The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis

S.O. Oyegoke, A.O. Adeyemi and A.O. Sojobi

ABSTRACT

Lagos State has grown from 300,000 and 500,000 in 1950 and 1991 to an unprecedented population of 15.7 million (Mabogunje, 2002). Already, it is projected to have a population of 25 million by 2015 which will make Lagos the third largest megacity after Tokyo and Bombay and a population of 29 million by 2020, with an annual growth rate of 8 %(UNCHS, 1996; George, 2010; LWC, 2011). This scenario presents enormous emerging challenges as well as opportunities that are numerous, diverse and inevitable.

This geometric population growth, coupled with accelerated industrialization and urbanization, has contributed immensely to the hydra-headed problems of water scarcity, uneven and inadequate pipe-borne water distribution and transmission, increased exposure to incidence of water-borne diseases such as typhoid and cholera leading to loss of lives and valuable man-hours. There is increased reliability on unwholesome water sources such as "pure" water sachets, polluted surface and underground waters, and increased urban poverty owing to a combination of the above problems, the increased cost of production for industries and increased distribution losses (Akunyili, 2003).

The major elements of water supply include surface and groundwater sources, water-treatment works-primary, secondary and tertiary, and pipe distribution systems. Lagos Metropolis and its environs are served by three (3) major waterworks, twenty-seven (27) mini-waterworks, out of which fifteen (15) were recently commissioned and ten (10) micro-waterworks, with a combined production capacity of 240MGD, which meets about 40% of current demand (LWC, 2011).

The rivers which traverse the state, namely Rivers Ogun, Oshun, Aye, Owo, Yewa, Iju all combine to produce a total safe yield of 3,565 MLD. The groundwater aquifer under the state located in the Coastal Plain Sand and Abeokuta formations at a depth between 600-800m is capable of a total yield of 650, 000 m^3/day (Oyegoke, 1986; Longe et al, 1987; Coode, 1997).

An estimated $3 Billion will be required for massive water infrastructural development within the next ten years according to Lagos State Government while $3.7389B investment is required to produce 3954 MLD (870MGD) which is enough to meet the year 2025 forecasted demand of 3900 MLD according to Challenge International Associates (2006). This can only be met by Public-Private Partnerships while concerted effort is made for investment recovery.

KEYWORDS: metropolis, waterworks, demand, population, groundwater, surface water, watersupply.

1.0 INTRODUCTION

According to United Nation's projections, by 2050 almost half of the world's population will be experiencing either water scarcity (<1,000m^3 of renewable water per capita per year) or water stress (between 1,000m^3 and 1,700m^3 per capita per year). It is estimated that 1 billion people in developing countries do not have access to portable water and unsafe water is implicated in the deaths of more than 3 million people annually and causes 2.4 billion episodes of illness from water-borne diseases each year.

The world urban population was projected to increase from 6.7billion in 2007 to 9.2billion in 2050(United Nations, 2008). 90% of this global entire population growth will take place in urban areas of developing economies (Brockerhoff, 2000 in Lunqvist et al, 2003, United Nations, 2004).

Megacities, with unprecedented size and complexity, have critical roles as gateways in the global economy, but they pose huge challenges for sustainable urban development. Their scale and complexities accumulate to a degree that makes these cities vulnerable in political, environmental, economic, and social perspectives. Nevertheless, properly managed or governed, megacities hold enormous potential for positive development, on both regional and international levels.

A megacity is defined as a city with a population of at least 10 million(UNCHS, 1996) and megacities are now home to almost one out of ten people of the world's urban population(Globescan & Hazel, 2007). Of the 27 megacities predicted for the year 2015, 18 will be in Asia, 5 in Latin America, 2 in Africa, 2 in North America and none in Europe (Ilesanmi, 2010). According to a global research project on 25 megacities, the mega-challenges that they face include: transportation, electricity, water and wastewater, healthcare, safety and security. This corroborates the infrastructural priorities proposed for megacities by Abiodun(1997) and George(2010) which includes portable water supply and sanitation, housing, civil construction, transportation, urban design, waste disposal and drainage system, healthcare delivery, security of lives and property, energy generation, distribution and supply. According to a UNDP estimate in 2004, 1.1 billion people lived more than 1km from the nearest safe water source (Watkins, 2006).

