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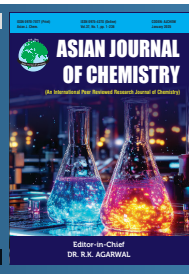

REVIEW

Progression on Water Supply Issues in Nigeria: Implications, Workable Management and Sustainability

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Water safety for domestic purposes remains a vital necessity for healthy living and human survival. Clean water is a non-negotiable requirement for direct consumption and other potential uses needed for ecosystem existence. The global world is facing with the challenge of pollutants that continuously affect water supply sources. The pollutants compromise water quality, making it unsuitable for drinking and domestic purposes. Water supply situation in Nigeria is expanding with different complications without any effort by the Government to resolve the menace. The various state water agencies in Nigeria responsible for potable water supply have remained inactive in the aspect of general delivery of piped water supply for all. The Federal Government that is responsible for funding this sector seems to be hiding in ignorance on this basic need of portable water demand. This has resulted to diverse sources of water supply by different people for their daily survival. This review focused on assessing the advancements related to resolve the water supply challenges in Nigeria. The objectives focused on simplifying the undermining implications and workable management practices towards sustainability. Sustainable practices that will accommodate green growth and green infrastructures is hereby recommended. This review further highlighted the role of integrating urban water management strategies as an option.

Keywords: Water supply, Pollution, Government failure, Sustainability.

INTRODUCTION

Access to safe and adequate water eases hygiene practice and sustenance measures needed to avert water related diseases and several frequent mistreated tropical ailments [1,2]. Clean and readily accessible water is significant for public health safety and improved standard of living [3,4]. This is achieved in terms of diverse uses which include food production, direct drinking, domestic purposes and recreational activities [5]. Clean, adequate, available, satisfactory, physically reachable and affordable water for individual and domestic use have been emphasized severally as everyone's right [6,7]. Improved water supply system, effective sanitation and clean water resources management is required for enhancement of economic development and also a contributor to poverty reduction [8,9]. Exposure and improper management of drinking water sources are considered unsafe and can cause a variety of health problems, including gastrointestinal issues, infectious infections and acute illnesses [2,10]. Bacteria, viruses and pathogens that brood in contaminated water usually cause water related illnesses inform of waterborne diseases. Adequate water must fit into drinking and domestic requirement, such include being free of irritating tastes, colour forms and odours and sustained at suitable limits of temperature [11]. These requirements are needed to satisfy the increasing demand for safe and potable water supply [9,11].

Water safety and adequate sanitation were included in the Millennium Development Goals (MDGs) for 2015 targets; along with the Sustainable Development Goals (SDGs) for 2030 targets [12]. The Human Right to Safe Drinking Water and Sanitation (HRTWS) was also implemented in 2010 following the UN strive fortitude for safe, affordable, adequate, accessible and available drinking water and sanitation services for all [4]. Evidences from WHO/UNICEF Joint Monitoring Program (JMP), 2014 report update on Drinking Water Safety and Sanit-

ation on SDGs programs and targets focused on explicitly attaining and achieving a collective and equitable access to clean and affordable drinking water for everyone by 2030 [8,13-15]. These programs and development also situate the need for sufficient access to safe drinking water for all, location or geographical region notwithstanding. This should also be a guide for national leaders in different countries to ensure these provisions are made available to citizens. Significant advancements, with 90% achievement, have been observed particularly in developed countries regarding the enhancement of access to clean and sufficient water [16]. Majority of the inhabitants in rural areas are now benefiting from the improved water sources [15]. Although, records also revealed that roughly 785 million people globally are still in need of adequate water services due to the failure of water infrastructures and discrepancies persevering between political groups, urban and rural regions [15-18].

The reverse of this development on clean water requirement is the situation in developing countries with Nigeria experiencing abysmal situation [17,19]. Access to safe and adequate water sources in Nigeria's environment has become retarded and progressing backward [8,9]. The JMP (WHO/UNICEF Joint Monitoring Program) report revealed a significant change of 1% increase between 1990 to 2012. However, these value incre-ase does not determine that those with access to piped portable water are linked to a reliable point within their locations through a Water Corporation network [8,16]. JMP report similarly, con-firmed a substantial reduction of 27% proportion of households having access to piped borne water to buildings, this was reported to have dropped from 33% to 6% between the period of 1990 to 2012 [8]. Nigeria is dealing currently with the urgent issue of numerous unsuccessful piped water delivery projects, caused by corruption and insufficient planning. As a result, many people have turned to using water from the unregulated sources, compromising its purity, in order to ensure their own survival. Therefore, this review evaluates the progressions of water supply issues in Nigeria. The objectives focused on utili-zing sustainable solutions and integrated urban water manage-ment strategies as a remedial target to water delivery in Nigeria Urban Environment.

