SUSTAINABILITY OF WATER SUPPLY IN NIGERIA

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Abstract
The official proportion of the population that can access portable water has remained at about 54% which justifies the increasing awareness of mounting demand for portable water. This study was undertaken within three (3) senatorial zones of Anambra State in Nigeria, with the objective of examining the factors affecting sustainability of water supplies and management. A mixed method of investigation was employed in the study comprising of qualitative and quantitative approach of Water use in Anambra, Nigeria with respect to sustainability factors of economic, social, and explore the contemporary achievements in water supply sectors and development strategies to sustainability in Anambra State in future. Findings made showed that challenges such as technical, operation, maintenance, and financial among others have hindered the goals to achieve sustainable water supplies in Anambra State, Nigeria. It may be necessary to opt for either mega surface water projects, groundwater program for urban towns, small towns and rural water projects, or a joint surface and ground water program to achieve sustainable water supply.
Keywords: *Sustainability, factors, water, supply, rivers*

Introduction

About Ninety seven percent (97%) of water from the available water in the surface of the earth is not fit for human consumption while only one percent is available for consumption by human beings (Serageldin, 1995). It is known that inadequate drinking water, lack of sanitation infrastructure and poor hygiene is responsible for the millions of deaths from preventable diseases yearly, (Skinner, 2009). These diseases include, diarrhea, malnutrition, nematode infections, filariasis, schistosomiasis and malaria, among others. Diarrhea alone is responsible for an estimated 1.8 million deaths yearly (Clasen, 2008). Therefore, access to potable water and sanitation is very crucial for primary health care in the world.

According to (Nfor, Olobaniyi, & Ogala 2007) (Olugboye & Haye 2011) Anambra state is drained principally by a number of rivers which includes River Niger, Anambra River. Others are Idemili and Mamu Ulasi Rivers Obizi, and Nkissi Stream. These rivers and streams with their attendant catchment sub basins, drain into the River Niger and then to the Atlantic Ocean. The Rivers are of different sizes and are mostly perennial. The Anambra River covers the East of the State. The River is fed from many riversides and tributaries which include the Ezu River, which is also called Mamu River in Orumba and Aguata local government. Together with other small local riverlets/Tributaries which include Aghommili, Awdaw and Haba, flow and build up the Anamabra River. The Anambra River is most prominent at

Otuocha in Anambra East Local Government, where the volume and discharge could be estimated at about 450m3 per min (100,000 gallons per min). The Idemmili River is another major river, it is fed from the hinter areas. The Ulasi River covers the Sothern and Western part of the State. A major tributary is the Ubu River which runs across Nnewi North and South LGAs. The surface water resources is capable of sustaining water supplies in the State.

Furthermore, the delivery of sustainable water supply or sanitation services requires good financial systems, among other factors, to be established, so that the infrastructure can be replaced when its life span expires, repairs can be done, along with the capacity to expand it and service delivery is improved as demand changes (Fonseca C, Franceys, R., Batchelor, C., McIntyre, P., Klutse, A., Komives, K., ... & Potter, A. 2011. Other factors critical to achieving sustainable supply of water includes policy factors, institutional issues, community and social factors, technology issues and natural environment, spare parts availability, maintenance issues and monitoring (Nicol, 2000). This study will explore these factors. Though it is now accepted practice to discuss water supply alongside sanitation, as the experience shows that the construction of water supply facilities, plus improved sanitation and excreta disposal, provide the most significant health impact. However, this study concentrates more on water supply systems because this subject is large enough by itself, although the questions are equally relevant to sanitation infrastructure. The water supply systems to be investigated will include the different kinds of systems currently used in the State and will cover several different zones so that the full range of factors affecting water supply systems can be evaluated.

Review of Related Literature

Factors Affecting Water Provision and Sustainability

Harvey and Reed, (2004) reviewed previous studies and literature by Abrams (1998), WELL (1998), Mukherjee & Van Wijk-Sijbesma (2002) identified eight factors critical to achieving sustainability of water provision as follows: “policy, institutional arrangements, financial and economic issues, social aspects, technology and the natural environment, spare parts, maintenance systems, and monitoring”. Some water supply projects or programs may focus on some of these factors while neglecting others, thereby risking non-sustainability of the projects. It is important, therefore, that water supply programs utilize a holistic approach which addresses all the factors above and understands the relationship between them (Harvey and Reed, 2004).

