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IMPACT OF WATER ACCOUNTING ON WATER SUPPLY IN NIGERIA

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Abstract

Water is at the core of sustainable development and is critical for socio-economic development, food production, and healthy ecosystems for human survival. It is, therefore, not surprising that the Nigerian government, individuals and non-governmentalorganizations haveput in great effort in water projects. Unfortunately, despite these efforts, potable water is yet to get to all parts of the country. There is the need for a systematic study on the current status and trends in water supply in Nigeria, for evidence-informed decision making, if potable water is to get to all parts of the country. This study, therefore, theoretically examines water accounting and propose methodologies for how water accounting can be used to alleviate the challenges of water scarcity in Nigeria. Furthermore, extant literature has shown that very few studies have been conducted on water accounting in Nigeria, with mixed submissions. In addition, most of these studies focus on developed economies and are descriptive in nature. These issues motivate this study, which advocates water accounting among Nigerian water authorities as a basis for evidence-informed decision making and policy development in alleviating water scarcity to ensureadequatewatersupply in Nigeria.

Keywords: Water accounting, Ecological impact, Governance, Water supply, Water resources, Water balance.

INTRODUCTION

Water is of immense importance to all aspects of life, society and our natural environment. The accelerated increase in global population over the last century coupled with intense economic development is causing unprecedented pressure on this precious commodity called water. The United Nations Department Economic and Social Affairs (UNDESA) reports that the current world population of 7.6 billion is expected to increase to 8.5 billion by 2030, 9.7billion by 2050 and 11.2 billion in 2100. The National Population Commission (NPC) and the National Bureau of Statistics (NBS) propose that a country like Nigeria, with apopulation of 150.3million and with a fast population growth, is likely to

experience great pressure on its water supply (Population Reference Bureau - PRB Report, 2008). This kind of growth poses significant challenges to governing institutions and infrastructure in developing countries already experiencing population-induced strains on their natural resources. As demand grows and per capita freshwater availability decreases, competition will likely increase due to scarcity if not effectively and properly addressed (Organization for Economic Cooperation and Development - OECD, 2009).

Water is hardly scarce given that the planet is mostly covered with water and Nigeria, being a River Niger area, is surrounded by water. Even with the availability of water, an average Nigerian cannot get access to potable water because the composition of the water is problematic as 97.5% is saltwater and only 2.5% is the freshwater resource. Out of this, only a fraction is usable as freshwater for ecosystems and human consumption, since nearly 70% of the world's freshwater resource is locked in glaciers and icebergs rendering it unavailable for human use (United Nations Educational Scientific and Cultural Organization - UNESCO, 1999). Moreover, in Nigeria, much of the land-based water is saline, but ancient fresh groundwater resources are also largely unavailable as renewal is limited and large-scale extraction may cause ecological mayhem.

Water is an essential ingredient for human security and sustainable development. Apart from growing food and supporting economic growth by ensuring diseases are kept at bay, water is also a fundamental and irreplaceable resource in all societies, including Nigeria (United States Agency for International Development - USAID, 2014).Scarcity and use of water are now global concerns. Physical water scarcity is a dire reality and poses a serious threat to economic development and human wellbeing. The acceptance of an unfettered desire for economic growth has arguably caused an exponential increase in water consumption resulting in another facet of crisis in water scarcity. The seemingly unrelenting conduct of human activity, constantly to embrace development and advancement in our growing technocratic industrial societies, is fuelling the demand for this indispensable resource (Devall & Sessions, 1999). Given its importance to human life, it is not surprising that water management is complex and water-related interests are frequently and increasingly contested even in areas of the world that are relatively well-endowed with water (UN-Water, 2013).

Access to water in sufficient quantity and quality can drive competition, where interests are perceived incompatible, as well as stimulate cooperation where there is mutual interest. The users of water accounting products are potentially even more diverse. For instance, local managers need to know that storages hold sufficient water to meet daily orders placed by irrigators. Regulators need to know whether projected water supplies will be sufficient to allow approval of new water entitlements. Downstream users such as crude oil refiners, product distributors and marketers need to know that upstream users such as the Oil wells explorers, drillers, producers, geologist, and so on are not using more than their share and the wider communities need to know that sufficient water is available to meet environmental and other social needs. The needs of these doers and users have driven the development of water accounting products which include inventory management software, complex water availability models, and improvements to public reporting.

Various studies have been conducted worldwide in diverse disciplines to address water crisis, issues encompassing water governance, water availability, ecological concerns and water management

(World Water Assessment Programme 2003, 2006, 2009). Although much emphasis has been placed on the issues surrounding this essential commodity, far less research has been conducted empirically in developed countries to examine the reporting of water accounting. Furthermore, related literature reviewed (e.g. Okoye, 2015; Idu, 2015; Ademiluyi & Odugbesan, 2008)showed that very few researches conducted on water accounting in Nigeria were water resources based and most of the literature were based on developed economies and were mainly descriptive in nature. In developing nations, a few countries like Botswana, South Africa, Morocco and the likes have developed water accounting resources in Africa. In Nigeria, despite the National Water Resources Master Plan initiative of 1995 and 2013 respectively, water accounting resources is still not developing as government is not giving it the desired attention. Also, research on water accounting has not been explored; it remains a neglected area in Nigeria. Hence, accounting for water is still an unresolved issue and demands immense attention in Nigeria (Idu, 2015).