Methodology: This review employed a desk research study method. The desk research approach allows accessing information from available sources [20,21]. It also includes handsearching of grey literatures and interrelated article references [20]. Data from several scientific and past studies databases was obtained from journals, articles and books. The data base search comprised of ResearchGate, ScienceDirect, Google Scholar and Scopus. Upon this selection, the final results were then perused for relevance to the review by screening the abstracts and the titles. The pertinent articles were then downloaded and reviewed thoroughly. This process helped to establish list of 127 references at the end of the information gathered. Again, the review article was narrowed down to accommodate published literatures from year 2000 to 2024. This was done with the aim to have a better understanding and to identify the knowledge gap for a comprehensive review.

Overview of water supply progression in Nigeria: Nigeria maintains its stand as the most populated country in Africa, having weighty difficulties in attaining SDG targets on clean water availability for all [22]. Nigeria with over 200 million people is presently being confronted with diverse developmental issues ranging from overpopulation, economy crises, default policies, academic imbalance, environmental challenges, failing and abandoned infrastructures among others [23,24]. The lack of infrastructures for portable water provision is a major obstacle to achieving global targets set by the SDGs [25,26]. Geographically, Nigeria features significant disparities, which is currently affecting every sector including the economic situations and water sector [27]. Water supply responsibility in Nigeria from the roles of Federal Ministry of Water Resources (FMWR) is shared among the three levels of government-federal, state and local. The federal government manages the water resources, formulate and coordinate national water policies, provide funding and technical support [8,22]. The state governments known as the state water boards or state water authority (SWBs SWA) oversees the urban and semi-urban water, manage and establish operation, oversee quality control and also responsible for authorizing and monitoring private water suppliers and provide technical support to local Governments [8,22]. The 774 local government councils are responsible for rural communities' water supply and management. However, it is evidence that LGAs council have recorded a big failure in this obligation. It was observed that LGA encountered frustration in this assignment due to funding issues and a shortage of staff, which remain unresolved at this time [28].

The State Water Agencies (SWA) reaction to this task of piped water delivery is near to failure and not efficiently performing [28,29]. There are acute shortages of portable water supply in almost all the affected states particularly the low-income people in the urban area [8]. This awful condition has conceded sanitation and public health within the environment. The State Report shows that 37 water agencies exist in Nigeria belonging to each state including the Federal capital Abuja [8]. Each of these SWA was established with the task to develop and manage portable water supply facilities in the state as well as meeting up the financial requirement [30,31]. Remarkably, other external investors and partners on water issues also function as a support to each state agenda on portable water provision. Such external support includes World Bank, European Union, African Development Bank (ADB), US Aid (USAID), UNICEF, Water Aid, WASH. NUWSRP among others [30,32]. However, NUWSRP has recorded construction of over 2,300 additional Water Points and 6,546 sanitation booths and hygiene services across the country. Studies from literature also revealed an increase of 30-34% access to portable water in year 2000, 70% increase after 20 years from year 2000 to 2020 [32]. However, there are also records of decrease in piped portable water supply, dropping from 16.76% in 2000 to 10.1% in 2020 reflecting a backward growth towards achieving the sustainable development growth (SDGs) [33,34]. Fig. 1 revealed a wide gap between population with piped and non-piped water between a period of 20 years.

