

Efficacy of Communication in Water Resources Management and Environmental Sustainability

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Abstract— One of the major factors that cause setback in water resources management and sustainability is communication breakdown. Lack of well-grounded communication process will only exacerbate existing challenges in the water resources and environmental management scheme. Water resources utilization, management and sustainability involve a chain of processes, and communication is indispensable for harmonious operation of these processes. In all the institutions involved in water management, the strategies and functions of the different bodies vary, and for efficient, equitable and sustainable management, these units must work collectively and collaboratively with one another in terms of their structures, policies, rules and regulations, a feat that can only be achieved by strategic communication. Governments establish laws, but the implementation will require great resources, perfection of design of operation, technical expertise, safety management, cohesive and vigilant teaming, experienced leadership, political will and social responsibility. Lack of effective communication will result in failures of policies and operational procedures, leading to degradation in the management of water resources. This research considers Lagos State with increasing space occupation and population density without enough public water supplies, misappropriation of water resources, un-gauged and undocumented abstraction, and increasing contamination of the water bodies. How can information and ideas be efficiently and effectively communicated to participants in the water resources management activities? How should organizational policies and Government laws be integrated and communicated to both providers and users in a way that will engender understanding of the processes involved in utilization, management and sustainability? What training might be employed locally, regionally, or internationally, to acquaint Government officials, civic society, institutions and stakeholders with communication tools that will aid responsible utilization of water resources and environmental management? These are the pertinent questions this study stands to analyze

Index Terms— Communication, Lagos, Management, Sustainability, Water resources.

INTRODUCTION/BACKGROUND TO THE PROBLEM

Water, whether groundwater or surface water is getting increasingly scarce, and there is a high acknowledgement of the challenges faced in effectively protecting and sustainably managing clean sources of water for human consumption, agricultural uses and preserving the environment. That is, it is imperative to create a safe and effective use of the water resources by improving the ability to find and sustain it, to detect and remediate contamination, and to manage agricultural lands and ecosystems better. In the present time, the issue of water resources management is now prominently broadcasted nationally and internationally. Against the backdrop of this environmental concern, there is increasing demands in Nigeria and the world-over, for highly skilled environmental managers. These specialists are essential to helping formulate strategies to meet pressing water resources management and sustainability targets set by governments and stakeholders both in Nigeria and across the globe. Therefore, for efficient and effective resolution of water resources management and sustainability challenges, expertise and experience are now geared toward environmental law, economics and policy formulation, environmental assessment techniques, environmental approaches and strategies. However, each of these alone will not be able to deliver the solution sought if they are not inextricably connected. The means for such a connection is effective communication!

Specifically, in Lagos State, it has been observed that as the years roll by, pollution and contamination of the water environment continues to intensify, due to highly increased demand for water resources, as well as un-gauged abstraction

and lack of management. Issues like these are quite pandemic in most African countries. A handbook published by Global Water Partnership and the International Network of Basins Organizations (GWP and INBO, 2009) [1] cited population growth, demographic changes, economic development and climate change as factors that have a critical impact on water resources, and that managing water resources though vital, is however, becoming increasingly complex and contentious. The implication here is that unless current uncontrolled abstraction is checked, and with increasing levels of pollution from both diffuse and point sources, in a few decades, our environment, specifically, Lagos State, may be facing total degradation.

One of the major factors that cause setback in water resources management is communication bottleneck in the scheme of things, and this need to be investigated. Lack of well-grounded communication process will only exacerbate existing challenges in the water resources and environmental management scheme. In water resources utilization, management and sustainability, there exists a chain of processes. Should there be a disruption in the linkage between these processes due to inadequate communication or lack of communication, the entire processes will breakdown. Therefore, communication is an indispensable tool in water resources managements and environmental sustainability.

The question of whether our environment is susceptible to instability and degradation may not arise if every participant takes cognizance of the challenges posed by water usage, and critically addresses the determining factors upon which a safe

operation of water activities is based. Unfortunately, a strict adherence to these factors is not guaranteed. Therefore, a chain of events may occur that will inadvertently lead to regrettable situations manifesting as water resources mismanagement and environmental degradation.

Governments always promulgate and enforce Acts, but the implementation of these Acts is far from being easy. Implementation will require great resources, perfection of design of operation, technical expertise, unending safety management procedures, cohesive and vigilant teaming, experienced leadership, political will and social responsibility. Since the support of all participants is indispensable to implementing and enforcing the Acts, the rules need to be communicated to all concerned in an understandable manner. However, due to lack of effective communication and sometimes complacency, operating personnel sometimes deliberately and flagrantly show disregard for operating procedures and policies, hence are directly or indirectly responsible for lack of adequate water resources management and consequently, environmental degradation.

Therefore, the questions are: how should information and ideas be efficiently and effectively communicated to participants in the water resources management activities? How will organizational policies and Government Acts be integrated, and how can they be communicated to both providers and users in a way that will engender understanding of the processes involved in utilization, management and sustainability? What training might be employed, locally and regionally, to acquaint Government officials, civic society, institutions and stakeholders, etc, with communication tools that will aid the utilization of water resources and environmental management responsibly? These are pertinent questions that this research paper stands to answer.