This study, therefore, seeks to propose methodologies for how water accounting can be used to alleviate the challenges of water scarcity and water supply in Nigeria, while theoretically examining water accounting with a view to creating awareness amongst Nigerians on the significance of water accounting in the Nigerian environment.

This paper is partitioned into five sections. Following the introduction is section two which reviewed extant literature on water accounting. Section three harps on the research method while section four discussed water accounting methodologies. Lastly, section five dwelled on the conclusion and recommendations.

LITERATURE REVIEW

The Concept of Water Accounting

The term water accounting has been in regular use for more than two decades and it is often defined differently. Several definitions have been proposed and used but noconsensus has been reached on a generally accepted definition for this term. Based on this, the Food and Agricultural Organization of the United Nations - FAO's - expert consultation recommended that in coping with water scarcity in 2011, the FAOshould develop andattempt to popularize the definition of water accounting (FAO, 2012).

Debate about water, its consumption, its long-term sustainability and related socio-ecological risks are nowadays central to many public constituencies (e.g. regulators, politicians, business, societal actors and so on). Existing data show that more than 2 billion of people are currently suffering the direct or indirect effects of the scarcity of water, because they live in desert or semi-desert areas or because they are affected by limited water resources (CDP 2014; WWC 2014).

Water is a renewable resource but patterns of water availability and accessibility vary in space and time, and are influenced by both biophysical and societal factors. The common perception is that water shortage (i.e. an absolute shortage of water supply in a specified domain) is the main reason for this state of affairs. However, the reality is that water scarcity, (i.e. an excess of water demand over available water supply) is by far the more important global challenge (FAO, 2012).

The key difference between water shortage and water scarcity is that water shortage is driven primarily by biophysical factors (e.g. rainfall, land use, geology) and the status of infrastructural supply systems (e.g. their capacity, condition and operating rules). While water scarcity is dependent both on water shortage and the multitude of factors that drive water demand (e.g. population increase and per capita

demand for water, economic growth, the need to protect aquatic ecosystems and so on) and the large numbers of political and socio-cultural factors that determine user-access to water of an acceptable quality e.g. water rights, social exclusion, poverty, unreliable power supplies, wars or localized conflicts (van Halsema & Vincent, 2012). Summarily, consumption and demand for water are influenced by different factors such as population growth, urbanization, food and energy security, increase in production and consumption (WWC 2014). All these factors, in one way or the other, affect and are implicated in the way in which "water" is (or should be) managed andcontrolled.

While many water sector professionals and the media refer to it as "a looming global water crisis", others contend that the more predictable challenges, or potential water crises, can be avoided or mitigated by adjusting the way in which water is managed and governed (FAO, 2012; Moriarty, Batchelor, Laban, &Fahmy, 2007). Their rationale is that, with good water governance and adoption of appropriate coping strategies, there is no reason why there should not be sufficient water to meet basic human and environmental demands on an equitable, sustainable and efficient basis, even in areas facing rapidly increasing water scarcity.

On this basis, there is a need for systems which are able to provide mechanisms, techniques and information for "governing" (i.e. managing and controlling) water. In this context, accounting-based information about water and related issues (i.e. consumption, availability, etc.) is essential. This information represents the key component of any "governing" system and regime through which to account for, manage and control water. From this perspective, therefore, it is essential to identify accounting-based mechanisms and techniques through which to generate, collect and disclose water-related information.

Water accounting has different origins and objectives. In the management and accounting literature there is no unique definition of what is and should be water accounting. In the management and accounting literature, the term 'accounting for water' or 'water accounting' is used to indicate the set of accounting-infused mechanisms/techniques. In particular, water accounting indicates "the process of accounting and communicating water resources related information and the services generated from consumptive use in a geographical domain" (Wateraccounting.org). According to the National Water Initiative (NWI, 2004) water accounting will ensure that adequate measurement, monitoring and reporting systems are in place in all jurisdictions, to support public and investor confidence in the amount of water being traded, extracted for consumptive use, and recovered and managed for environmental and other public benefit outcomes. Water accounting includes any scientifically accurate quantitative analysis and reporting of water resources to support scientific, management, governance and development outcomes. A similar definition is also used to describe the activities of disclosure as the act of collecting and making available data on the current state of water management (Morrison & Schulte 2012). Accounting for water can be considered as a vehicle, or a mechanism, through which water users can discharge accountability (Russell & Lewis 2014).

Water accounting, as mentioned above, represents a relatively new field of domain and space in the management and accounting disciplines (Tello, Hazelton & Cummings, 2016; Hazelton 2013; Chalmers, Godfrey & Potter, 2012a). In more recent years, an embryonic but relevant body of studies has gradually emerged in the management and accounting literature. In the accounting literature (Egan, 2014a; Hazelton, 2013; Allan 2012), the focus of research on water-issues has been mainly on

the reporting aspects and processes, which are defined as the "methods of recording and reporting water information" (Chalmers, Godfrey & Lynch, 2012b). The focus on the reporting, which has a long tradition in the SEAresearch (Rusconi & Contrafatto 2013, Rusconi 1988; 2013), is relevant because it is through this process that it is possible to provide accounting-based information about the responsibilities for the actions, accounts and accessibility of the accounts (Contrafatto & Signori, 2012) related to the governmentof water. This reporting process is supported by specific accounting systems (e.g. General Purpose Water Accounting systems; Water Footprint; Water Management Systems), which as suggested by Hazelton (2013) and Hoekstra (2017), are those systems that generate and provide the information for the water accounts andreports.