In Nigeria rural communities, nearly 49% of the population is reported to have access to safe water, while 30% have better sanitation facilities However, 72% of the population in urban

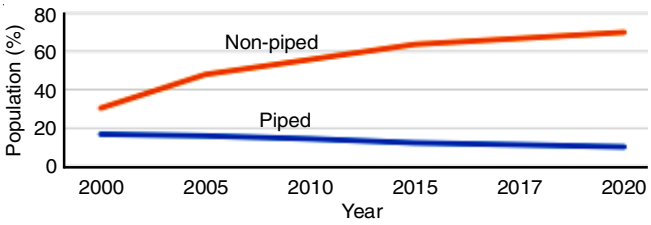

Fig. 1. Showing range of population with portable piped and non-piped water supply [33,34]

area now have access to reliable portable water supply while adequate sanitation practices are rated 44% [32,35]. The state water utilities managed by different state Governments are responsible for these supplies. This responsible act is with the urgent demand in attaining the Sustainable Development Goal (SDG) Target 6. The next phase of meeting up with the remaining 28% population in urban area still lacking access to safe piped water before 2030, requires a progressive effort from all State Water Agencies (SWA).

Overview of public water delivery at state level: Drinking and domestic water is measured and considered as an essential good that cannot be jeopardized or play over with at a bargained amount [36]. The supply of water is a merited human right that should be accessible by all, ability to pay notwithstanding [37]. The performance of water delivery at state level will be judged based on the service area covered in terms of piped water delivery. This is because piped portable water supply was generally considered a safe water supply compared to other vulnerable water sources [32]. Table-1 revealed the level of potable water delivery at state level. The selection of the state represented was based on geographical distribution of state water agencies. This distribution also follows the six geopolitical zone in the country [38,39]. The distribution includes the North East region (NE), North Central (NC), North West (NW), South South (SS), South East (SE) and South West (SW) [30]. Two states from each of these geographical zones were selected for assessment. The selected states include Benue state, Federal Capital Territory from NC regions. North East (NE) includes Adamawa and Taraba (NW) includes Kaduna, Kano. However, (SE) includes Anambra and Enugu state. (SS), we have Port-Harcourt, headquarters of Rivers, Cross Rivers state selected. From (SW) Lagos and Oyo were assessed. Portable water supply progression was assessed in the selected states and also their level of preparedness for SDGs target in 2030.

Fig. 2 revealed the percentage proportion of water schemes that are not functioning in selected 20 states in Nigeria. The results confirmed 46% of a national average water schemes lacking behind [36]. According to Abolarin *et al.* [59], this number accounts for about half of the country's population, and it has greatly contributed to the failure of water sector.

Identified glitches hindering water delivery at state level: There are lots of challenges faced at state level in realizing the set target of 100% piped water delivery in line with SDGs 6 agenda [59]. Some states are putting in much effort to ensure delivery towards meeting up with the target of 2030 by SDGs

