economic development and environmental sustainability. The lack of accessible, reliable and safe drinking water, together with poor sanitation and hygiene threaten the health and livelihoods of citizens. In 2015, as much as 31.5 percent of Nigeria's 182 million residents did not have access to safe drinking water (FAO, 2016b). Notably, 52 percent of Nigeria's population reside in rural areas, 42.7 percent of whom do not have access to safe drinking water. In the urban parts of Nigeria, about 19.2 percent do not have access to safe drinking water (FAO, 2016b).

On the whole, Nigeria's internal renewable water resources are in abundance, but a huge percentage of the available water resources is unutilized or poorly utilized (FAO,2016b). There are several concerns associated with the water situation in the country such as pollution and water-poverty; as well as socio-economic, health and livelihood issues, among others. This discussion paper highlights and focuses on a single sustainability threat in the prevailing pattern of use and management of Nigeria's water resources. It briefly maps out the current situation in Nigeria's water resources sector. It furthermore outlines a simple steady-state economic framework to explain the sustainability implications of the absence of a properly functioning regulatory regime for natural resource use – this is akin to ‘the open access problem’. Finally, drawing on some of the issues raised, it concludes with a few recommendations for water resource sustainability in Nigeria.

2. WATER RESOURCE USE AND MANAGEMENT IN NIGERIA

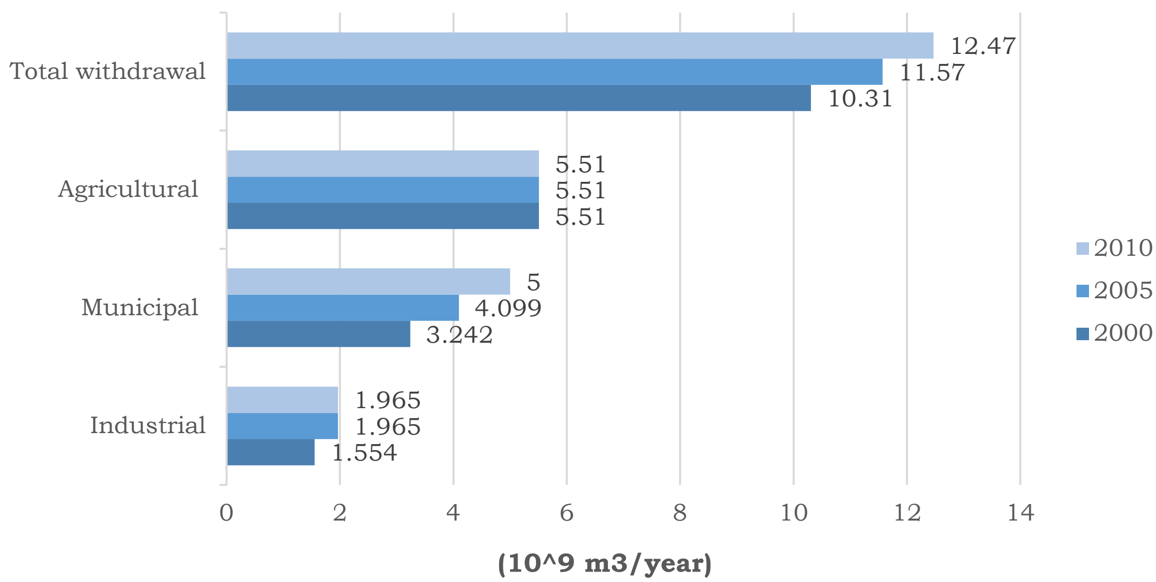
The major statute regulating the use of Nigeria’s water resources is the Water Resources Act of 1993 – hereafter, the Act - (amended in 2004 and 2016). The Act is “to promote the optimum planning, development, and use of Nigeria's water resources” (Federal Government of Nigeria, 1993: para.1). Among its other provisions, the Act vests the right and control of Nigeria’s water resources in the Federal Government of Nigeria. It allows individual states in Nigeria to make provision for the management, use, and control of water resources within their respective boundaries, subject to the guiding policy and principles of the Federal Government. Nonetheless, the Federal Government often intervenes by directly financing investments, to increase water access.

Pursuant to the Act, Nigeria’s Federal Ministry of Water Resources (FMWR) is the agency of government charged with the primary responsibility of coordinating the water resources sector in the country, as well as leading a national policy and strategy for the public provision of water (FAO, 2016b).