The essence of a holistic approach to water supply management adopted in this study is to ensure that all the relevant components and factors are considered in the totality of their effects on the whole process in order to achieve the sustenance goal of the system. The concept of water supply system is made up of three main components that are one-way directional and serially complementary in significance and criticality (Bhatia, 2009;Okoye, 2015). They are essentially linked through design, function, and performance. These are the source, treatment and transmission/distribution. In this paper, in response to calls for mapping the domain of SEA and achieve SDG (Thomson, 2014; Bebbington & Larrinaga, 2014) we carry out an extensive literature review to investigate how we can accountfor the current status and future trends in water supply, demand accessibility and use.

THE ROLE OF WATER ACCOUNTING IN CURBING WATER SCARCITY

Sustainable Development and the SDGs

Water accounting helps to monitor and achieve all the 17 SDGs on economic growth, poverty reduction, and environmental protection. Not only is water used for all human, social, economic and natural activities, water is explicitly linked to meeting SDG 2 on food, SDG 6 on water, SDG 7 on energy, SDG 13 on climate adaptation and SDG 15 on terrestrial ecosystems (UN, 2017; Merrey, 2015).Economic planners and environmental organizations need water accounting to cross-check whether their plans make hydrological sense (i.e. is there enough for all users and uses?)

Limited New Supplies of Water

Water accounting informs us that at the global scale the total amount of freshwater available for humans and the environment is more or less fixed, and many basins are unable to locate new supplies of freshwater (Mekonnen & Hoekstra, 2016). Nevertheless, society rightly asks how water supplies can be boosted, recognizing that they vary considerably over time and space. Some solutions, known as supply enhancement solutions, include inter-basin transfers between catchments, desalination of saltwater, building storage to capture floodwater, recycling wastewater and managing aquifers for withdrawals. Water accounting calculates whether these solutions genuinely augment supplies and help to bridge shortfalls or whether they simply constitute a "sleight-of-hand" shifting supply from one time slot to another or from one user (often the environment) to another without those shifts being made transparent, evidenced andsanctioned by public/policy agreement.

Rising Water Demand, Water Scarcity and Water Competition

Rising world population and urbanization, coupled with a growing demand for food and the need to secure environmental flows, have led to increased demand for water (Green et al., 2015; FAO, 2012; Amarasinghe & Smakhtin, 2014; CAWMA, 2007). This rising demand, setagainst a fixed (though

increasingly variable) supply set by the global hydrological cycle, gives us water scarcity. Water scarcity in turn leads to higher competition among different users of freshwater. Managing this competition by distributing available water between users is a major water governance challenge. Water accounting informs policy-makers as to whether interventions (such as new dams, irrigation schemes or water law reform) will materially assist in managing water scarcity and competition.

Water Variability Dealing with Water Shortages

Climate variability aggravates water scarcity, with climate change-induced variability expected to increase (Scheweet al., 2014) and extremes likely to be more frequent and severe. Droughts are examples of water variability and recent cases show their impact on urban areas surrounded by irrigated agriculture (e.g. Cape Town, Los Angeles,rural villages in the Sahel). In many cases, droughts in agricultural and urban areas have led to over-pumping aquifers, resulting in severe land subsidence and affecting infrastructure and the capacity of aquifers to hold water (e.g. Mexico City) (Galindo-Castillo et al., 2017). In developing and transitional economies, drought can lead to famine, death, migration and even political and social disorder (Obokata, Veronis & McLeman, 2014;von Uexkull, 2014). Water accounting during droughts calculates how much water remains in stocks and flows, and what new supply and demand-side measures will further stretch resources. Combined with foresight studies, water accounting can help prepare for climate shocks (Briggs, 2017) thereby serving as a buffer to sustain water supply.

Improving Water Productivity in all Sectors

With rising population, food, fibre, fuel and feed demands, it is essential to achieve optimal levels of water productivity, production and efficiency of water use in urban, agricultural and industrial systems (CAWMA, 2007). In agriculture, the goal is to manage water andother inputs (e.g. soil, farm technology and labour) so that crop yields are optimized for a given context and set of constraints (Giordano et al, 2017). Water accounting contributes to these debates on the relationships between productivity, efficiency andwater withdrawn andconsumed.

Distributing Water More Equitably and with Better Timing

The productivity of irrigation systems and well-being in urban centres will respond to more timely and more equitable distribution. Nearly all human, natural and human-caused processes benefit from clean, fresh water, delivered on time. Water accounting within these domains informs that distribution process can cumulatively result in being more efficient and productive.

Water Roles are Changing Rapidly

Water accounting is responding to and reflecting the changing roles within water management and governance. Corporations, charities/NGOs, utilities and water user groups are more involved in issues of water than ever before (Hepworth and Orr, 2013) while at the same time governments are looking for ways to shed responsibility and shift to light-touch facilitative and regulatory roles. However, major problems arise from these changing roles. Some questions to be asked are: “How do current arrangements of infrastructure and institutions support these new roles?” (Soliev et al., 2017) and “How are these roles conjoined to create sufficient oversight rather than gaps?” In other words, how might state-owned and operated infrastructure share operational data and decision-making with the private sector and user groups (NRC, 2012) and vice versa? And how can state agencies access water data from the private sector and user groups?