The different forms of water usage, as mentioned earlier, is inextricably linked together, and to achieve sustainability, a generally acceptable modus operandi termed Integrated Water Resources Management (IWRM) has been internationally established, which defines a holistic technique in managing the finite water resources efficiently, equitably and sustainably. The widely-accepted definition of IWRM is given by TAC (2000) [2]: "IWRM is defined as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". The key word is 'coordinated', which can only be achieved by efficient and effective communication. Hovland (2005) [3] stated that sharing evidence, information and knowledge is usually communicated to inspire and inform development policy and practice, and hence, communication, when it is done well, does not only benefit the 'recipient', but also the 'sender'.

STUDY AREA: LAGOS STATE

The project area is Lagos City environs, with data generated from different parts of the state, covering the 20 Local Government Areas (LGAs). Lagos (Fig.1), with a population that doubled over the last 15 years to 20.19 million in 2012 (Jide-

onwo, 2014) [4], one of the fastest growing and one of the most populous cities in the world, is an urban settlement located in the south-western part of Nigeria, covering an area of approximately 3,496km² and is bordered by Ogun State to the North and East, Republic of Benin to West and Atlantic Ocean in the South (Kaoje and Ishiaku, 2017) [5].

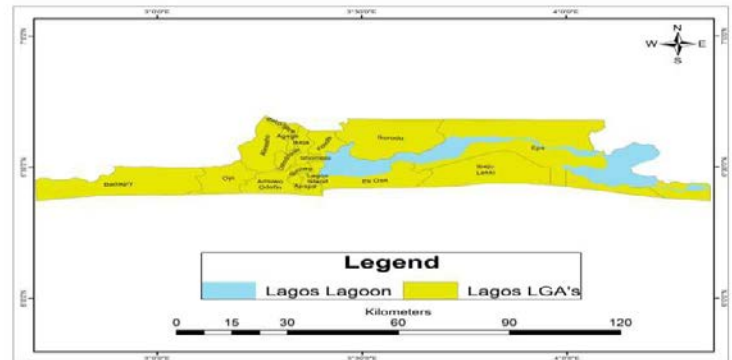


Fig.1: Lagos Metropolitan Map: Source – Remote Sensing and GIS Lab, University of Lagos

The drainage system of Lagos State is characterized by a network of lagoons and waterways, and most of the major water bodies are the Yewa and Ogun Rivers, Lagos and Lekki lagoons, Ologe lagoon, River Imede and River Omu (Soladoye and Ajibade, 2014) [6]. Longe *et al.* (1987) [7] in their work showed that: the surface geology is made up of the Benin Formation and littoral alluvial deposits, with the Benin Formation consisting of thick bodies of yellowish (ferruginous) and white sands; the sub-surface geology consists of complex lithologies of an alternating sequence of clay and sand deposits, with a cyclicity of sedimentation depicting a nearshore depositional environment; the water-bearing strata consist of sands, gravels, or admixtures of the two, and texturally these are fine through medium to coarse, and poorly to well sorted, with the sand deposits generally loose near the surface become moderately dense with depth, and occasionally with clay interbeds; and identified two principal climatic seasons, a dry one from November to March and a wet one which starts in April and ends in October with a short break in mid-August, and the annual precipitation is above 1700mm, which serves as a major source of groundwater replenishment.

PURPOSE OF STUDY: LAGOS CITY, A CASE STUDY

Why is information needed on water resources utilization, and why is it important to communicate information to all stakeholders? If adequate information on water resources (both surface water and groundwater) is correctly gathered and properly inventoried, and this effectively communicated to all stakeholders, it will enable water management authorities to develop the right strategies for water utilization and sustainability. In order to accomplish this, pertinent questions will be: what current information does the city have on groundwater and surface water movement? Does the city have current, state-of-the-art detailed information on the sub-surface, and consequently the aquifers and water movement?

Is there any information on movements and replenishment, as well as protection of surface water bodies? Are water management agencies and town planners well informed on surface water (e.g. rivers, streams, lakes) behavior? What is the present trend of the relationship between water and town planning authorities and end-users? Are there any sources of information for water agencies and town planners? And if any, how is the data contained in the information authenticated? Is any valid information shared with all stakeholders, and to what use do the stakeholders put the information? Communicating verified information and authenticated data to agencies, suppliers and end-users will aid significantly in improving water quantity, quality and sustainability.

To this end, this study considers communication gaps in water resources and environmental management in Lagos State, analyses the factors and variables that are the provenance of such shortcomings, and proposes an effective information flow and communication framework that can engender transparency and collaboration so that environmental sustainability may be achieved in the water sector. Without adequate understanding of water resources management and environmental sustainability challenges in the present time, it will be difficult for individuals, civil society, business and government to respond to these challenges appropriately and effectively. Dissemination, education and awareness boosting are required to improve the understanding of a broad cross section of the society. That is, we communicate, then we communicate, and we communicate.

PRESENT CHALLENGES

Lagos State, for many years faces challenges with respect to portable water supply and utilization. The challenges comprise increased water scarcity because of non-supply or irregular supply from government or government agencies, lack of adequate information due to convoluted regulations and bureaucracy, flooding of most parts of the city (including Government resident areas) after heavy downpour and pollution of the water bodies. Government agencies have created intricate systems that have impeded progress. Lagos State is lacking in the necessary information, technical and personnel that are instrumental to efficient water resources management and sustainability. Which department coordinates exploration and exploitation for water resources? Which personnel are responsible for these activities? Are the municipalities or local governments informed about water resources project? Are the different communities involved in these projects? If the responses to these questions are negative, then efficiently managed water resources cannot be guaranteed.