The state ministries of water resources and the respective state water agencies have the formal responsibility for the direct provision of water services at the local level (FAO, 2018). However, most state water agencies are barely operational, and the ones that are operational grapple with dilapidated colonial-era infrastructure and water loss. Even so, they can hardly determine the amount of water distributed and lost as there are virtually no water meters installed, and a flat rate tariff structure is common (JICA & FMWR, 2014).

According to available data from the Food and Agriculture Organisation of the United Nations (FAO), the total water withdrawal in Nigeria has been increasing. From 10.31 billion m^3 in 2000, it increased to about 12.47 billion m^3 in 2010 (Figure 1). Most water withdrawal in Nigeria has been for agriculture use, particularly irrigation. Between 2000 and 2010, water withdrawal for agriculture was relatively stable at about 5.51 billion m^3 per year. There has also been increasing withdrawal of water for municipal use, reflecting Nigeria's growing urban population; and there has been a considerable draw on water for industrial use as well. Water withdrawal for industrial use remained the same between 2005 and 2010, at 1.965 billion m^3 per year, while municipal withdrawals have steadily increased from 3.242 billion m^3 per year in 2000 to about 5 billion m^3 in 2010 (Figure 1).

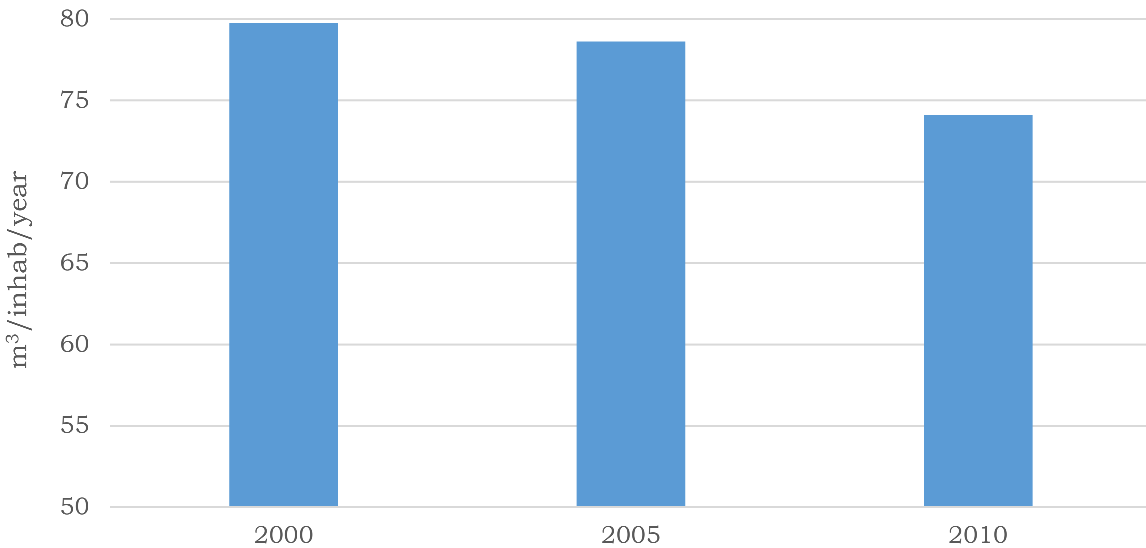
Figure 1: Water withdrawal in Nigeria by kind of use, 2000 to 2010 (10^9 m^3/year)



Source: FAO. 2016. AQUASTAT Main Database - Food and Agriculture Organization of the United Nations (FAO)

Another indicator of water use is the total water withdrawal per capita. That is the amount of water withdrawal relative to the population or number of inhabitants of an area. In Nigeria, total water withdrawal per capita decreased from 79.77 billion m^3/inhabitants/year in 2000 to 74.12 billion m^3/inhabitants/year in 2010 (Figure 2).

Figure 2: Total water withdrawal per capita (m^3/inhab/year)



Source: FAO. 2016. AQUASTAT Main Database - Food and Agriculture Organization of the United Nations (FAO)

The decrease in total water withdrawal per capita is arguably, however, driven by a more rapid increase in Nigeria's population rather than any concerted effort by the relevant authorities at addressing the nation's water use patterns. Nigeria's population is projected to reach 230 million by 2030 (from 184 million in 2015) (JICA & FMWR, 2014). As the country's population increases and it pursues further agricultural development and higher levels of industrialization, without deliberate action to manage its water use, total water withdrawal will increase even more, leading to a strain on its water resources.