Accommodating the Effects of Non-Water Policies

In areas with limited water resources, non-water policies arising from elsewhere in the economy can alter the balance of water demand (World Bank, 2007). An example is where a policy to increase food security in a semi-arid region by irrigating during the dry season puts additional pressure on already limited surface water resources. Alternatively, there are also many options for reducing water consumption by switching economies out of irrigated agriculture towards light industry or the service sectors (Allan, 1993, 2012). Water accounting can help model these scenarios and reveal how they affect the balance between water supply and demand.

BACKGROUND REVIEW AND UPDATE OF NATIONAL WATER RESOURCES MASTER PLAN IN NIGERIA (1995 & 2013)

Discussion of water accounting in Nigeria would be incomplete without a discussion of the Water Resources Master Plan which was developed in 1995 to last till 2015 but was revised in 2013 to take effect from 2016 till 2030 in consonance with the Sustainability Development Goal (SDG).

In Nigeria, the government has led the process of water resources development since the 1970s. The Federal Ministry of Water Resources and Rural Development (FMWRRD) as it was then known undertook the formulation of National Water Resources Master Plan with the assistance of the Food and Agriculture Organization (FAO, 2012), aiming at efficient management and development of water resources. However, due to lack of funds, this work was not concluded; coming up with only a draft report. In order to complete the master plan, FMWRRD requested the Japanese government to conduct a study on the water resources master plan. Accepting the request from the Nigerian government, Japan International Cooperation Agency (JICA) raised a team of consultants to come to Nigeria. The study was conducted over a period of three years from end of March 1992 to end of March 1995. The Master Plan studied and came up with results of current status and problems related to water resources in the country. It recommended and mapped out the plans for water source development, water supply, irrigation and so on.

In recent times, water shortage has become more serious mainly in the northern part of the country because of increasing need for irrigation, water supply, energy generation etc. as a result of population growth and economic development. Therefore, adequate development and management of water resources became acritical necessity to meet these needs andpreventenvironmental damage.
With this background, the Government of Nigeria requested for technical cooperation from Government of Japan to review and revise the Master Plan for the promotion of optimum water resources management (the Project). In response to this request, JICA raised a Project Team to implement the Project (the JICAProject Team) consisting of consultants andcommenced the Project in August 2011 till date, based on the Scope of Work signed and agreed between the Federal Ministry of Water Resources (FMWR) and JICAin March 2011.

The objective of the project is formulation of the Master Plan on Water Resources Development and Management for Nigeria spanning 2014-2030 (hereinafter referred to as M/P2013).In addition, a Draft Catchment Management Plan (CMP) will be formulated for two priority hydrological areas. This is expected to lead to the establishment of Catchment Management Office in each of the two hydrological areas. This would subsequently be replicated in the remaining hydrological areas across the country.

Fifteen years have elapsed since the formulation of the M/P1995 and the following challenges and issues have emerged:

1) Water demand is increasing as a result of population growth andeconomic development.
2) It is usual that river flow may decrease in the dry season. In recent years, however, some rivers dry up completely between December and January. Groundwater sources also dry up more than before in dry season mainly in northern part of the country. Actual water resources potential shows considerable difference fromwhatwas assessed in the M/P1995.
3) With the impact of Climate Change, the frequency of extreme weather events is increasing and the damages caused by water shortage or heavy rains etc. are on the increase. Therefore it is necessary to incorporate new approaches such as forecast/mitigation of natural disaster into management and development of water resources.
4) In addition to the establishment of Nigeria Integrated Water Resources Management Commission (NIWRMC) which will take responsibility for water-resources management at the national level, the Catchment Management Office (CMO) will be established under NIWRMC in eight hydrological areas. Catchment Management Plan will therefore be formulated on the basis of coordination and agreement between stakeholders for better allocation of water resources.

With the above background, the project commenced in August 2011 in order to revise the M/P1995 for the promotion of optimum water resources management in Nigeria.

National Water Resources Master Plan 1995 updated as M/P2013

Following the ineffective implementation of Water Sector M/P1995 due to several reasons, it became imperative to do a review of it in light of emerging new realities, as it had become clearly outdated 20 years after its conception. The review and update is the current M/P2013. The national plans such as Nigeria Vision 20: 2020, Water Sector Roadmap informed the key policy thrust in the M/P2013. Accordingly, its goals are targeted to improve current situation in the water sector and to address:

i. Low rate ofaccess to safe andclean water andsanitation facilities
ii. Low contribution of irrigation to national food security, and
iii. Insufficient utilization of hydropower as renewable source ofenergy.

The revised M/P involved evaluation of water resources potential and demand projection on the basis of the philosophy of integrating development, utilization and management of water resources. In formal terms, this is known as Integrated Water Resources Management(IWRM).

The revised draft of National Water Resources Master Plan (M/P2013) was prepared by JICA Project Team in collaboration with the Nigerian Counterpart Teambased on available data and information and guided by the philosophy of IWRM. The main components of the plan are: (i) Water Sources Development Plan; (ii) Water Sub-sector Development Plan and; (iii) Water Resources Management Plan.

The main target of the M/P2013 is to enhance the social welfare and to contribute to Nigeria's economic growth according to the national plans such as “Nigeria Vision 20: 2020”, although some negative socio-environmental impacts by implementing the M/P2013 could appear. In order to avoid significant negative socio-environmental impacts, the following are strategically considered for formulating the M/P2013: (1) Water Source Development (2) Water Supply and Sanitation and (3) Irrigation andDrainage.