Below are some of the current critical impediments in water resources management and sustainability:

- **Scarcity:** although there is a massive surface water body and a huge deposit of groundwater in the sub-surface, water supply is increasingly scarce, and population growth astronomical
- **Lack of procedures/systems:** there are no institutions and structured processes to: monitor surface water

movement and activities; monitor and document borehole drillings, which have impacts on the water table; monitor withdrawals, which are linked to surface water movements; and gauge aquifer performance (a determinant of yield)

- **Strategies:** lack of knowledge of, and plan for urban and rural developments
- **Cost of growth:** there is no defined means of generating revenues and no funding appropriated for water resources usage and management
- **Inadequate impact assessments:** lack of monitoring of withdrawals have a direct bearing on over abstraction, which can easily induce saline-water intrusion, impact on the integrity of wellbores, land subsidence, etc
- **Research and Development (R&D):** does the state have any R&D process and any form of state-of-the-art technology from whence findings may be applied to efficiently and effectively manage and sustain water resources?
- **Political will:** lack of connection between policies, users and stakeholders may hinder supports in terms of creating awareness and securing commitment amongst all parties about water issues.

METHODOLOGY – DATA ACQUISITION

The aim of water resources utilization and management is sensible and gauged usage, and control or total avoidance of water pollution and contamination. However, how could this be achieved without adequate understanding and communication with water resources exploration, water supply and water conservation? The whole gamut of water management and sustainability is an integrated process in which all phases are linked, and efficient and effective communication between the phases becomes a must. Otherwise, the integrated water utilization and management process will be jeopardized.

To actualize the aims and objectives of this study, applicable methodologies adopted were:

A. Desktop Study/Review of Literature

Previous investigations on water resources management, including exploration, exploitation and contamination (such as saltwater intrusion), were reviewed.

B. Questionnaire

(i). Initially, a 4-page questionnaire (open-ended) was created and given out to 35 respondents from different LGAs of the state. However, only 11 completed questionnaires were returned. People cited that the questionnaire was cumbersome, and it took more than 30 minutes to complete.

General Response/Comment: residents do not have any ideas of the agencies in charge of water and/or sanitation. They have never met or held meetings with any government personnel regarding water utilization and disposal. Most residents have privately dug boreholes, and few are connected to government water supply. Some say they pay water bills and others say they pay no bill, whether water comes or not. They believe that if government were serious about water supply, utiliza-

tion and disposal (including sanitation), residents will be willing to pay. They do not understand monitoring and metering of water usage. Most drains go into open gutters. There has never been any communication with either previous or exiting government agencies.

(ii). A new, three-page questionnaire (Table 1), comprising 26 closed-ended questions (that warranted only a YES, NO, or NO IDEA response), was distributed amongst Lagos State residents, from different Local Governmental Areas to capture data that would be representative of the entire state. 150 were distributed, and approximately 120 responded. Data generated from the responses were tabulated (Table 2) and displayed in graphic plot (Fig.2). The questionnaire was given out in a way that it could capture both male and female genders, as well as adults and youths, from age 20 and above.

C. Personal interview

This phase was to observe and analyze the perennial problems besieging the water sector by direct personal communication with the populace, to gauge their views on any possible connections between the public, the private and the government water planning agency regarding to water supply and utilization. Content of interviews comprised: what is the main challenge facing the government in regard to water supply, usage and wastewater management; what are the practical reasons purported for proliferation of boreholes, rather than pipe-borne water; are borehole drillers licensed, and what agency is responsible for issuing license; is borehole drilling monitored and which body does the monitoring; what method is employed to conserve water; what are the structures, policies and legislations established by the government on water and wastewater; what systems have the government put in place to generate and distribute water, to dispense information and communicate technical issues to users and stakeholders; should there be private water companies, and what effects might this have on water distribution, usage and management; what solutions would the individual proffer?

General responses/comments: it is believed that water is limited in terms of funds and astronomical increase in population in the state plus decay in infrastructure to facilitate water supply. People are of the opinion that government established Lagos Water Corporation (LWC) with the aim of water distribution for domestic and industrial usage, but currently everything is in a state of comatose. Some government officials explained that the LWC is an autonomous agency, originally under Ministry of the Environment. Now there is no relationship between Physical Planning, Ministry of the Environment and the LWC. The Corporation no longer takes approval from any ministry and it cannot be ascertained if any project is executed or not. Consequently, non-availability/inadequate water supply by the Corporation has engendered borehole proliferation in the state. Residents explained that borehole drilling is not monitored or supervised to any level of compliance, and drillers are not licensed by any agency. The interviewees observed that the government should ensure provision of adequate water supply for the populace by increasing the number of water work projects in the state and other infrastructures required to get water to each house should be put in place. However, considering the inefficiency of the government, it is of general

opinion that private sector should be licensed to engage in water activities, but rules and guidelines should be set to safeguard the interest of stakeholders without jeopardizing investors' interests. Some people support borehole drilling to complement government activities, but the drillers should be monitored and regulated for sustainability. Interviewees generally don't know the structures, policies and legislation that the government should adopt since the LWC and other environmental agencies are practically non-existing! Residents are unaware of any established system for information sharing and communicating technical issues to users and stakeholders except for bills forwarded to houses and occasional complaints by the users/customers. According to the respondents, the government could create a metered system for water users to discourage wastage, and disciplinary actions for amateur borehole drillers, that is, if regular water supply can be guaranteed. Water conservation, according to the residents, is the use of tanks (both underground plus overhead) to store water and construction of dam (by Government).