Policy Context

National policies and strategies should be established in a way that recognizes the service-based nature of water supply and the key role government plays in providing support, co-ordination and regulation (Harvey and Reed, 2004). The Dublin

agreement provides a common basis for the development of policies in the WASH sector with the principles:

i. "Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment"
ii. Development and management of water should follow participatory method that involves users, planners and makers of policy every level.
iii. Recognition of women as major players in the provision, management and safeguarding of water in non-negotiable.
iv. Water has economic value.
v. In recognition of the linkages between poverty, water and sanitation. In countries where existing policy and strategy papers do not adequately recognize these linkages, advocacy campaigns may be required to highlight the need to incorporate rural water supply strategies in the national PRSPs (Harvey and Reed, 2004)

The Sector-Wide Approach (SWAP) has been popular with donor agencies as a means to improve performance in the water sector through centralized budget support through programs rather than isolated projects. Davis and Brikke (1995) explain that centralized management often contributes to the failure of operating and maintaining water systems because of:

- Over dependence on government resources;
- User expectations that government is responsible for everything;
- User nonpayment of water user fees; and

Non-user involvement in making decisions that concerns their water supplies various opportunities and constraints provided by decentralization policies. Sohail (2001) argues that the main constraint is that local institutions often lack sufficient resources and expertise to provide sufficient regulation and support to the private sector.

The development of national policies and strategies should be led by the relevant government institution through a consultative process with other stakeholders, resulting in the adoption of best practice for the sector. The Nigeria government is currently developing a national water and sanitation policy which would provide all Nigerians with sufficient water, appropriate sanitation, to make sure that Nigeria lives ^in hygienic environment. This implies that the entire State would be keyed into the best practices of the world and would hold hope for Anambra state.

Institutional Aspects

Harvey and Reed (2004) provide details on institutional issues influencing water supply sustainability and notes the move away from the traditional project approach with a finite life span, and focus on the water supply infrastructure. Many donors are now moving towards a program approach, so that the government and institutions

can take the key roles, budgetary allocations can be made for ongoing institutional support, there is the opportunity to develop long term policies and strategies and sustainable partnerships and solutions can be developed over time. The Sector-Wide Approach (SWAP) is becoming an increasingly popular program approach for the Water Sector in yielding to the failure of project-based approaches to make sustainable progress. (Well, 1998) devotes a section to institutional perspectives and provides four different operation and maintenance models with levels of responsibility which vary between government systems and local community management. Harvey and Reed (2004) outlined six different partnership models for service delivery including: community management model, public-private partnerships, manufacturer-NGO model, primary healthcare model, least subsidy model and the government service model. Although the community management model has been the predominant partnership model in many developing countries, its popularity has not been matched by similar levels of success concerning of the sustainability of the water services as many systems fall into disrepair soon after installation (Harvey and Reed, 2004). Nigeria's experience is such that most project fail barely weeks after commission. Stronger institutions are needed to promote and support community management with adequate funding provided for agencies to perform supportive tasks (Davis and Brikké, 1995). New strategies developed by implementing agencies that recognize the need for ongoing institutional support and the importance of budgeting accordingly (Nedjoh et al., 2003). Capacity building of the various institutional stakeholders is essential, as without adequate capacity at different levels of government and at local level, services will not be sustainable (Abrams, 1998). This is essential tool for the improvement of sustainable issues in Anambra State where capacity building is low.

Social Aspects

In many developing countries, collecting and carrying water is part of women's daily routine, which is physically demanding and stressful. Despite the major role women play in carrying water and domestic usage they are rarely consulted in decisions concerning the site, formulation of the project, and its operation and maintenance (Well, 1998). The participation of women in water supply projects can have a several benefits. As women and girls are the primary users of the water supply, their input into the location and design of the facilities can contribute to improved access and operation of the process. Women are often concerned with efficient functioning in water supply and are motivated to do something about it (Harvey & Reed, 2004). Women may also often perform better as treasurers than men if trained appropriately (Davis &Brikké, 1995). They may also support the project through their participation in the payment of household water tariffs. It also provides opportunities to meet wider development goals such as striving to achieve gender equity and empowering women (Harvey & Reed, 2004).