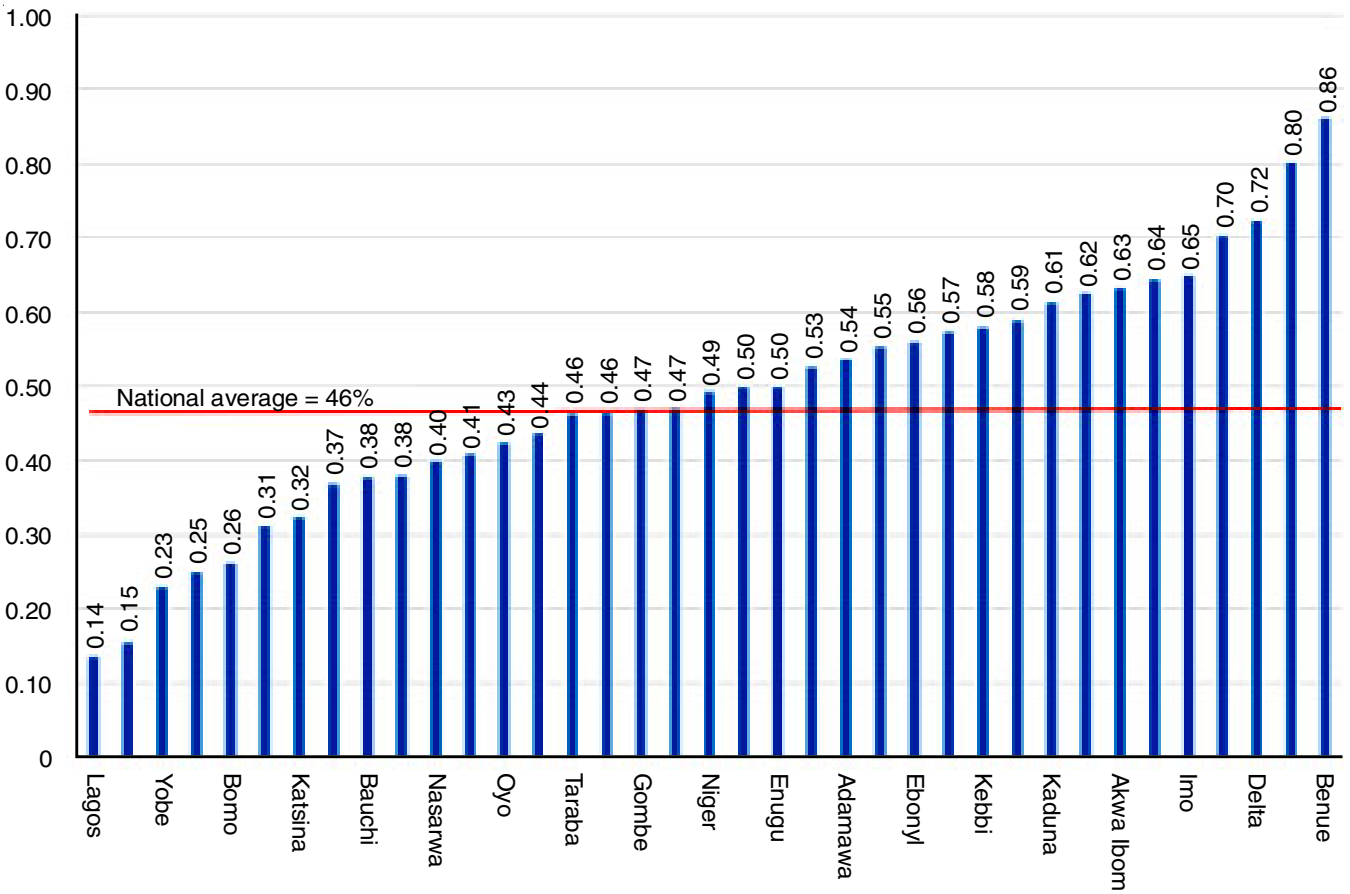

Fig. 2. Unfunctional water schemes in some states [35,59]