With a growth rate of 3.5%, an urban population will be doubled in 20 years.

The forces identified for this explosive growth include industrialization, mass transportation and the telecommunications revolution (Hall & Pfeiffer, 2000).The management challenges posed by the growth on a mega-scale are substantial (Jones & Visaria, 1997) coupled with rapid urbanization(Paddison, 2001).However, the overwhelming problem is not urban growth, but the lack of political will and use of inappropriate and obsolete planning paradigms.This is where the challenges lie for developing economies.

Nigerian urban population which was about 3.5 million in 1950 rose to about 78.8 million in 2010 and is expected to increase to 217 million in 2050(UN, 2008) out of which 75% will reside in urban areas(Akiyode, 2010). In many developing countries, urban infrastructure lags behind infrastructural needs.

The evolution of Lagos State as a megacity in a developing economy like Nigeria is phenomenal, both demographically and spatially (Ilesanmi, 2010). The population of Lagos grew from 25,000 in 1866 to 665,246 in 1963, 7,800,781 in 1991 and reached the megacity status in 1995(Bamgbose et al, 2000; Ilesanmi, 2010).

Lagos was believed to have a population of 17 million in 2009, with an estimated growth rate that is ten times faster than that of New York and Los Angeles (Lagos State Government, 2009). It is expected that the population of Lagos megacity will be 24.4 million by 2015, making it the world's third largest city after Tokyo(28.7 million) and Mumbai(27.4 million)(UNCHS, 1996; George, 2010), although currently the fifth largest city in the world(Ilesanmi 2010).

The economic, administrative, social, institutional, industrial and commercialization growth made Lagos an attractive place which continues to encourage the influx of people to the city (Akiyode, 2010). Lagos, being a former capital city of Nigeria until 1999, still remains the industrial and commercial center of Nigeria (Adelakun, 2009).

The rapid growth of megacities of the developing world has posed major water planning and management challenges (Biswas et al, 2004) and for Lagos in particular. The city has suffered several infrastructural neglect and setbacks (Ilesanmi, 2010; CIA, 2006) and hence, effort is being made to ensure the infrastructural development in the state fits its megacity status, which is pioneered largely by the state government.

Water supply and water security is one of the challenges facing Lagos State as a megacity. Water security is defined by Grey and Sadoff(2007) as the 'availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to the people, environment and economics.' According to World Water Forum (2000), water is vital for the life, the health of the people, and ecosystems, and a basic requirement for the development of countries.
The city's infrastructural challenges can also be attributed to the use of ad hoc, isolated prescription, unsustainable initiatives and paucity of innovative solutions in planning and development.

2.0 CURRENT AND ENVISAGED WATER SUPPLY CHALLENGES

The current and envisaged problems of water supply in the megacity are enormous and include growth of slums, poor level of service, poor and inadequate recticulation network, high level of distribution losses, increasing level of poverty, pollution, inadequate monitoring of water-related projects, poor quality control, water-related diseases, energy generation and capacity building. Likewise, the funding, management and efficient running of water services , as well as the need to find infrastructural solutions that are environmentally sustainable remains an uphill but surmountable task(Anselm, 2010). According to Kehinde and Longe(2003), our water supply sector have been bedeviled by problems such as inadequate infrastructure for water treatment and distribution, ageing and corroded pipe network, booster stations, unplanned extensions, non-availability of maintenance and repair services and poor staffing and capacity building

The growth of slums in Lagos state also calls for grave concern. Almost 70% of the Lagos metropolis reside in slums which grew from 42 in 1985 to over 100 in 2006(FRN, 2006; Davis, 2004). Provision of water supplies to these regions should be included in the foci for water supply because of there potential for population concentration.