The National Water Resources Master Plan identifies all the key issues (projects) the Ministry of Water Resource in Nigeria should undertake between now and 2030 with specific interventions to achieve the objectives contained in the plan. Amongst the objectives to achieve is 100 percent water supply to Nigerians before 2030. However, the Nigerian Minister of Water Resources, Alhaji Suleiman Adamu in May, 2016 said over 50 million Nigerians were yet to have access to water supply as the country only achieved 69 percent coverage of water supply (Daily Sun May, 2016). Going by this report, it is evident that water scarcity still persists in Nigeria, and this is why water accounting is imperative if we must achieve the SDG of water for all in 2030.

Water Resources in Nigeria

Water is a natural resource of fundamental importance. It supports all forms of life and create jobs and wealth in the water sector, tourism, recreation and fisheries (Ntengwe, 2005).Without water, life as it exists on our planet is impossible (Asthana & Asthana, 2001).97.5%of water on the earth is salt water, leaving only2.5%asfresh water of which over two-thirds is frozen in glaciers and polarice caps. The remaining unfrozen fresh water is mainly found as groundwater, with only a small fraction present above the ground or in the air. Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world, and as world population continues to rise at an unprecedented rate, many more areas are expected to experience this imbalance in the near future (Mekonnen and Hoekstra, 2016).

While Nigeria is known to be endowed with abundant water resources, the availability of potable water is a problem in many parts of the country (Onokerhoraye, 1995).The Nigerian government has long considered the provision of water supply services to be the responsibility of the Federal, State and Local Governments. However, the public sector has not been successful in meeting more than a small portion of the demand for water by residential and commercial users. Services are in critically short supply (FRN,2000).

From 1999 to date, Nigerian government has expended huge amount of public funds on provision and management of water, still no potable water for consumption. Successive Nigerian governments have been pursuing with vigour aggressive water supply programmes and donor agencies also have been making their impacts in the sector through expansion of water supply infrastructures. Despite these efforts, the public is still disenchanted because access to safe water is not improving (NEST, 1991; Emoabino & Alayande, 2007). The value of water is determined by two elements; supply-the cost of providing the resource in a certain quality, quantity, and location which varies in different parts of the country and demand-the utility to humans and their willingness to pay for that utility (Cech, 2005). The demand for water is fast outpacing its availability for consumption and the supply of domestic water is seriously constrained by the rising population andnon-accountability (Udoh & Etim, 2016).

Many households, often the poorest, end up purchasing water from private vendors usually much more expensive than from the public supply. Water supply services, where they exist, are unreliable and of low quality and are not sustainable because of difficulties in management, operation and pricing, and failure to recover costs. Many water supply systems show extensive deterioration and poor utilization of existing capacities, due to under-maintenance and lack of funds for operation (FRN, 2000).

In Nigeria, water accounting has not gained prominence because providers of water have little or no knowledge about water accounting and the likely adverse consequences of non-water accounting to water users. Also, water accounting is uncommon in Nigeria because only limited amount of information is available about water-related issues which include quality, valuation, and storage capacity. There is a surprising dearth of information about the total available water inflows andoutflows of the entire water cycle. These and many more are the reasons for water crisis that brought about water scarcity in Nigeria. Water accounting is therefore advocated as it would assist water policy decision-making inNigeria.

Global Water Accounting Studies

Freshwater is considered the lifeblood of human civilization and a vitally important non-substitutable resource (Alivia, Jha, &Sanjeev, 2008). The World Water Assessment Programme (2009) stresses that "urgent action is needed if we are to avoid a global water crisis". Further, "managing water is essential if the world is to achieve sustainable development. This challenge is even more pressing as the world confronts the triple threat of climate change, rising food and energy costs, and the global economic crisis (World Water Assessment Programme, 2009).

Maunders and Burritt (1991) examine the ecological crisis and the role of accounting information. They argue that the monetary representations of accounting information cannot fully capture the ecological impacts created by an entity (such as the depletion of the ozone layer resulting from an entity's activities). The provision of non-monetary measurement of ecological impact, such as compliance with standards information, is one way of tackling this issue. Hence, they suggest that environmental assets should be examined from both ecological and accounting viewpoints to provide comprehensive reporting and add value to the accounting information. Molden and Sakthivadivel (1999) predict that future irrigated agriculture will have to produce more food with less water because of the increasing competition for this scarce resource. As large part of the world's population is being threatened by water shortages, these authors suggest that water needs to be appropriately accounted for to understand better the present use of water and formulate actions for improvements in water management. They state that the prime objective of water accounting is to account for water use, depletion andproductivity.

Water is depleted by four generic processes: (i) evaporation, where water is converted from its liquid form to its vapor form and transferred to the atmosphere, (ii) flows to sinks, where water flows into a sea, saline groundwater, or other location where it is not readily or economically recovered for reuse, (iii) pollution, where water quality gets degraded to an extent that it is unfit for certain uses, (iv) incorporation into a product, where water is incorporated into a product through an industrial or agricultural process such as bottling water, or incorporation of irrigation water into plant tissues (Molden, 2007; Molden & Sakthivadivel, 1999).

Molden and Sakthivadivel (1999) made a significant contribution by presenting a classification system on how to account for the use and productivity of water resources. Their 'Water Balance Approach' outlines a broader way to perceive the water cycle where it is based on the concept of mass conservation, the sum of inflows equates the sum of outflows plus any changes in storage. This method presents ausefulapproach to the conceptofwater accounting at the basic level.