3. OPEN ACCESS USE OF WATER RESOURCES

Water is a renewable resource and the amount of water on earth is essentially constant. However, it is always moving around in a complex cycle through the atmosphere, underground, in glaciers, and surface waters such as lakes, oceans, and rivers (Hartwick & Olewiler, 1998). Therefore, although it is a renewable resource, the quantity and quality of water (the stock) available in any area, can be depleted due to several factors such as overuse, pollution, and climate change[1].

Water is an essential resource – arguably second only to air – needed to sustain life on the planet. The strict allocation of water as an economic good whose value is based on the actions of buyers and sellers, and the amount they are willing to exchange for it could therefore raise equity, moral and philosophical concerns. This is even more so for developing countries like Nigeria where there is a high incidence of poverty. There is, however, a more holistic view to the allocation of water as an economic good which involves an integrated decision-making process on the allocation of scarce resources, and which does not necessarily involve financial transactions (Van Der Zaag & Savenije, 2006).

On the other hand, an open access rights regime defines a situation where a resource can be claimed and assessed by anyone, independent of the markets, and for which there are no exclusive and transferable rights. From standard economic theory, the absence of private property rights in the allocation of any resource breeds exploitative incentives in consumers, which could lead to the depletion and disappearance of the resource[2].

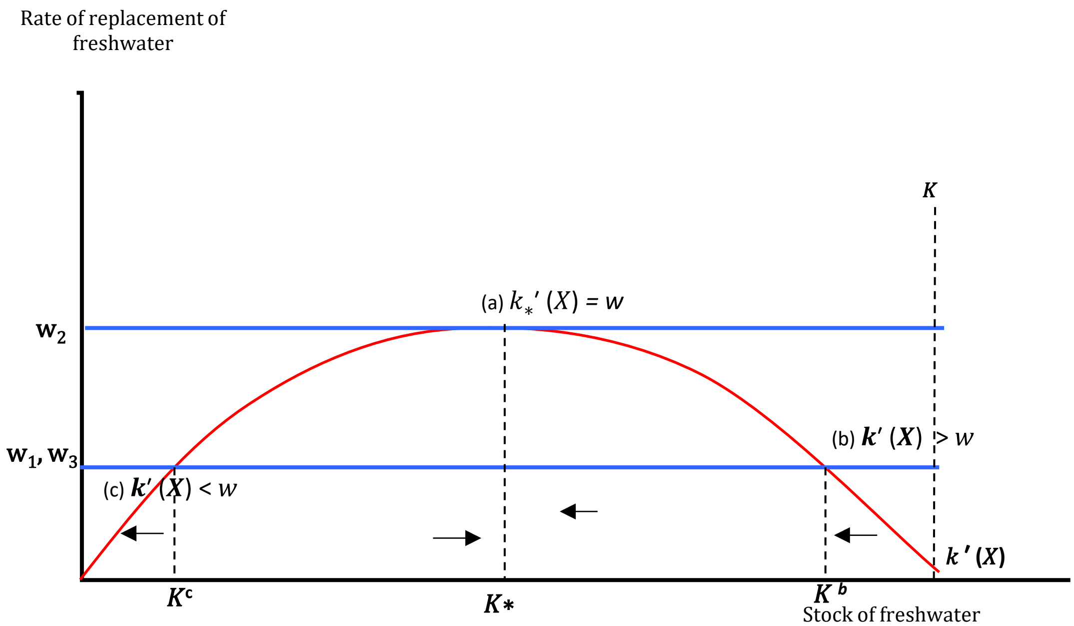
A simple steady-state model

We can use a simple steady-state framework to understand the impact of open access use of water on its sustainability over time. Such a simple model is illustrated in figure 3. Assuming there is a fixed stock of freshwater (K), in an area (Nigeria in this case), the rate of replenishment of the stock of water $\boldsymbol{k'}(\boldsymbol{X})$ over time, can either be increasing, constant or decreasing, as depicted by the inverted curve in figure 3.

Figure 3: Steady-State analysis of open access use of freshwater

[1] The previous statement makes the assertion that water "is always moving around in a complex cycle". The depletion referred to in the second statement is the quantity and quality in a particular area. It helps to think in terms of water possibly being trapped in some other phase of the cycle, and in a state that is not useable for current purposes owing to non-renewal; more like freshwater versus sewage water.