TABLE-1
LEVELS OF PORTABLE WATER SUPPLY AT STATE LEVEL

States	Achievements/remarks	Ref.
Lagos State Water Cooperation	Lagos Water Corporation (LWC) wastewater treatment plant was expanded from 2.4 million gallon per day to 45 m gallons per day. Additional 70 m gallons per day is also draws from the Owo River. Report also states that seven mini-waterworks here are also functional. This provision is expected to cover 12.5 million people in the state. However, 320-million-gallon water remain as a gap. This is equivalent to 33% yet to be covered of piped water in the state.	[8,32,40]
Oyo state (Project Completion Report)	The Water Corporation of Oyo State (WCOS) has Achieved 40% target of piped water supply. Base on the report from PCR. There is still demand gap of 60%. Although, 12 water schemes are presently going through renovation in the four zones which include Ibadan, Ogbomosho, Saki and Oyo zone.	[41-43]
Markurdi, Benue State	About 25-30% of the population has access to portable water supply. Other 70% inhabitants fetch raw water from the polluted Benue River. The study also revealed that only 5 projects out of 18 functional water projects are implemented. Showing grossly inadequate.	[44]
Abuja (Federal Capital Territory)	As at 2012, it was estimated that only 14.4% of households benefit from Federal Capital Territory Abuja Water Works (FCTAWC) while 33% was estimated in 2015. There is still a demand gap of 67%. All effort made by the Water Works as well as the privatization ideas aim at attacking the capability shortfalls have not yet materialize or rather eliminated the problem.	[30,36,45]
Rivers State	Report from World bank 2015 confirmed that River State Water Board (RSWB) is still within 5% coverage. This was further supported by (ADBG, 2023) confirming insignificant effort. The study further confirmed that RSWB services only 4.5% the population. This shows 95% demand gap in delivery. Other citizen depends on self-drilled boreholes and external water vendors. However, reports from Urban Sector Water Reform, reports that rehabilitation of water utilities and infrastructures is in progress.	[30,46,47]
Cross Rivers	Cross River State Water Board Limited (CRSWBL), shows a route for mega water demand gap. The initial gap in 2015 was 298,708 cubic meters per day in 2015. There is a projection of 559,213 cubic meters per day by 2030, given the existing water supply capacity while the present water gap stands at 479,452 equivalents to 95%. 5% piped water delivery has been so far.	[32,48]
Kaduna State	Kaduna State Water Corporation (KDSWC) presently has a wide margin to cover in meeting up with the water delivery. The demand gap over supply stands at 83% equivalent to 772,986 m^3/d and only 17% coverage has been achieved so far.	[32,49]
Kano State	Kano State Water Board (KSWB), has achieved about 22 water treatment plants that source, treat and distribute water to the residents This has aided KSWB supply of about 415 million liters daily. About 50 standing commercial water pumps is connected to boreholes where piped water is not connected. The demand gap in supply still showing more than 59%. Only 41% coverage has being achieved.	[30,50,51]
Taraba State	In Taraba, a new WASH Policy was developed, approved and launched in 2019 while a new water bill was passed into Law in December 2019. The law has led to the re-naming of Taraba Water and Sanitation Agency to Taraba Water and Sewerage Corporation (TAWASCO). Taraba Water and Sanitation Corporation (TAWASCO). This project execution led to connection of 8,833 leading to a success of 67% coverage as at 2019 against 36% coverage in 2015 and 53.3% in 2016. However, 33% demand gap is yet uncovered.	[30,41,52]
Adamawa State	The detailed study revealed that the state is still having a demand gap of 2 0% as at 2024. This indicate that only 50% residents have access to a safe piped water. Report also proved that a lots of projects on water supply is presently been witnessed in Adamawa state. The result was noticeable in the delivery of solar power boreholes, hand pump borehole and electric power pumps that was recently acquired.	[53,54]
Anambra State	49% of piped water delivery is said to have been covered at Anambra state The State Water Board suffered some setback until 2021, when Governor Soludo rehabilitated 5 large urban water works, which brought about changes in the water supply dynamics in the state. Water is now reported to be gushing out from these huge installed facilities at different fetching points at Awka, Otuocha and Onitsha. However, 51% is yet uncovered.	[55,56]
Enugu State	This study confirmed as at 2017, 85.6% of the water supply schemes have failed completely and abandoned while only 14.4% of the schemes are functional. However, report from Enugu State water cooperation confirmed that some of the abandoned projects were rehabilitated in year 2023 by the present Governor Soludo. Therefore, a total coverage of 69.9% has been achieved. 31.1% is yet unachieved.	[57,58]

but, there are hindering factors opposing these moves. Fig. 3 illustrates the anomalies hindering safe piped water delivery to all citizens in Nigeria. These problems are discussed under five sub-headings.

(i) Unplanned population increase: Rapid urbanization and population growth have increased water consumption, leading to a severe shortage in available water resources [54]. The urbanization increase in Nigeria is rated at 4% per annum, which is presently exceeding the new water connections [59, 60]. The consequence of this drift is a swift rise in the number of inhabitants living in urban centers that will unreasonably increase the portable water demand [61]. The challenge lies in unplanned provisions in Nigeria that does not accommodate future projection increase in the number of people [62,63].

Fig. 3. Glitches hindering water delivery at state level

This can also be attributed to poor planning and short sighted. This impact of poor planning affects majorly all infrastructure in urban areas. Presently, few available infrastructures are now being over utilized due to population increase. Infrastructure provision in cities should be enhanced to accommodate both the present and the future users.

(ii) Obsolete and deteriorating water infrastructures: Another big problem is outdated and obsolete water infrastructure, which can be caused by of a number of factors such as shoddy equipment maintenance, a shortage of qualified repairmen, subpar starting equipment and unethical business activities [54]. Moreover, the rampant corruption during the procurement process may also play a role, leading to low-quality and short-lived life of the equipments. The problems here range from the breakdown of water treatment plants, grounded or broken down of machineries, equipment and operational input [52]. Poor power supply and upsurge is another factor contributing to frequent equipment breakdown [64]. Frequent on and off power stress in Nigeria also affects the efficiency of the operational equipments for water production.