RESULTS AND ANALYSIS

A detailed look at the statistics (Table 2 and Fig.2) of responses to the questionnaire (Table 1) clearly shows the alarming trend of the ignorance of the populace and stakeholders in matters relating to water resources management in Lagos State. Not only do most of the people lack knowledge of the specific roles the government should play in issues of generating, distributing and sustaining adequate quantity of water of good quality, they are also grossly unaware of the damages they themselves directly and indirectly inflict on the finite water source.

Checking responses between questions 2 to 12 (Table 1), it can be easily observed that higher number of boreholes (Table 2) are scattered throughout the state compared to pipe-borne water. Although the statistics show a reasonable figure for pipe-borne water, close discussion shed more light on this. The insightful information gathered was that there is pipe-borne water, but how often does the water run in the pipes? What quantity of water do the pipes bring when the water does run? Many opined that the supply is erratic, and when it does come, it cannot be completely trusted for good quality. Often, some of those pipes are laid in open drains (Plate 1) and in sewers (Plate 2) that may be broken, and wastewaters sometimes find subtle entrance into the water pipes. So, majority of the people prefer to use the supply they can trust – hence, they embark on bore-holes drilling spree as shown by the high value! Occasionally, a public water main may run, but the scenario is a nightmare for residents as they face endless hours on queues (Plate 3) waiting to get water.

High values of 'NO' (questions 4, 5 and 6 as displayed in Table 2 and Fig.2) show the citizens have little or no comprehension of which agencies oversee water issues, what surface water and groundwater imply and what water resources management indicates. More than half of respondents answered 'Yes' to conserving daily water usage. However, during personal interview, most did not even understand what water conservation implies, as observed in their response!



Plate 1: water pipe in open drains



Plate 2: water pipes in sewers



Plate 3: endless water queue

Furthermore, people are completely segregated from the government as the populace doesn't know which arm of the government is responsible for water issues, and the government obviously does not know the people. Knowledge of surface water, such as rivers, streams, and lakes, as well as groundwater is non-existing as observed in the responses during personal interviews. People only know that they suffer from lack of adequate water of healthy quality, but they are completely oblivious to what causes this and why. The people are a part to this chaos since many often display gross indiscipline in their daily use of water. Nonetheless, statistics (questions 13 and 14) still show that some of the populace have the presence of mind to conserve water by harvesting rain water and keeping the taps closed when not in active use, but a very

high percentage of the people (shown by higher peaks in Fig.2) are not into water conservation, as they exhibit wastage attitude. Question 15, regarding to the use of metered water supply, the response is equal.

During personal interviews, it was obvious that while some people believe that there should be regulation of usage via metered system, others however, disagree with this, stating that it will be cumbersome, burdensome, and most importantly, will not be transparent as the regulators can easily manipulate the meters to read higher rates for daily usage. They cited similar situations of government defrauding the population using metered power supply. The irony is that though the communities lack regular supply of water, yet when it rains, most of the communities are flooded with water! The dilemma is no water, no drainage.

As statistics have shown (questions 7, 16 – 18), that there are challenges in water supply, flooding and wastewater disposal, and the general believe is that the government and the people can (and should) contribute to combating water shortage, flooding and sanitation challenges, but nobody appears to be able to fathom where or how to start. High number of responses agrees with the need to bring in private sectors to combat these challenges. But again, the question is how? The issue of water supply, utilization and sustainability is inextricably linked and cannot be dealt with in isolation. The people, the private sector and the government must link and become one in order to answer the what, why and how. That is, valid information must be shared, and all the stakeholders must be educated in all water-related issues, starting from source, treatment, storage, distribution, utilization, and disposal, a feat that can only be achieved by effective communication.

Question 19 is quite critical. Many responded that their sewage disposal is located less than 10 metres from their water (be it tap or bore hole) supply system. This can constitute a potential health hazard because sometimes, the septic tanks can leak and seep into groundwater system. Generally, many people in Lagos act with impunity with their execrable degradation of surface water bodies, caused by direct human urination (Plate 4) and defecation (Plate 5), as well as dumping of sewage (by trucks) collected from household (Plate 6). Respondents have shown (questions 20 – 24 in Table 1) with high 'NO' values in Table 2, and as depicted in the graphic plot (Fig.2) that they lack any knowledge of government agencies in charge of water utilization, wastewater disposal and sanitation, and that there is no communication or information exchange with any agencies, and if such agencies do exist, they obviously do not carry out their responsibilities. Also, if there are regulatory laws that guide water utilization, wastewater and sewage disposal, the citizens are unaware of such laws as there is no medium of communication between utility users and providers. So, how can the people have access to adequate quantity of water of good quality for consumption and other uses? The citizens act with impunity and the government likewise is flagrantly unresponsive to their duties. What is the consequence? The epidemic is astronomically becoming pandemic!

private organizations and government agencies. The element that will connect all participants inextricably is education and effective communication, and this cannot be over-emphasized!