Furthermore, the inability of government to consistently provide adequate water contributed to the proliferation of 'pure water' manufacturing in Nigeria and the urban poor often spend up to 10-20 times more on water from vendors than piped water(Akunyili, 2003)

2.1 STATE OF WATER SUPPLY IN LAGOS METROPOLIS

The Lagos Water Supply System comprising 3 major waterworks(Adiyan, Iju and Isashi), twenty-seven(27) mini-waterworks and ten(10) micro-waterworks has a combined production capacity of 240mgd which only meets about 40% of current water demand, an improvement from 25% in 2006(CIA, 2006; LWC, 2011). In line with the Masterplan(Table 1), which aims to close demand gap in line with the MDGs, recently fifteen mini-waterworks, each with a production capacity of 2MGD and a recticulation network of 5km,were delivered across 15 LGAs, precisely Ajangbadi, Ajegunle, Ikorodu, Isheri-Oshun, Epe, Meiran, Magodo, Badore, Ojokoro, Mosan-Okunola, Ikate, Abule Egba, Imeke-Iworo and Oshodi.

The inalienable gap was due to largely to population explosion, faulty and poor maintenance culture, frequent power outage, poor planning and lack of political will. As of year 2005, there were 160,000 service pipe connections and 5200 standpipes.

The Lagos State Water Supply masterplan, which is in three phases, aims to reduce waste and un-accounted for water, increase amount of billed water and collection efficiency and increase access to portable water, largely driven by management contract. Based on the masterplan, projected water demand for the megacity is estimated as 733 MGD while production capacity would have been 745MGD (Table 2).

Table 1: Lagos State Water Supply Master Plan (LWC, 2011)

Short Term (2010-2013)	Medium Term (2014-2017)	Long Term (2018-2020)
Adiyan II	Odomola II	Yewa II(Desalination)
Odomola I	Adiyan III	Odomola III
Ishasi Expansion 12mgd	Yewa I(Desalination)	Upgrading Ishasi (12-35mgd)
Ota Ikosi Waterworks	Ibeshe(Desalination)	

Table 2: Demand Gap Estimates-Short, Medium and Long Term (LWC, 2011)

Year	Population	Water Demand (mgd/mld)	Water Production (mgd/mld)
2010-2013	20,837,250	625/2,838.03	362/1,643.48
2014-2017	25,327,808	633/2,873.19	622/2,823.26
2018-2020	29,320,103	733/3,327.83	745/3,382.30

As of 2007, about 74% of the installed production capacity of existing waterworks is from surface water treatment works while the overall performance of centers relative to their installed capacity is 39.53

The three major waterworks derive their water from River Ogun with safe yield of 2596MLD while other river sources that need to be exploited include River Osun (260MLD), River Aye (105MLD), River Owo(159MLD), River Yewa(233MLD) and River Iju(216MLD).

The groundwater works can only be sourced from two regional hydrogeological aquifers namely Abeokuta and Coastal Plain Sands Formations (Oyegoke, 1986; Longe et al, 1987; CIA, 2006) with the latter being the main aquifer for Lagos metropolis. For areas far from the coast such as Ikeja, Itoikin, Eredo, Igbonla and Otta, the Abeokuta formation(ABF) is located between a depth of 188m to 750m with yield varying from 29m^3/hr to 200m^3/hr. On the other hand, the Coastal Plain Sand (CPS), a multi-aquiferous system, has a yield value varying from 20-100m^3/h (Longe et al, 1987, Coode Blizard, 1997). A major concern, however, is the recharge of these aquifers with envisaged potential usage of groundwater to meet the water demands for Lagos South East, Lagos South West and Victoria Island.