(iii) Low-cost recovery: Non-revenue water and low-cost recovery is listed among the anomalies affecting state water agencies (SWA). The proper installation of the water meter has not been completely achieved hindering optimal revenue recovery observed in developed cities [59,64]. User charges and readiness to pay that addresses matters such as the inability of SWA to properly collect the fees and the failure to pay charges for water from the users still exist [25]. Illegal connections and sharp practices are usually witnessed within the public receivers using piped water freely without making the subsidized charges. Vandalization and theft of the available water infrastructure is also a factor accrued to cost recovery [65]. Continuity becomes a problem when cost of water generated per time is not recovered. This factor has left several SWA bankrupt and unproductive [64,66].

(iv) Poor financing/budget allocation on water section: Poor investment attached with low financing of most state water providers contributes to inadequacy of water delivery. The expenses involved in generating piped water is usually more than the budget allocated or planned for [26,60]. The water sector as confirmed from literature in some states are delivered at a subsidized cost lower than the cost of tariff to the public users [1]. This condition of subsiding with a very low budget allocation compare with the rise in water demand is a disagreeable situation. State water authority (SWA) has been able to recover the subsidized costs of water passed on to the customers including miscellaneous cost such as labour, maintenance, chemicals and electricity cost [67,68]. Poor deployment and harmonization of finances for water supply advances and development including poor external funding and incentives often causes inefficiency in portable water supply [59]. The recent fund allocation and investment is not adequate to maintain the sector performance therefore, there are evidences of a low yield and output [69].

(v) Disjointed obligation on water supply: The delivery of piped portable water in Nigeria has been fragmented and uncoordinated among the three arms of government. Recognizing shared duties amongst federal, state and local governments are poorly harmonized due to distance and close catchment locations [70]. The roles and responsibilities at the Federal, state and local levels of government, including the several ministries and organizations involved in water delivery is becoming unclear [59]. The problem is politically connected with diverse situations ranging from lack of government commitment, regional sentiments arising from political interferences, political uncertainty, policy misalignment, nonconformity to laws and exploitation [16,71]. The fragmented responsibilities have escalated all these political problems giving undeserved problem to water delivery system [19,72]. These fragmented roles among government arms have also resulted to water quality declined since there is no suitable water quality standard as well as sanctions for polluters [64].

Implications of inadequate clean water delivery: Access to clean and safe water has become a global concern both in developed and developing countries. The implication ranges from the ignorance and lack of awareness of the danger associated with contaminated water intake especially in rural areas and localities [73,74]. The particulate pollutants affecting water sources are extending wider than they were before. The increased urban population resulting to intensification in urban activities is the major factor behind pollutants increased yields in water sources [74,75]. Other factors comprise of natural environmental factors such as rock inundation, soil formation and climate change impact. Water that is not from a safe source is regarded unfit for drinking and other domestic uses [76]. Water from contaminated sources is noted to have caused several diseases and infections ranging from cholera, diarrhea, typhoid and other life-threatening fatal infections affecting children under the age of 5 years [73,73]. The intake of contaminated drinking water and poor hand hygiene have potentially contributed to the yearly deaths' records of 829,000 people from diarrhea [77]. It is also projected that cholera disease is also often cont-

acted when a person drinks water from contaminated sources especially with fecal substances. However, an estimate of 100,000 children under the age of five years die yearly due to water-borne related diseases in Nigeria [13,78,79]. The reason lies in their rapid and critical phase of complicated brain building, hormone development and bone building which can be disrupted at early stage [80]. Other implications of contaminated water will be discussed under the following subheading.

(A) Water-related diseases: Water-borne diseases inflict illnesses and infection generating from both direct consumption and indirect exposure to contaminated water [81,82]. Several studies from literature have reported the implication of drinking contaminated water, food containing polluted water and engagement in recreational functions [83]. Ghernaout [84] conveyed that about two billion people globally lack access to safe drinking which resulted to water borne diarrhea that bring about the death of about 20 million babies annually. About 58% of the total population in Nigeria is recorded with no access to piped water clean water [59]. The implication is noticeable in frequent hospital visit and death records of children below the age of 5 year.