TABLE 1
WATER AND ENVIRONMENTAL QUESTIONNAIRE

NO	QUESTION	YES	NO	NO IDEA
1	Have you lived in Lagos City Metropolis > 5 years?			
2	Is your water source Tap water?			
3	Is your water source Borehole?			
4	Do you know the Government Agency responsible for water supply?			
5	Do you understand what surface water and groundwater mean?			
6	Do you understand what water resources management means?			
7	Do you have water scarcity in your Local Government Area?			
8	Do you have drainage and flooding problems in your LGA?			
9	Can and should Government contribute to alleviating water supply and usage problems			
10	Should Private Sectors play roles in water supply, usage and sanitation challenges			
11	Should the communities contribute to water supply and usage challenges			
12	Do you and your family control your daily water usage?			
13	Do you collect rainwater?			
14	Do you allow water to keep running while you brush your teeth?			
15	Would you support that Government provide metered water supply system?			
16	Do you have challenges regarding wastewater disposal?			
17	Do you know where your wastewaters drain into in your LGA?			
18	Can and should Government contribute to alleviating challenges posed by wastewater disposal?			
19	Is your sewage disposal located < 10 meters from your water supply system?			
20	Do you know the Ministry responsible for wastewater & sanitation?			
21	Do you seek to get information from the Government on water?			
22	Have you had any communication/forum with any Government Agency on water supply, utilization, scarcity and wastewater?			
23	Are you aware of any regulatory laws on water usage and wastewater disposal?			
24	Do residents obey regulatory laws on water usage and disposal?			



Plate 4: urinating in water



Plate 5: defecating in water



Plate 6: dumping sewage in water

Since most of the people know little or nothing at all on water management and sustainability, the responses: 'YES'; 'NO'; and 'NO IDEA' to questions 25 and 26 were probably based on their assumed interpretation in this regard. That is, if they know the agencies that oversee water affairs, and these bodies function and ready to incorporate the citizens in their agendas, a reasonable number of respondents believe most of the problems plaguing the water sector will be alleviated. According to the statistics, about a third or more of the respondents agrees that borehole proliferation constitutes a menace, yet every newly constructed house has a water borehole drilled, and these same citizens constitute resources users, stakeholders,

25	Do you believe the different bodies/agencies of the Government should work together, and with the citizens regarding water resource usage, management, and sustainability?			
26	Do you believe that several private boreholes may adversely affect the environment?			
NO	QUESTION	YES	NO	NO IDEA

TABLE 2
DATA FOR RESPONSES TO WATER AND ENVIRONMENTAL QUESTIONNAIRE

QUESTIONS	YES	NO	NO IDEA
1	110	13	0
2	41	80	2
3	89	32	2
4	39	69	14
5	26	81	13
6	32	85	3
7	73	39	16
8	76	39	5
9	107	7	2
10	114	20	4
11	114	12	3
12	79	46	2
13	47	71	3
14	19	90	4
15	58	56	8
16	90	16	13
17	26	85	16
18	113	11	6
19	53	42	27
20	28	86	6
21	28	81	13
22	11	93	13
23	29	72	38
24	18	66	36
25	46	37	36
26	46	43	32
QUESTIONS	YES	NO	NO IDEA

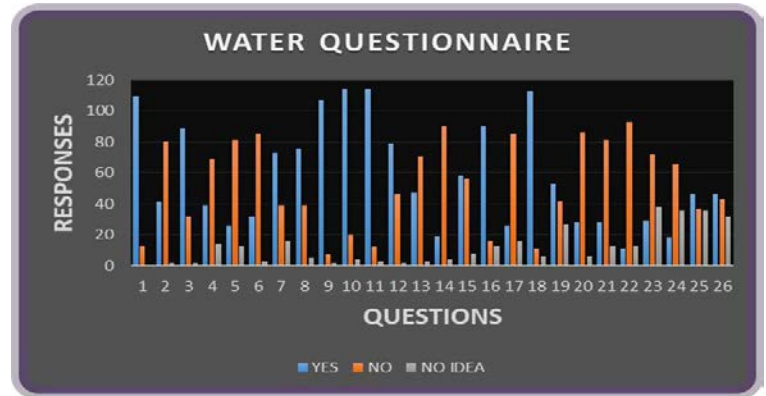


Fig.2: plot for water and environmental questionnaire data

DISCUSSIONS

Relevant Case Studies:

- i. The South African Government has made some progress in reducing the water and sanitation backlogs in the country. They have attributed these backlogs to factors such as, population growth, urbanization, inadequate maintenance of infrastructure and low institutional capacity. It has been established that the long-term sustainability of the urban water cycle (water supply, sanitation, drainage, wastewater treatment, groundwater and urban rivers) depends on a clear understanding of the links between each of the various elements. Research carried out suggests that if decision-makers had a better understanding of the linkages, they would be better able to provide solutions to the service delivery crisis (Mureverwi *et al.*, 2018) [8].
- ii. The issue of communication among water suppliers, town planners and the Water Resources Board (WRB) was addressed at Brown University, a project which showed that there was a need for standardization or reporting procedures. The research identified a lack of frequent and detailed exchanges of information between water suppliers and planning agencies. There was both a lack of empirical information (research) and communication breakdowns which have limited the effective dissemination of what knowledge does exist (Alexandra, 2005) [9]. It was also discovered that there was a general lack of recognition of the issue of potential over withdrawal, possibly because there was a definite lack of knowledge, consequence of a breakdown in communication that hinders management process.
- iii. The place of communication in water resources management has also been emphasized by the analy-

sis carried out in Venice. The paper allowed drawing a picture of state of the art of the communication, dissemination and exploitation of research results for Integrated Water Resources Management (IWRM) in the Mediterranean Area and identified recommendations and common strategies for strengthening the research impact on policies and society. It was advised that communication activities and research efforts should be improved at different levels: between projects and International Organisations, between different projects and at the project scale itself (Yaella and Carlo, 2008) [10].