[2] This concept is broadly referred to economic theory as "The Tragedy of the commons"



Source: Authors' illustration

The rate of replenishment of the stock of freshwater $\boldsymbol{k'(X)}$ in this case, can be thought of as a simple function of factors such as climate change (CC), the natural rate of replenishment (NR), the original size of the stock of water (S), and several other factors (Y); so that we have a model as follows:

$$k'(X) = k\ (CC, NR, S, Y)\ldots \qquad (1)$$

If we go further to assume a constant rate of water withdrawal[3], *w*, for simplicity, we can consider three of the possible scenarios **(a)** $k'(X) = w$ **(b)** $k'(X) > w$, and **(c)** $k'(X) < w$, illustrated on figure 3 with the horizontal lines w_1, w_2, and w_3 respectively. We can choose a hypothetical optimum desirable level where the rate of replenishment of the stock water $k_*'(X)$ is at its highest. In scenario **(a)**, where the rate of withdrawal is equal to the rate of replenishment, the stock of water will be

[3] Water withdrawal is defined by the OECD, (2018) as the total volume removed from a water source such as a lake or river either permanently or temporarily, and conveyed to a place of use. When the rate of withdrawal of freshwater is greater than the rate of its replenishment - either by the natural process of the water cycle or through artificial water treatment and recharge systems, the stock of freshwater available steadily declines.

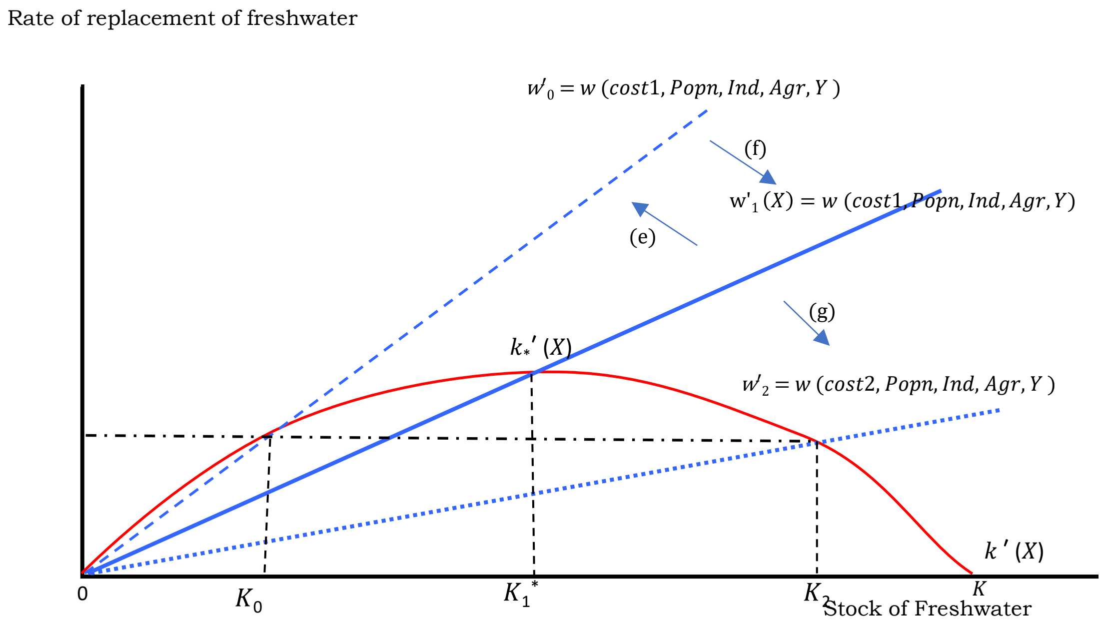
sustained at the k_*^a level. In scenario **(b)**, where the rate of withdrawal is less than the rate of replenishment w, the stock of water will be maintained around K^b stock. In scenario **(c)**, where the rate of withdrawal is greater than the rate of replenishment, the stock of water will steadily decline until it is totally exhausted.

The Committee on U.S Geological Survey Water Resources Research, (2002) discusses some models that have been used in the literature to estimate and explain the variability in water withdrawal across the U.S. These models typically include an array of independent variables. For our purpose here, however, and deriving from some of the variables identified in the literature, we can assume the rate of withdrawal $\boldsymbol{w}'(\boldsymbol{X})$ to be a simple increasing function of the cost of water withdrawal (e.g. water license fees), population (Popn), industrial use (Ind), agriculture use (Agr), and an aggregation of other factors (Y), so that we have

$$w'(\boldsymbol{X}) = w\ (Cost, Popn, Ind, Agr, Y)\ldots \qquad (2)$$

Holding other factors constant including the rate of replenishment of freshwater $\boldsymbol{k}'(\boldsymbol{X})$ at any time t, we can examine the impact of open access use of freshwater as shown in Figure 4.