Water accounting calls for different concepts. Molden and Sakthivadivel's (1999) water accounting classification of different types of water flow is a useful tool in the planning and evaluation of water resource systems. This requires different types of inflows (surface, subsurface and precipitation), outflows (utilizable, non-utilizable) and depleted water (beneficial and non-beneficial) with storage facilities serving as a buffer between different levels of supply and demand. Many similar models are available. The key is that they are trying to account for all the water in the system. The World Water Assessment Programme (2009) advises that this water box is dependent on management decisions and, in turn, these are influenced by politicians, civil society, the business and economic sectors, all of whomhopefully have access to good information aboutthe resource they are influencing.

METHODOLOGY

This study is a desk study as it provides an initial understanding of the characteristics of water accounting as a specialized area of study. Desk research is another name for secondary source of information research. Desk research is not about collecting data but, a review of previous research findings or existing literature to gain a broad understanding of the field of study. The study is primarily based on qualitative literature survey approach, being an exploratory research. The study is based on secondary information sourced from the journal articles, referred books, websites, annual reports and newspapers in order to have thorough insights of the issues related to water accounting with a view to suggesting likely ways on how water accounting could be used in addressing challenges of water scarcity andachieve sustainable development goalcome 2030 in Nigeria andbeyond.

DISCUSSION ON WATER ACCOUNTING METHODOLOGIES

Water accounting is the systematic study of the current status and trends in water supply, demand, accessibility and use in domains that have been specified. FAO (2012) defines water accounting as the systematic acquisition, analysis and communication of information relating to stocks, flows and fluxes of water (from sources to sinks) in natural, disturbed or heavily engineered environments. Water accounting is a systematic process of identifying, recognizing, quantifying, reporting, and assuring information about water, the rights and other claims to that water, and the obligations against that water.

Water accounting comprises different methods to quantifying water resources in much the same way as finance does. The water accounting and water auditing framework developed by FAO (2012) was an approach that connects water accounting to water auditing with the specific aim of reforming water governance. The framework incorporates the quantitative rigour of water accounting with a wider social process and dialogue driven analysis ofwater governance.

In water accounting, the Basin water accounting is an important method to assess how supplies of water are distributed to and consumed by different sectors or uses. Developed by the International Water Management Institute (IWMI) in partnership with UNESCO-IHE, Water Accounting Plus (WA+) uses public domain remote sensing datasets to analyze the water flows, fluxes, stocks, consumption and services from complex river basins, countries or sectors (Karimietal., 2013). Over the past few years, the increasing availability of data from earth observation satellites has dramatically changed our ability to quantify water resources atdifferent scales.

The hydrological methods is a method found in the traditions and ongoing developments in the field of hydrology, these methods help to assess different water resources and observe changes to the hydrological cycle (such as changes in rainfall, groundwater levels or river discharges). Hydrological data is neededatall scales from the field to the basin.

The sector-or user-specific methods for determining operational performance and risks is a method which each sector, user or system develops particular methods for assessing performance and risks within its own domain. For example, irrigation systems can generate summary or time-step statistics on farm productivity, efficiency, infrastructure operation and so on. In another example, a corporation, supply chain or sector (e.g. clothing or food type) can develop and benchmark its water footprint using a number of different methods (Hoekstra, 2017; Christ, Burritt &Varesi, 2016). All these are water accounting approaches used to boostwater sufficiency.

Water accounting in a practical sense is used as a basis for evidence-informed decision-making and policy development by answering questions such as: What are the underlying causes of imbalances in water supply (quantity and quality) and demand of different water users and uses? Is the current level of consumptive water use sustainable? What opportunities exist for making water use more equitable or sustainable? Water accounting is often used as a basis for multi-scalar assessments of; (i) the efficiency or productivity of different water uses or users; and (ii) the risk that attempts to increase water efficiency or productivity result in negative externalities, that is, someone's gain in water productivity will result in someone else's reduced access to unpolluted water.

In this study the definition of water accounting adopted is that of Food and Agriculture Organization-FAO, (2012) which views water accounting as the systematic quantitative assessment of the status and trends in water supply, demand, distribution, accessibility and use in specified domains, producing information that informs water science, management and governance to support sustainable development outcomes for society andthe environment.

A critical aspect of water accounting is that it considers and assess both the supply and the demand sides of water accounting systems. From the perspective of water accounting, water supply and demand can be characterized as follows (Amarasinghe & Smakhtin, 2014):

Supply side:

The availability of rainfall, surface water, groundwater and unconventional water resources (e.g. treated waste waters) in space and time.

Capacity, condition and Operation and Maintenance procedures of water supply, storage and treatment infrastructure.

Demand side:

Different users demand for water in space and time, and the extent to which these demands are satisfied.

Patterns of consumptive or non-consumptive water use in space and time.

Water service levels that are experienced by different users in space and time and the benefits they derive in monetary andnon-monetary terms such as improved health and well-being.

Water accounting is the foundation of sound water management decisions (World Bank, 2007). A major strength of water accounting is that it can be used to: consolidate, assess and interpret information and evidence from a wide-range of different sources, develop an information base for specified domains that is shared and accepted by key stakeholders, and support cycles of learning, stakeholder dialogue and evidence-informed decision-making (Foster, Perry, Hirata & Garduno, 2009).

Water accounting was developed from three distinct perspectives, namely: hydrology, irrigation or civil engineering and monitoring and evaluation (Perry, Steduto,Allen, & Burt, 2017).