- iv. The state of Guanajuato, Mexico has created a Groundwater Technical Committee to open an arena in which different water users and governmental officials gather to seek for solutions to the problems of water misuse and distribution. It is also a forum through which water users and authorities have direct channels of communication from top to bottom and vice versa, enabling the possibility of implementing several regulatory decisions by consensus (TAC, 2000) [2].

All the case studies enumerated above clearly show that the finite water resource can be sustainably managed only when there is dissemination of vital information through various levels of organizational procedures achieved via strategic communication.

Borrowing from the afore-mentioned studies, it is obvious that the present perennial water management degradation in Lagos State is largely due to lack of adequate, verifiable technical information and appropriate dissemination of this information via effective communication. The whole gamut of operational failures in water management in Lagos State is embroiled in a single scenario: there is a huge disconnect between all the state's agencies. Lagos Water Corporation (LWC), Lagos State Urban Renewal Authority (LASURA), Lagos State Physical Planning and Development Authority (LASPADA), Ministry of the Environment (MOE) and the Ministry of Water Resources operate autonomously! There are no integrated plans and policies to achieve common goals. There are no definite and direct objectives for these agencies. Hence, they sometimes duplicate projects, causing conflicts and consequently, resulting in projects becoming stalemate.

For example, in South Africa, water resources are managed by the Department of Water Affairs and Forestry (DWAF), and this same body allocates water to sector users, but the National Department of Agriculture (NDA) takes the lead in integrating initiatives in the agricultural water use sector (DWAF, 2004) [11]. Oosthuizen (2002) [12] also identified other institutions for water management, like the Catchment Management Agencies (CMAs) and the Water User Associations (WUAs), showing distinct functions. Similarly, the water supply in Denmark is regulated by law issued by the Ministry of Environment, who delegates the responsibility to the 98 municipalities, and the city of Copenhagen benefits from 100% coverage

of pipe distributed tap water delivered 24 hours a day 365 days in a year, and it is important to add that the water is of high quality, has a pleasant taste and can be drunk directly from the tap (Ministry of Environment Denmark, 2017) [13].

All these organizations have varied, but defined functions, and for efficient and effective water resources management, these different bodies work in harmony with one another in terms of their structures, policies, rules and regulations, a feat that is achievable only by excellent strategic communication. This type of system of operations is grossly lacking in Lagos State because there are no distinctively established agencies with defined functions, policies and rules of law.

The problem of water management in Lagos is convoluted due to prolonged communication snags in the state. For example, the Lagos Island environ is ostracized from the rest of the state, and residents rely mostly on borehole as the means of water source. This is quite critical as this environment is a coastal area, and saline water ingress is a high possibility. There is no map of the area to delineate saline water prone areas from other areas; hence boreholes sunk are susceptible to saltwater. The Mainland areas of the state face the same situation. Lack of functional government underground water system has created unhealthy complications for citizens. Although there is pipe-borne water here and there, however, the main functional water supply facility is water borehole (drilled mostly unprofessionally). Proliferation of borehole is by land-owners and during government projects. So, how do other citizens get water when water doesn't run in the government water pipes? Individuals purchase borehole water from water tankers (Plate 7), truck pushers called 'Mairuwas' (Plate 8) or from people who sell 'pure water' as wholesales using motor truck delivery (Plate 9) or from those that sell retails (Plate 10). By the way, people trust 'pure water' sellers than the government, hence paving way for water selling business to thrive uncontrollably. Unfortunately, due to lack of hope in the government, relying on these water sellers could constitute health hazards as neither the provenance nor the purity of the so called 'pure water' can be ascertained. Again, communication failure continues to wreck havoc in the society.



Plate 7: water tanker

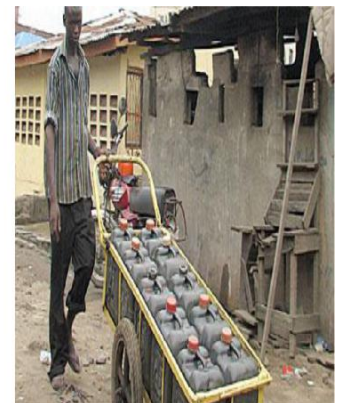


Plate 8: truck pushers

Even government officials have declared that the above menial processes of getting water by Lagos State residents have come to stay and that the government is clueless on how

to combat the situation. For example, the former governor of Lagos State, Babatunde Raji Fashola, during his reign in office observed that proliferation of boreholes constitute long term environmental problems, and to abate this, he inaugurated a one-million-gallon-per-day capacity World Bank assisted Mini Waterworks at Iponri, enjoining the residents to cultivate the use of waterworks rather than boreholes, as expressed in his address: "Let us shut down those boreholes because they have long term environmental impact and environmental damage to our state and our people" (Vanguard, 2012) [14].