The initial distribution network was aligned approximately North-South and connecting the treatment plant at Iju in the North with Victoria Island in the South. A trunk was added westwards from Isashi waterworks in 1977, then additional primary trunk mains added between 1988 and 1992 to convey water from Adiyan waterworks. Additional mains required are as shown in table 2. However, it is sad to note that some of the mains were laid prior to 1950 and due to age, encrustration and plant intrusion, have their capacity drastically reduced. Affected areas include Apapa, Yaba, Ebute Metta, Lagos Island and Ikoyi. Furthermore, some areas of the megacity, though with high residential and commercial density, do not have mains. These include Gbagada, Oworonshoki, Idimu, Akute, Isheri, Agbara,

Ikorodu, Alimosho, Mowe, Ogijo to mention a few. It is imperative that all the existing service reservoirs were rehabilitated and new ones built to provide for capacity to meet two(2) hours average flow by 2015(CIA, 2006).

For most water schemes, the water works are usually set up while the power supply is still pending or under construction. As a result, such schemes eventually collapse partly due to poor handling by unskilled hands in power generating equipment and unbearable running costs. In addition, the location and diversion of waterworks several kilometers from their headworks such as Iju and Adiyan, leads to system disturbance, perennial low voltage leading to increased losses on the transmission lines and reduced operational efficiency of the waterworks. Hence, the need for Independent Power Supply. The energy requirement to meet year 2025 water supply is shown in Table 3.

Table 3. Energy Requirements water supply expansion to 2025 (CIA, 2006)

Waterworks	Design Capacity	Proposed Expansion	Overall Required	Overall Energy Demand	
				(KW)	(KVA)
Adiyan	318.22	636.44	954.66	21615	27019
Iju	204.57	-	204.57	5102	6400
Isashi	18.18	141	159	3900	4875
Odomola	-	260	260	6240	7800

According to the report of Challenge International Associates(2006), the capital cost for Iju and Adiyan intake and headworks is $19.35m, the extension of IPP supply to Iju headworks being $2,307, 692.30 while the operation and running cost for Akute is $100, 800/day.

3.0 CURRENT GLOBAL BEST PRACTICES IN WATER SUPPLY AND MANAGEMENT

As the world is a global village, there is need to incorporate best practices from developed and developing countries so as to improve our water management and supply. There is need to adopt the Japanese philosophy of "Dantotsu": *gaining the best of the bests by learning, assimilating and improving* in order enjoy the derivable benefits and drastically improve our water management and supply.

3.1 BEST PRACTICES IN WATER SUPPLY AND SANITATION: LEARNING FROM SUCCESSFUL PROJECTS

Successful water supply and sanitation projects contribute directly to the attainment of MDG (Millenium Development Goal) Target 10(halving by 2015 the proportion of people without sustainable access to safe drinking water and improved sanitation).
Based on a review of eighteen(18) projects approved by the Asian Development Bank(ADB), 35-40% of the projects of each group(urban, rural, urban/rural) were considered highly successful and the rest successful(ADB, 2007).
The characteristics of these projects are as follows:

i. Rapid urbanization created a strong demand for the output of water supply/wastewater treatment projects. *The rapid urbanization in Lagos State should gear us to ensure our projects are successful.*

ii. Community participation in the design, construction and operation and maintenance of sub-projects which led to socio-economic benefits to the local people. Project formulation involved extensive consultation with local government staff, local NGOs, representatives of indigenous people and other beneficiaries while addressing there concerns about the impacts of water supply and sanitation projects.

iii. Decentralization which has helped local governments and residents to be increasingly involved in undertaking cost-recovery measures, tariff reviews.

iv. Ability to learn from past lessons and incorporate the lessons in project design. *This helped them to design projects in a cost-effective manner.*

v. The projects typically (1) were run by financially self-sustaining water supply institutions, (2) put in place WUCs(Water User Committees), and (3) adopted the "user pays" principle.

vi. Technical innovation and environmental protection. Induced recharging of water resources using an infiltration basin was pioneered in the Philippines under a ADB

project. There was significant reduction in untreated wastewater allowed to flow back to the ecosystem which promoted rational use of water resources and improved the quality of freshwater and coastal ecosystem.

vii. Proper O&M (Operation and Maintenance) helped ensure long-run sustainability. Beneficiary participation resulted in a stronger sense of ownership and willingness to accept some O&M responsibility and to pay higher tariffs.

viii. EAs (Executing Agencies) were committed, highly involved in project implementation, supported by institutional strengthening and training activities, and provided with counterpart funds in a timely manner.

ix. Consultants and contractors performed well.

x. Regular ADB monthly review and co-ordinating meetings among EAs and implementing agencies proved to be a proactive and effective mechanism for promoting expeditious procurement activities, cost savings and resolving problems.

xi. The projects were pro-poor which helped in poverty reduction, greater productivity and improved healthcare.