The hydrological perspective: This is based firmly on an understanding of the physical processes that govern volumes and rates of water flows, fluxes and stocks in different landscapes and/or under different agro-climatic conditions or management regimes.

The engineering perspective: This focuses primarily on the design, construction and operation of storage structures, bulk transfer schemes, well fields, irrigation and drainage schemes, municipal water-supply systems and water treatment plants. Or, put in another way, the focus is on managing stocks of water (in time and space) and the transfer of water through pipelines and canal systems from sources to where it is needed.

The monitoring and evaluation perspective: This focuses on using water accounting to support or underpinmanagementdecisionsorasameanstolearnlessonsorgainincrementalimprovementsin policies and practices on both the supply and demand sides of water supply and water services delivery systems.

Summarily, the idea behind water accounting is the existence of scope worldwide to improve water-related sectoral and inter-sectoral decision-making at local, regional and national levels. Improvements are often initiated by basing decisions on 'best-available' information, evidence and analysis, rather than intuition, assumptions and guesswork. It would be inexperienced to believe that improvements in water governance or policy development will follow automatically and seamlessly from water accounting. The collection, evaluation, analysis and interpretation of biophysical and societal information that are central to water accounting are subjected to uncertainty and professional biases and, as behavioral scientists are quick to point out, irrationality. However, mutually-supportive water accounting has much to offer as apractical approach to; (i) assembling andchecking the veracity of information from multiple sources; (jj) analyzing, modeling and interpreting this information; and (iii) assembling robust evidence to support decision-making, policy development and new courses of action.

The methods and tools used in water accounting are well-known to hydrologists andengineers such as mapping and spatial analysis, water balance analysis, water quality analysis, trend analysis, modeling of water flows, fluxes and stocks and demand forecasting. Information collected during water accounting is typically varied and addresses a range of biophysical issues. Likewise, outputs are equally diverse in their formats and their target uses andaudiences.

The relevance of water accounting becomes more important where available water is fully or over allocated. Water accounting tracks quantities of water, aiming to maximize the way that available water can be managed to meet known water needs. Water accounting matters because, without reliable

information, debate is uninformed and stakeholders have no basis for challenging factually incorrect or biased positions. Similarly, effective planning is near impossible if stakeholders are working with their own differing information bases. Yet, such a situation is very common. For example, government line departments, when attempting to align plans, rarely have access to a common information base. Similarly, local level water users may have a very different perception of their levels of water services as compared to organizations that are responsible for delivering these services. A key output of water accounting is, therefore, a common information base that is acceptable to all the key stakeholders involved in planning or other decision-making processes.

Water accounting is necessary because it often disconnects exist between hydrological knowledge based on scientific evidence, and popular understanding of hydrology based on beliefs, folklore and hearsay. Water accounting plays a central role in identifying hydrological beliefs that are, in reality, myths. It is important, however, to recognize that while facts and evidence may be important, they do not always change opinions. Many beliefs are deep-seated and holders of these beliefs have a tendency to reject any facts or evidence that challenges or is inconsistent with these beliefs(Hoekstra, 2017).

The question at this point is, how do we account for the current status and future trends in water supply, demand accessibility and use? In some cases, the question is relatively easy to answer. The two broad categories of water sources are surface and underground sources.
(i). *Surface water:* This is water that is extracted directly from streams, rivers and lakes. These sources generally contain larger quantities of turbidity and bacteria than groundwater and often, the surface waters of rivers and lakes are polluted by the influx of sewage or industrial wastes. In an article from Encyclopedia of Earth, the Niger Delta Basin was identified as the principal surface water basin in the Delta region which covers an area of 584,193 km.(ii). Ground water: This is water obtained from wells and springs that feed streams, rivers, and lakes. In its course, ground water dissolves soluble mineral matter. The ultimate source of all natural potable water on earth is rainfall. Groundwater contains high concentrations of dissolved chemicals. Nigeria has extensive groundwater resources, located in various hydro geological areas together with local groundwater in shallow alluvial (Fadama) aquifers adjacent to major rivers (Okoye, 2015).

Water from these sources could be pumped from the wells and springs to an appropriately located storage tank in or near the home and, all being well, water would flow under gravity from this storage tank to the tap(s) in the home. So, in this case, this is how water reaches the home and the costs incurred are: (1) Capital costs of constructing the system; (2) Recurrent cost of Operation and Maintenance (O&M) such as pumping costs, repair costs; and (3) the cost of routinely testing the quality of the well or spring water. This is as simple as a piped water-supply system can be. However for most water users, delivery of water from "rain clouds to the home" on a secured, reliable and predictable basis is more challenging.

In many regions of the world, sustainable and reliable delivery of water (or rather water services) to homes at the same time protecting environmental flows, has become increasingly complex and problematic (UN, 2017; Merrey, 2015). Particularly, if overall demand is surpassing supply, the delivery of water services is often less about engineering and more about politics, governance, managing and protecting sources, resolving conflicts about water, ensuring rights to water are respected, and so on. It

is also about understanding and monitoring what is going on between the rain clouds and the water users. This is where water accounting plays a crucial role.