Plate 9: wholesale seller



Plate 10: retail seller

Likewise, the LWC, through its former Group Managing Director, Mr Shayo Holloway, raised an alarm on the dangers of borehole drilling, pollution of groundwater by salt water, landslides and health issues (Vanguard, 2012) [14]. Yet, water rarely runs in the pipes! Ironically, the same government continues to use boreholes in most of its construction, engineering and environmental projects! Only 10% of the population is being served by the LWC, while the rest of the population gains access to water from private boreholes (house owners) or from informal private sector participants such as water vendors (Jideonwo, 2014) [4] as shown in Plates 7, 8, 9 and 10. This method of water supply has been necessitated since the government has failed dismally in providing portable water for the citizens. This was corroborated by the former Chairman of the Nigerian Institute of Building, Lagos State Chapter, Mr Kunle Awobodu, when he reported that there is no access to portable water and that even the policy makers support the practice of constructing borehole, because the public water system has failed everywhere (Vanguard, 2012) [14]. Consequently, indiscriminate construction of borehole and consumption of borehole water with reckless abandon continue, posing imminent dangers to the populace.

Since there is no communication from one part of the state with another, this huge disconnect creates a disconformity in water channeling, and important information that is imperative for effective decision making is lacking. It should be emphasized here that no one personnel or group of personnel is responsible for this, rather it is due to the feebleness of communication in the government water agency and other institutions. The questionnaires reflect pure ignorance of the people as to what effective water management is, and how it may be accomplished. Also, personal interviews lucidly indicate sincere interests of residents to achieve effective water usage and healthy sanitation process, and the government personnel re-

flected positive intention to carry out their functions dutifully if they have access to enabling tools, such as adequate information, technical skills, equipment, effective communication, sincere and pragmatic administration, and most importantly, transparency in procedures.

This takes us to the issue of administration. Which agency has been established to issue permits and enact rules and regulations that must be met prior to any water projects? Are their integrative and cohesive processes between the government agencies that are involved in various phases of water utilization and disposal? Is there a check-and-balance system on water usage in terms of quantity and quality? Is there cost-effective allocation of funds toward water quantity availability and quality improvement? Is the public informed on the consequences of their actions, such as urinating (Plate 4), defecating (Plate 5) and emptying sewers by trucks (Plate 6) into open waters? What about non-compliance with constituted rules and regulations? How should people be deterred from flagrantly disobeying systems of operations?

The administrative sector cannot work if the technical sector is not functioning or non-existing! The state is not able to produce modern geological and hydrogeological maps that can give information on the sub-surface aquifers and hydrodynamic settings. These maps are imperative to efficiently and effectively execute water projects, because they will be the basis upon which design, both surface and sub-surface, will be based. Furthermore, measuring instrumentation should be established at base stations to carry out continuous measurements of climate and rainfall pattern, as well as runoffs.

In Denmark, direct abstraction from surface water was prohibited and groundwater abstraction was regulated to secure a certain minimum flow in all rivers, mainly through moving abstraction wells away from riverbanks and wetlands (Thomsen and Stockmarr, 2009) [15]. However, in Lagos, people, including government workers, do not have technical knowledge of rivers and wetlands functioning. Neither the government nor citizens know the value of water abstracted from the underground source annually, as well as any knowledge of groundwater recharge. There is also no idea of what pollutants may affect shallow aquifers. As mentioned earlier, Lagos State Government comprises many agencies, including wastewater department. Yet, there are no distinct functions that each of these agencies performs. This leads to indiscriminate usage of surface water and groundwater, without any monitoring activities. The consequences of these are over-depletion and pollution of the water bodies. Abstraction from the groundwater source should require a permit, to be renewed at specific time intervals, and abstraction must be measured annually with figures reported to constituted authority in charge of such activities.

This will ensue adequate management and sustainable use of the water bodies. But this can only be achieved by participatory approach, hence valid information must be shared between designated bodies, water suppliers and users. Turton and Ohlsson (1999) [16] shed light on this when they opined in their research that water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

CONCLUSIONS AND RECOMMENDATIONS

There is the need for a change, and immediate change. The present agencies need to be substituted with new establishments that can exhibit innovative approaches to unravelling the present chaos. Competent personnel must be consulted to derive, from investigations, models that will guard against over-abstraction from water wells, a situation that may put generations to come at grave risks. In Nigeria, and specifically Lagos State, the main method of groundwater investigation is borehole drilling, a method that produces only point source information, creating uncertainties in the generated models. Sub-surface geological, geophysical and geotechnical investigations and geochemical analysis, which will provide spatially dense data are needed for scientific completeness.

From the questionnaires and interviews, it is obvious that there is an abyss of disconnect between the populace and the government. As a way forward, government should create and expand public information and involvement procedure that will provide mechanisms for integrating the community with the agencies in water-related issues. Such process will facilitate participation that is open and inclusive and fosters an opportunity for feedback from the public. Participation should involve playing active roles in water policy planning and decision-making. Consequently, this will have a direct impact on how the people apply water in their daily activities and their mode of wastewater disposal.