(B) Over-extraction of groundwater: Regular extraction of groundwater is increasingly threatening aquifers and the sustainability of biodiversity [85]. Many Nigerians who can bear the expense of borehole drilling have opted for it as an alternative water source when the piped water supply appears unreliable. The consequences are observed in the depletion of aquifers especially when water abstraction is becoming too frequent and surpassing the natural ground water recharge that is already infected by urban land use pattern [15,86]. Groundwater will therefore become depleted with possible tendency of sea water intrusion, discharge of untreated sewage from broken septic tanks and domestic contaminated water flowing into the aquifers [87]. This process will also contaminate the individual borehole system that has taken more than 40% water source delivery in the country [85,88]. The implication is observed in ground water levels fall, inaccessible ground resources, seawater infringement, land sinking and collapsing, streamflow shrinkage and wells running dry [85,89,90].

(C) Disruption of ecological biodiversity: Continuous abstraction of ground water resources has been declared harmful on flora and fauna survival. The intrusion of seawater and other polluted sewage water under the ground can result to habitat deprivation, damage and loss of biodiversity as well as the interruption of ecological progressions [91,92]. Flora and fauna organisms as well as other invertebrates, could suffer from reproductive disarrays, developing irregularities and reduction in population sizes. Some species may even face annihilation as a result of groundwater extraction [93].

Sustainable solutions to water delivery in Nigeria urban environment: The need for sustainable water delivery and a re-evaluation on Nigeria water sources and delivery in realization of Sustainable Development Goal (SDGs) targets now become essential. Managing portable water delivery necessitates the execution of solutions justifying and enhancing the use of obtainable resources with specific care for the environment [33,94,95]. Many countries are introducing integrated urban water management strategies being adopted as part of a more holistic approach to managing the urban hydrological cycle as option for water delivery [96]. These integrated water management strategies should also be incorporated in Nigerian system to justify the applicability and alternate water source rather, than explaining and lingering on a particular problem of obsolete water infrastructures and breakdown of machineries. Among these sustainable water infrastructures are explained under four subheadings. Fig. 4 described the sustainable approaches resulting from the integrated urban water management strategies that several countries have adopted to improve safe water delivery. This sustainable solution is hereby recommended for a better water delivery in Nigeria.

Fig. 4. Sustainable approaches to water delivery

Rainwater harvesting (RWH): Rain water has been recognized as cost-effective small-scale approach with useful advantages to compliment water supply with lessen anomalies and worries as generated from other methods [97,98]. It also one of the recently adopted water management strategies integrated for urban uses for better holistic option in handling hydrological cycle [99]. Integrated urban water management approaches arose as a remedial response to increasing population, climate change factors, urbanization activities, resulting to water stress and scarcity [99]. Rainwater harvesting (RWH) could fit into Nigeria system as a sustainable solution that should be included as an alternative source of water [100]. It should be welcome as a complimentary source that could help mitigate the water crisis problem both in urban areas and rural communities [101]. These methods of safe water access have been long practiced in the rural areas at a small-scale sustenance. The unavailability of storage facility as well as good rain water channel in most homes makes it a short period sustenance [98]. It entails suitable provision for the capturing either from the roof or from the runoff, collection and storage. Developed countries that are faced with water scarcity crises have grabbed this approach with

modernized equipments to assess more water [100,102]. Rain water harvesting is equally a substantial added value to SDG 6 target under Clean Water and Sanitation Program. It will enhance and bolster water security by offering a sustainable alternative for water. Installation of several numbers of rainwater tanks at locations that lack access to portable piped water will solve a whole water problem [103-105]. Local rainwater harvesting system comprises of a collection point/surface, channels for transportation of the water from one location to another [105]. Other improved equipment is now being incorporated such as first-flush filter that helps to avert and filter the initial dirty, filtration system and subsidence equipment that eliminate debris and pollutants before the water flows to the storage tank or reservoir [106,107]. Rainwater harvesting also featured several sustainable benefits to the environment and natural resources. It helps in flood mitigation, reduction of storm water runoff flow, reduce erosion, reduce non-point source pollutant loads in water bodies and also help in climate change mitigation and adaptation [108]. Scientists have equally reported that rain harvesting requires lesser energy output, machineries and equipment compared to the usual pumping of groundwater system accompanied with several challenges obtainable in Nigeria water cooperations system [105].