3.2 BENCHMARKING, PERFORMANCE INDICATOR AND BALANCED SCORECARD IN WATER INDUSTRY

The increasing involvement of the public has made a greater demand on utility leaders for a better level of efficiency, effectiveness and competitiveness in the water and wastewater industries. Furthermore, the absence of competitive market pricing makes it impossible to determine directly the quantity, quality and the level of service provision to be supplied. The use of benchmarking in the water industry has been studied by Hubert & Smeets(2000) and Helland and Adamsson(1999) where it has been found useful in the Nordic countries of '6 Cities Group' comprising Copenhagen, Helsinki, Oslo, Stockholm, Gothenburg and Malmo and also The Netherlands.

Though the benefits of benchmarking has not been fully realized in practice in the water and wastewater industry owing to difficulty in normalizing data, concerns about their use and effectiveness and difficulty in definitions, which is different from accounting definitions, it has also been found useful in some European countries such as Austria, Finland, Italy and Switzerland, South Africa(Parena & Smeets, 2001) where they were initiated by the government, National Water Associations, independent consultants or companies in the water and wastewater industry.

Benchmarking is of two forms namely, metric benchmarking and process benchmarking. Metric benchmarking deals with identifying areas of underperformance requiring changing the way things are done while process benchmarking is the vehicle for achieving this change through assimilation of best practices.

According to American Water Works Association(1996), Benchmarking is ' a systematic process of searching for best practices, innovative ideas, and highly effective operating procedures that lead to superior performance and then adopting those practices, ideas and procedures to improve the performance of one's own organisation'. Benchmarking can be done via self assessment, peer review or the use of consultants.

The performance indicators for benchmarking which are germane to the water industry include: production, distribution, environment, customer service, financial and economics, customer orientation, water quality, planning, network operation methodologies, level of service and operational performance, engineering and purchasing processes, organizational, technical and market processes(Parena & Smeet, 2001).

From the above lists, the four main items that gives a complete and balanced picture of the utility's performance are: Water quality, Service, Environment, Finance and Efficiency.

Since it was difficult to provide comparable data on quality, service and environmental aspects, a more practical approach , a financial model was adopted which included four costs namely: taxes, capital costs, depreciation and amortization and operational costs.

The benefits of benchmarking are enormous and include:

1. Investigating the relations and correlations between processes or functions in order to check achievable cost savings and improve efficiency
2. It helps to benchmark the management of projects, of know how, or resources and of investment return.
3. It is used by donors as a comparative reference to determine the relative and operational performance efficiency of borrowers and to set yardstick performance targets for borrowers against industry best practices.
4. It helps in identifying areas with potential for performance improvement; promote suggestions about organizational structures and related control systems, more apt to overcome

performance limitations while boosting rediscussion of roles, functions and procedures.

5. It provides decision makers with an overall perception of the utility performance as a strong support in making strategic choices.
6. The application of Performance Indicator to the Water Supply Systems by IWA (Alegre et al, 2000) is based on demanding and realistic objectives. Albeitly, it has been found that the use of percentages by volume for NRW (Non-Revenue Water) is unsuitable for regulation, environmental protection, contract supervision, financial optimization and operational management.

Internationally, the use of ILI (Infrastructural Leakage Index) and Banding System has been adopted. The ILI is a dimensional ratio of Current Annual Real Losses(CARL) to the Unavoidable Annual Real Losses(UARL)(Lambert et al, 1999, Liemberger, et al, 2005). It has the advantage of identifying not only what the current losses are, but also permits an initial estimate of the maximum potential for reduction in real losses at the current pressure. Developed countries with good infrastructure conditions have an ILIs of 1.0 while developing countries have ILIs in excess of 10 or even 100.