In most homes, pipe-borne water is absent and some even lack boreholes. Ideally, this situation should invoke a sensible and economic use of the limited supply by consumers. However, the expected disciplined application is lacking as portrayed by unbridled waste because there is no direct consequence for the flagrant waste. To arrest this situation, government agency in charge should ensure that water is carried to the populace unhindered and should adopt a system of inventing the supply and users, so that quantity used is directly billed to discourage waste and encourage conservation. To achieve this, the government needs to go state-of-the-art by using digitalizing supply and billing. Accounting and management expertise must also be top-notch to effectively generate revenues on usage and create deterrent measures for those who might disabuse the system put in place. A key factor to success is the ability of the government to ensure constant supply and maintain regular monitoring of all instrumentation upon which sustainable service provision is based.

In summary:

- As a regulatory agency, government should be responsible only for policy making, planning, water allocation, monitoring and enforcement, while private consortium should oversee providing water services, and only licensed personnel should be allowed to provide these services. Allocation and usage should be constantly checked for efficiency and transparency. Government must promulgate decrees to regulate allowable abstraction/extraction of sub-surface water body, and withdrawals should be monitored and in-

ventoried. The decrees should carry stringent penalties to deter people from flagrantly disobeying systems of operations. This will engender a long productive life for the underground water systems.

- Government should encourage civic society and community participation in the processes of water usage and management. That is, there should be creation of functional, community-involved and transparent environmental management department, which will encourage regularly scheduled meetings between government agencies and the community where interactive discussions will ensue. Establishing a water management committee can help in ensuring coordination and consistency of messages. Stakeholder participation will be encouraged if relevant information is made readily available in a timely manner. Furthermore, are government agencies hands-on in evaluating water service providers? This is a must to encourage competitiveness and transparency regarding service delivery.
- It is evident from the data that knowledge base of water utilization in Lagos State is porous. People lack knowledge of where water comes from and who should manage water for quality assurance and conservation. Therefore, the government should enhance public education and information (both scientific and socio-economical) on the different phases of water utilization in order to balance the availability and quality with unrelenting demands for this finite resource. According to Howarth and Butler (2004) [17], education program should include communication principles, which tackle ignorance of the need to reduce water use, awareness of the need to reduce water use, interest in reducing water use, desire to act to reduce water use and action to reduce water use. Adults and youths should form a committee to work on broadened and comprehensive campaigns, including publicity, launching ceremony, exhibitions, competitions and events, using insightful mass media, such as TV stations, Newspapers, Billboards, etc that create graphic appreciation and enhance quicker understanding and adaptation to the theme of the message. Incorporating local NGOs will further strengthen water conservation since they are able to operate and communicate at the levels of the local communities.
- Regular research and investigations on groundwater and surface water must be on-going for updates with the ever-dynamic cutting-edge technology. The state must embark on detailed groundwater mapping in order to have an in-depth knowledge of the sub-surface water dynamics and cataloguing data of sources of water and allocations, and authenticated

information be made public. As stated by Reisz (2013) [18], groundwater mapping is the first step to a stable and sustainable water supply. So, the need for state-of-the-art technology (for good data collection and secure management), personnel expertise and political will cannot be over-emphasized. Water reuse and recycling programmes should be developed and implemented. Also, establishing a public water storage capacity, utilization and disposal information network across the state would be endearing.

- Ungauged systems, uncontrolled abstraction and lack of monitoring processes are some of the causes of the problems plaguing water resources management in Lagos State. For example, the groundwater in Denmark belong to the public, a landowner does not own the groundwater beneath his/her property, so the right to abstract and utilize the groundwater is granted by the local authorities where the well field is located (Ministry of the Environment Denmark, 2017) [13]. If water is abstracted from the sub-surface aquifers excessively, pumping could exceed safe yield and recharge capacity. When this occurs close to a surface water body, such as streams, these will begin to dry up. In such a situation, it is imperative to communicate to all that are involved in water projects that any water developments must not be embarked upon in the proximity of such surface water body. Gauging equipment and monitoring systems will provide reliable data upon which assessment of water resources availability, in terms of quantity and quality, as well as long-term effects of continuous usage and impact of climate change depend.
- In terms of conservation, people should be discouraged from excessive use of water by introduction of reasonably high-water fees, metering of water consumption and encouraging the use of utilities that will enhance low flow rate. In terms of protection, penalties for deliberately polluting the water bodies by human beings must be stern and unrelenting. Litigation and prosecution must be the watch-words for those who put the health of the state at risk by exhibiting such foul behaviour.
- Environmental impact assessment analysis should be carried out to evaluate the socio-economic and environmental effects of water sources, allocation and usage, as well as wastewater disposal.
- Finally, and most importantly, the government must be sensitive and practical, and realize that their police tendency cannot work when it comes to water management. For example, the Ministry of the Environment calls itself the 'Environment Police'. Household water usage cannot be imposed on the populace. It is

by consensus and a shared responsibility between the government and the citizens that water management practices can be adopted and upheld.

In a publication by ECRI and RIWRB (2006) [19], it was established that communication and awareness building are essential ingredients in all forms of water resources management. Consequently, the need for the government, industry and populace to collaborate at all levels on how best to respond to optimize the use of the scarce water resources and the risk of severe water shortage cannot be over-emphasized. Respondents have corroborated the need for this collaboration in their resounding 'YES' to questions 9-11 (integrating participation of government, private sectors and communities) as shown by high values and high peaks on Table 2 and Fig.2 respectively.

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