Water reclamation approach: This approach is known as water recycling and reuse, which involves wastewater from community, stormwater, industrial processes and return flow. This type of water source is adequately treated before supplying to the users [109,110]. The incorporated treatment process makes it fit and safe for the specific reuse purpose. The planned reuse purposes could include irrigation of farmland, industrial process water reuse, portable water re-supply for other indoor uses and ground water recharges [111,112]. Cities in both developed and developing countries facing water crises as well as large organizations have long incorporated water reclamation appro-ach in reducing water crises stated that the environmental and social advantage of water reclamation include reduction of drinking water consumption and wilding the capacity value of water services and its corporate responsibility [113-115]. Water reclamation can also be beneficial to Nigeria urban areas as an alternative source. The different State Water Agencies (SWA) can incorporate this as part of their action target in resolving water crises towards SDG 6 water sustainability. Implementing strategies that align with the circular economy need not require substantial expenditure and might begin with modest sites in local water circuit regions [110]. This area should be free from industrial flow or runoff effluent implications that would require expensive and complicated equipment or mach-ineries.

Incorporating green growth and green infrastructures: In urban areas, green growth is connected to the delivery of basic services which also accommodates water resource supply management [116,117]. Green growth is perceived as a practical tool for accomplishing the timeless objective towards sustainable development. The motive is to drive the economy towards improved technologies and consumption forms that will induce jobs and economic growth and also lessen implication on the environment [118-120]. Green growth focused more on growing investments, ideas and innovations that will reinforce sustainable development and offer new economic prospects in urban areas. Green growth creates opportunities for sustainable growth within a geographical area such growth includes job creation, talent attraction and investments [117,120]. They can also sprout high productivity output through the initiation of different economic prospects, markets enhancement, access to communication and the supply of capital and skills [121]. Sustainability of water resource management and delivery can be enhanced through green growth if the opportunity can be utilized at various state water agencies (SWA). It will only require attraction of foreign investment, improving on technologies and innovations that will promote the state revenue and capabilities of the economic. This will also improve portable water delivery when technological advancement is achieved. Green infrastructure integrates both the engineered system and the natural environmental features to deliver clean water, preserve and restore the value of ecosystem [122,123]. It is regarded as an approach to water management and preservation without undermining the natural water cycle. Green infrastructures practices in the developed countries include rain gardens, green roof, permeable surface, infiltration planters, trees and tree boxes and rainwater harvesting systems [124,125].

Improve on external collaboration and partnership: The need for external collaboration and partnership on water delivery improvement in Nigeria is termed essential at this moment. State Water Agencies (SWA) can take advantage of Water Partnership Program [126] a multi-donor trust fund that supports World bank projects on water challenges [127]. They provide technical support and logical work for project beginners, preparation and execution across global water subsectors. A total of 214 activities that involved 62 countries since inception of the program. The targets focus on water planning, technologies, administration, stakeholder participation and established practices that improves supply and delivery of portable water for urban areas. Integrating external collaboration and partnerships in the field of water engineering is now needful. Professionals and technical knowhow that is applicable in other countries especially in the aspect of water meter for cost recovery should be welcomed in the various states for adequate partnership and improvement on portable water delivery. Most African countries such as Nairobi, for example, engaged the activities like water partnership programs (WPP) on water challenges. The result was witnessed in potentials exploring alternative water sources for the city. Part of the success was observed in reviewing the building code to allow rainwater harvesting, greywater and wastewater reclamation project [87].

Conclusion

This review evaluates the developments of water supply issues in Nigeria. The need arises as a result of the necessity attached to clean and piped water delivery for all towards SDGs 6 target by 2030. An assessment into State Water Agencies in different states show that most states are making efforts in realizing this target. Concerns emerge regarding the methods to overcome these anomalies, ensuring that all citizens have access to portable piped water. The need for sustainable water

delivery, re-evaluation on Nigeria water sources and delivery in realization of Sustainable Development Goal (SDGs) targets now become essential. Integrated water management strategies should also be incorporated in Nigerian system to justify the applicability and serve as an alternative water source rather, than explaining and lingering on a particular problem of obsolete water infrastructures and breakdown of machineries. More effort should be focused on sustainable approaches such as rain harvesting, water reclamation processes, green growth, green infrastructures as well as improvement on external collaboration and partnership as a remedial solution towards achieving SDGs 6 target in 2030. In conclusion, this review emphasizes several sustainable benefits especially on rain harvesting to the environment and natural resources. Flood mitigation, reduction of erosion rate, storm water runoff flow, non-point source pollutant loads in water bodies and also help in climate change mitigation and adaptation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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