On the other hand, the banding system(Table 4), adopted by the World Bank Institute, is a matrix approach to identifying a technical performance category(Bands A to D) for a Utility's management of real losses and guidance on the type of actions to be undertaken by the Utility. Proactively, it has been endorsed and promoted by the South African Water Resource Commission, Australian Water Services Association, New Zealand Water and Waste Association and American Water Works Association (2003). Where the density is different from the average density of connections of 40 per km of mains, ILI is used to identify appropriate band for the system under consideration.

Table 4: Banding system for developed and developing countries
(Source: WBI NRW Training Module 6: Performance Indicators, 2005)

Technical Performance Category		ILI	Real Losses in Lits/connection/day				
			10m	20m	30m	40m	50m
Developed	A	1-2		<50	<75	<100	<125
	B	2-4		50-100	75-150	100-120	125-250
	C	4-8		100-200	150-300	200-400	250-500
	D	>8		>200	>300	>400	>500
Devel	A	1-4	<50	<100	<150	<200	250
	B	4-8	50-100	100-200	150-300	200-400	250-500
	C	8-16	100-200	200-400	300-600	40	
	D	>16	>200	>400	>600	>8	

The bands are interpreted as follows:

A- Further loss reduction may be uneconomic unless there are shortages

B- Possibilities for further improvement

C- Poor leakage management, tolerable only if resources are plentiful and cheap

D- Very inefficient use of resources, indicative of poor maintenance and system condition in general

However, balanced scorecard for water supply, addresses five main issues namely:

1. State of water resources: This is concerned with water scarcity, withdrawal practices and foreign dependency.
2. Management of access to water: This highlights percentage of population with safe access to water, continuity of water supply and estimate of UFW (Unaccounted For Water).
3. PSP (Private Sector Participation): This aspect of scorecard beams light on presence of private water operators, estimate of population they serve, location of contracts, type of contracts and year of introduction of PSP.
4. Regulatory Framework: This discusses presence of regulatory of agencies, effective independence, separation of powers and roles, corporatization of local water operators and decentralization of water public administration.
5. Pricing Policy of Water: This addresses finance for operation, differentiation in local setting of tariff, use of metering system, progressive block tariff structure and price increase with quantity used.

The application of balanced scorecard to the water industries in the Middle East and North African countries has shown that for privatization of the water industry to be highly successful, there must be a well-defined regulatory environment, competition and institutional framework. Although privatization has recorded significant success in Municipal waste management in Lagos State and a huge success in the telecommunications industry, the same is yet to be said of the water industry. Although there are various forms of private sector involvement which includes

service contract, management contract, lease contract, BOT (Build, Operate and Transfer), concession, joint venture and full divestiture, Lagos State water supply has not progressed largely beyond that of service and management contracts which are the lowest form of private sector involvement. Undoubtedly, this is still a far cry from concerted efforts needed to meet the emerging challenges of water supply in Lagos State and it is high time an enabling environment was created for progressive PSP as government alone cannot grapple with the enormous challenges of this sector in Lagos State.

3.3 WATER RECYCLING AND REUSE

In order to reconcile competing demands for water, there is need for expansion of the supply, management of demand more wisely and responsible use of water resources. Since public water supply accounts for approximately 70% of total water demand, it presents a great resource for portable substitution. Water reuse is a horizontal application that pulls together the normally segregated discipline of portable water treatment and wastewater treatment for public health and environmental protection through reducing the competition for water (Durham et al,)

Appropriately treated wastewater have been found applicable in agriculture in the Mediterranean countries owing to water scarcity while in some cities in Northern Europe, 70% of their portable water resource during the summer is obtained from indirect portable reuse. Evidence of successful water reuse has been found in Australia where a target of 20% of reuse of wastewater has been set in some territories. Indirect recycling of wastewater has been found to be safe (UKWIR, 2004) and as such wastewater reclamation and reuse need to be embedded into integrated water resource management (Bixio et al, 2005a).