Figure 4: Open access use of freshwater



***Source**: Author's illustration*

Supposing there is a shortfall in the stock of freshwater because of a non-anthropogenic factor such as changing weather conditions (e), with open access use, the reduction in the available quantity of freshwater will increase the pressure on water resources and lead to a higher rate of withdrawal, corresponding to $\boldsymbol{w'_0(X)}$, and could lead to a total depletion. Open access use could also see early comers drawing more freshwater than they may require - the so-called "first in time, first in use principle" (Hartwick & Olewiler, 1998:77).

However, water regulations in the form of water licenses and fees, rationing, caps on water use etc., can be used to maintain the rate of water withdrawal at $\boldsymbol{w'_1(X)} = w\ (Cost_1, \overline{Popn}, \overline{Ind}, \overline{Agr}, \bar{Y})$ **(f)** or reduce it to $\boldsymbol{W'_2(X)} = w\ (Cost_2, \overline{Popn}, \overline{Ind}, \overline{Agr}, \bar{Y})$ **(g)** as shown in figure 4. Hence in the simple model presented above, the absence of any defined (and/or enforced) property rights to water could result in a "tragedy of the commons" situation, where the available stock of freshwater is overused to depletion.

4. SUSTAINABILITY IMPLICATIONS OF NIGERIA'S WATER RESOURCES USE PATTERNS

Most of Nigeria's water resource use is 'open access', and there are no clear or defined property rights guiding water use. This is despite the 1993 Water Resources Act, which stipulates that a license is required for water abstraction for commercial use. As observed by the Federal Ministry of Water Resources, (FMWR, 2012) the water resources act "has not yet been fully implemented and water is withdrawn without a license; even by government agencies".

With the lack of enforceable regulation of water use, in several parts of the country individuals and industries have the incentives to consume much more water than what is supported at an efficient level. Typically, anybody that can afford the cost of digging a well or drilling a borehole does so. Moreover, this practice is pervasive since the state-owned and managed water agencies are non-functional, and the colonial-era water infrastructure is mostly dilapidated.

Tying this to the illustration shown in the steady-state framework, the sustainability implications of the current water use patterns in Nigeria are dire. Most of the water withdrawn for various primary and secondary use in the country is not recycled. Rather, wastewater from various activities finds its way into Nigeria's water bodies untreated. This is added to the unabated levels of water pollution in the country from other human activities. In the relatively drier Northern parts of Nigeria, there is significant overuse of water relative to the available water resources. In 2016, the FAO, (2016b) reported that "the expansion of irrigated crop production and inappropriate agricultural practices (including overgrazing, lack of crop rotation, inadequate land fallowing etc.) have led to a lowering of the water table". The uncontrolled drilling in coastal Southern parts has shown to result in salt-water intrusion (FAO, 2016b). Over time, the gradual accumulation of salt makes it difficult for the soil to sustain agriculture and could lead to desert-like conditions.

Therefore, the quality and quantity of water available for current use and for the future is constrained and reduced considerably. The ensuing pattern of unregulated, open access use of groundwater, and the water loss in Nigeria will inextricably reduce the supply of water available in the future, as well as further severely impact the environment negatively. There is no simple way of ensuring an efficient allocation of water resources, especially within an intertemporal framework, and more so in a country like Nigeria. However, a simple market-based economic model would suggest that efficient allocation should be at the point where the price that users are willing to pay equals the marginal cost of supplying water (and in an extended sense, the marginal social/environmental costs) (Hartwick & Olewiler, 1998).

5. CONCLUSION

One question that arises from the foregoing is: how can Nigeria transition from the prevailing open access use of its water resources to a more market-based model?

Water is an economic good by many standards. There are a few debates in the economic development literature about what this means, however, within the context of managing Nigeria's water resources for sustainability, it no doubt entails a firsthand focus on ensuring adequate investment in the necessary water infrastructure like dams, water reservoirs, waterworks, etc., at all levels. This will make it more realistic to regulate water use and manage the supply of water in Nigeria.

Water is an invaluable resource for life on the planet and should be treated as such. It must be treated as a vital commodity, having a real value, which as a matter of urgency should be managed holistically; with the aim of ensuring efficient human use and promoting environmental sustainability. As water is a basic human need, measures will also need to be adopted to balance the economic efficiency and affordability aspects of water resource management especially for a developing country like Nigeria with its significant levels of water poverty.

Meanwhile, it is important to note that the lack of adequate and up-to-date data on the available water resources, and the corresponding level of demand is a structural constraint to proper sustainability planning in Nigeria. With the necessary infrastructure and data in place, water rights can be properly allocated using water charges and relevant licenses to closely match demand and supply conditions for water use efficiency and sustainability.

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