Since water accounting includes aset of methods to monitor water supply andusage on a regular basis to create measures of performance such as productivity, efficiency and equity, we therefore propose these methodologies on how water accounting can be used to alleviate the challenges of water scarcity andwater supply in Nigeria as follows:

i. Water accounts contribute to the issue of water reuse; therefore, we propose that water treatment plants which represent a sector in the water accounts be created for water reuse and recycling to reduce water scarcity and water supply in Nigeria.
ii. Water accounting would help government to have an idea of the cost and extra benefits of improved treatment technologies and how much value-added to be generated. We suggest that Nigerian government should invest in more improved treatment technologies as they generate much more reusable water. This would help to augment potable water supply and/or reduce demand for potable water in Nigeria.
iii. With water accounting the uncertainty about the amount and quality of water available from year to year in terms of both stocks and flows are ascertained, this would aid water resources authorities to plan with these figures thereby reducing water scarcity in Nigeria.
iv. Water accounting, together with water auditing, can be used to improve understanding of the 'cost' in water terms of sustainable development; the level of water governance needed to deliver sustainable water services; and the water implications of delivering and achieving Sustainable Development Goals (SDGs) in Nigeria.
v. Water accounting can be used to improve transparency over water allocations and enable stakeholders to challenge policy-makers to adopt sustainable solutions that may be at odds with short term voter, legal, fiscal interests. This would help reduce water scarcity.
vi. Lastly, water accounting can help to identify cross-sector water problems. This would make organizations to work together to enable everyone to address problems collectively, achieve consensus, and establish resource needs and data requirements. This would help to alleviate water scarcity challenges among organizations.

CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS

Conclusions

The International Water Management Institute (2008) argues that water is a fundamental issue because it has become the prime challenge of survival in today's world and it has a significant impact on health, food security, poverty and the environment. Gleick (1998) investigates fresh water resource management arguing inadequate access, inappropriate management, and rapid population growth to be the cause of a growing global water crisis and that new approaches to long-term water planning and management are required to guarantee access to freshwater resource for future generations. Plummer and Tower (2009) noting the volatile political nature of water policy with the related accounting communication of this precious resource opines that water is a limited resource, thus water allocation becomes a zero-sum game. They opined that some stakeholders will win with a more 'efficient and equitable' reallocation, while others will lose and potentially lose badly with related devastating economic consequences because, not all stakeholders are equally adept or financially able to garner their political lobbying power.

In Nigeria, how policy is to be made for a product like water with static and even decreasing supply but ever growing demand has been identified (Okoye, 2015; Emoabino & Alayande, 2007)as a major challenge to the Nigerian water authorities. Governments in the past have in asense bankrupted future generations by over-allocating water rights to stakeholders who are financially able to garner their political lobbying power to win with a more 'efficient and equitable' reallocation, yet others will lose and potentially lose badly with related devastating economic consequences. Global warming, climate change and the resultant deep drop in water catchment areas are finally making governments face the harsh andunpalatable reality of this unsustainable policy.

World Water Assessment Programme (2009) posits that managing water is made more difficult by the lack of knowledge and information required for decision-making and long-term planning. Few countries across the globe know how much water is being used and for what purposes, the quantity and quality of water that is available and that can be withdrawn without serious environmental consequences and how much is being invested in water managementand infrastructure.

Observations from the various related literature reviewed revealed that appropriate policies and additional communication are needed from Nigerian water authorities especially in the areas of the amount of available water, storage capacity and more insights on quality and valuation of water. There is almost a complete absence of information of Molden and Sakthivadivel (1999) style of accounting for inflows (surface, sub-surface and precipitation), outflows (utilizable, non-utilizable) and related depletion (both beneficial and non-beneficial) of water. Hence, a higher level of water accounting communication is advocated. In conclusion, water accounting is a necessary tool that if embraced would help to cushion the problem of water scarcity in Nigeria.

Recommendations

Based on the findings of this study, it is recommended that:

i. Government should create awareness among water providers in Nigeria by organizing lectures, seminars, workshops and symposia to educate them on the relevance of water accounting in ensuring adequate water supply in the country. This should be the responsibility of the Federal Ministry of Water Resources

ii. The Nigerian Government should create the Nigerian Bureau of Meteorology which should have the clear mandate of the Federal Ministry of Water Resources to create the 'National Water Account' that would assist in meeting the information needs of various stakeholders and improve the public understanding aboutwater resources in Nigeria.

iii. An independent advisory Water Accounting Standards Board (WASB) should be created by the Financial Reporting Council of Nigeria (FRCN) in collaboration with the Federal Ministry of Water Resources to oversee the development of the Water Accounting Conceptual Framework (WACF) and water accounting standards. The WACF would provide the conceptual parameters for water accounting and assist in the development of Nigerian Water Accounting Standards (AWASs) as well as the preparation and presentation of General Purpose Water Accounting Reports (GPWAR) by relevant private and public sector organizations that are responsible for adequate Water Supply in Nigeria.

iv. In comparison with other international development partners, General Purpose Water Accounting Reports (GPWAR) that focus on the monitoring and measurement of and

reporting aboutwater rather than providing statistics about water should be introduced by the Federal Ministry of Water Resources into the Nigerian water system.

Suggestions for Further Study

In view of the limitations of this research and without bias to our findings, suggestions for future research in this area could proceed in these directions:

i. Firstly, future research should explore the causal link between water accounting and sustainable development across several reporting jurisdictions. In this regard, replicating this study in different settings would be worthwhile to establish the validity and generalizability of the present findings across different contexts.
ii. Secondly, future research should be empirically conducted in this area in Nigeria, following the fact that water accounting is anemerging field of study in accounting.
iii. Lastly, future study should explore issues relating to "accounting for water" as an integral part of social accounting tradition and the "management" and "control" implications on the economy, ecology and society.

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