The applications of water and wastewater reuse includes amongst others:

a. Agricultural irrigation
b. Urban, recreational and environmental uses including aquifer recharge
c. Process water for industry
d. Direct and indirect portable water production
e. Combinations of the above

The benefits of water reuse/recycling include:

1. Decreases net water demand and adds value to water
2. Keeps portable water fro drinking and reclaimed water for non-portable use
3. Lower energy costs compared to deep groundwater
4. Reduce manufacturing industries cost by using high-quality reclaimed water
5. Reduces nutrient discharge to the environment and loss of freshwater
6. Manage the recharge of surface and ground waters to optimize quality and quantity
7. Controls the problem of over-abstraction of surface and groundwaters
8. Increase local ecological benefits through the creation of wetlands and urban irrigation
9. Integrates with all parts of the anthropogenic water cycle to enable cohesion between all regulators and industries

For these benefits to be achieved, there is need for regulatory and institutional framework to be put in place at state and national levels tailored to take advantage of water and wastewater recycling and reuse opportunities. This requires the development of a relevant national water quality and good practice guidelines to enable water and wastewater reuse to be implemented for all environmental, social, public health and other beneficial applications and these need community and stakeholder participation from the start.

There is also need for investigating project viability based on environmental, social and economic benefits while clarifying quality and real costs to enable viable water recycling and reuse projects to proceed (Bixio et al, 2005b).

4.0 RECOMMENDATION AND CONCLUSION

To be able to grapple with the enormous challenges of water supply for Lagos megacity, the following recommendations are made:

I. There is need for a radical change in paradigm in water supply projects' design, implementation, monitoring and maintenance.
II. Water supply projects should be designed to be cost-effective justifying the huge capital expenditure involved and the tariffs introduced should be pro-poor and exhibit price differentiation for the different socio-economic groups in the state where necessary.
III. The water supply projects should embrace technical innovation and environmental protection which includes aquifer recharge since there is greater focus on groundwater abstraction.
IV. Wastewater recycling should be embedded into integrated water management with benefits such as protection and conservation of freshwater resources, amongst others. This will require development of national water quality and good

practice guidelines and model project viability studies.

V. The funding/donor agencies should perform there oversight functions by co-ordinating monthly review meetings between executing agencies and implementing agencies. This will promote expeditious procurement activities, cost savings, resolution of project problems and timely project execution and delivery.

VI. Likewise, qualified consultants and contractors should be used.

VII. Encouragement and introduction of Private Sector Participation (PSP) in provision of water supply with appropriate, well-defined regulatory environment, institutional framework and financial support.

VIII. Community participation and stakeholder engagement is sine qua non to sustainable water supply in Lagos State.

IX. The use of performance indicators, benchmarking and balanced scorecard in the water industry should be adopted forthwith as practiced in developed countries.

CONCLUSION

There is need for a paradigm shift in addressing the water supply challenges of Lagos State as a megacity. Though these challenges are enormous and multifaceted, they should motivate us to ensure we achieve successful outcomes from our water supply projects. Assimilation and adoption of best practices from developed countries and entrenchment of effective project management by all stakeholders will go a long way in ensuring sustainable water supply for the teeming water demands of the state. Furthermore, water resources management should embrace environmental protection which will help in conservation and preservation of freshwater resources while cost-effectiveness and community participation should be inculcated in the design, implementation and monitoring of water supply projects.

In addition, proper attention should be paid to the slums and other fringe areas of the state which forms the foci of population explosion. Henceforth, our water resources planning and management should be proactive rather than being reactive; thereby saving huge costs and improve the welfare of the citizenry while safeguarding the well-being of the eco-system.

Finally, government should create a conducive and attractive environment to allow increasing private sector involvement in the provision of water infrastructures across the state. This will help the government to focus on its core duties as well as create employment opportunities with improved level of service.

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Department of Civil and Environmental Engineering,

University of Lagos, Lagos, Nigeria.

Email: oyegokeso2002@yahoo.co.uk