Technological Factors

Brikké and Bredero (2003) list the following technical issues: technology selection, complexity of technology, technical ability to respond to demand, technical skill needed to operate the system, spare parts availability, and the overall costs of operation and management. Brikke and Bredero (2003) also provide a list of nine factors that influence the approval of community water supply technology. General factors include: demand, capital costs, extension capacity, compatible norms and legal frameworks, compatibility with existing water supply systems, comparative advantages and technical skill requirements. Factors relevant to operations and management include: water treatment, water source protection, existence and use of traditional water sources, and wastewater drainage. Sara and Katz (1998) found that the quality of construction and design can have a major impact on sustainability of water supply systems. Lockwood (2004) asserts that the choosing of technology is crucial for 'scaling-up' community management water services is increasing levels of complexity and service demand increased management capacity, higher water tariffs and spare parts from foreign countries. Harvey and Reed (2004) provided four "golden" rules to selecting appropriate technology for rural water supply systems: use what's already there and improve on it; select low-cost rather than high-cost solutions; where possible select household rather than community solutions; and if you can dig don't drill. A quote from Wagner and Lanoix (1969), although it is not gender sensitive, illustrates the responsibility of an engineer to keep the design as simple as possible. An incremental approach can also be chosen to water supply provision so that water supply schemes are planned incrementally to suit the ability and willingness of a community to participate and pay for the improving levels of service (Skinner, 2003:1).

Environmental Factors

Mukkerjee& Wijk-Sijbesma (2002) lists environmental sustainability as a key aspect of water supply sustainability, and elaborate that water sources face multiple threats from overextraction, contamination from waste disposal, and industrialization, while the water facilities themselves can created breeding places for mosquitoes. WHO, (2000), recorded 2.2 million deaths every year in developing countries from diseases related with inadequate drinking water, low sanitation and poor hygiene.

Spare Parts Availability

Supplying spare parts for water supply is a critical factor that affects sustainable water supply system. In several cases, donors do not provide spare parts after construction, the communities to pay for the spare parts, but the parts are not readily available due to supply chain issues. This problem motivated the Water and Sanitation Program (WSP) to develop a global initiative called the 'Supply Chains Initiative' which aims to assist development practitioners to make the environment acceptable for private sectors delivery. (WSP, 2000). Harvey and Reed (2004) suggest that for the spare parts to be sustainable, the supply chain must be effective,

efficient, equitable and replicable. (WELL 1998:161) explained the principle of standardization benefits the supply of spare parts, as limiting the range of spare parts increases the quantity items required, so local suppliers will be more willing to stock the spare parts for reasons of increased demand for a reduced range of items. (Oyo, 2002) for instance argues that simpler technologies often need less parts, have shorter supply chains and have cheaper prices which help to stimulate consumer demand. (Brikké and Bredero, 2003) suggest that before opting for a specific technology, the mechanism for supplying parts must be investigated.

Financial & Cost Recovery Aspects

There is a growing acceptance that to carry out cost recovery of rural water systems effectively, an understanding of project costs over the expected life of the project is required. Evans (1992:20) notes that much of the data on water cost and sanitation was patchy and inconsistent particularly in respect to what should be added in the definition of costs. This approach is used to analyze the unit costs of the various components which enables fair comparisons to be made between different types of water supplies and for different service levels (Fonseca et al., 2011). The four main indicators chosen for defining water service levels are quantity, quality, accessibility and reliability (Moriarty et al., 2010). Several authors noted the importance of cost-effectiveness in designing community water supply systems, in terms of capital and recurrent costs.

Well (1998:164) suggests that "engineers have a responsibility to find the most appropriate least-cost. More so, Harvey and Reed, (2004) include "opt for low- cost rather than high-cost solutions" as one of four golden rules regarding the selection of appropriate technology for rural water supply systems. The type of financial management system used will be influenced by what type of overall management system is selected for the water supply system. Brikké (2000) provides a summary of the basic aspects of a financial management system which should be implemented by a water supply committee, provides possible options and emphasizes that the financial and operational responsibilities need to be clarified between the various stakeholders.

In a review of literature about willingness-to-pay for water services in low-income countries (Merret, 2002), the main factors mentioned which contribute to low willingness- to-pay are:

- Economic life is getting harder and therefore households should give priority to domestic expenditure.
- In political life persons/parties give support for non-payment.
- Public service quality is poor.
- Government is corrupt and so payments go into the pockets of public servants.

Measuring Sustainability

Measuring sustainability is difficult task but however various survey tools were made for this purpose (Hodgkin, 1994); WSP South Africa, 2000). The Water Aid Country Office in Malawi developed an alternative tool for the rapid measurement of sustainability called the "Sustainability Snapshot" (Sugden, 2003). Their intention was to develop an effective evaluation tool that was: (i) easy to understand (ii) quick (iii) discussion provoking (iv)applicable to all circumstances (v) non-prescriptive, and (vi) effective even in extreme circumstances. This approach refers to the Water, Engineering and Development Centre (WEDC) sustainability matrix which indicates that finance, maintenance and spares supply are dependent on policy, institutions, community and technology are mandatory to achieve sustainability.

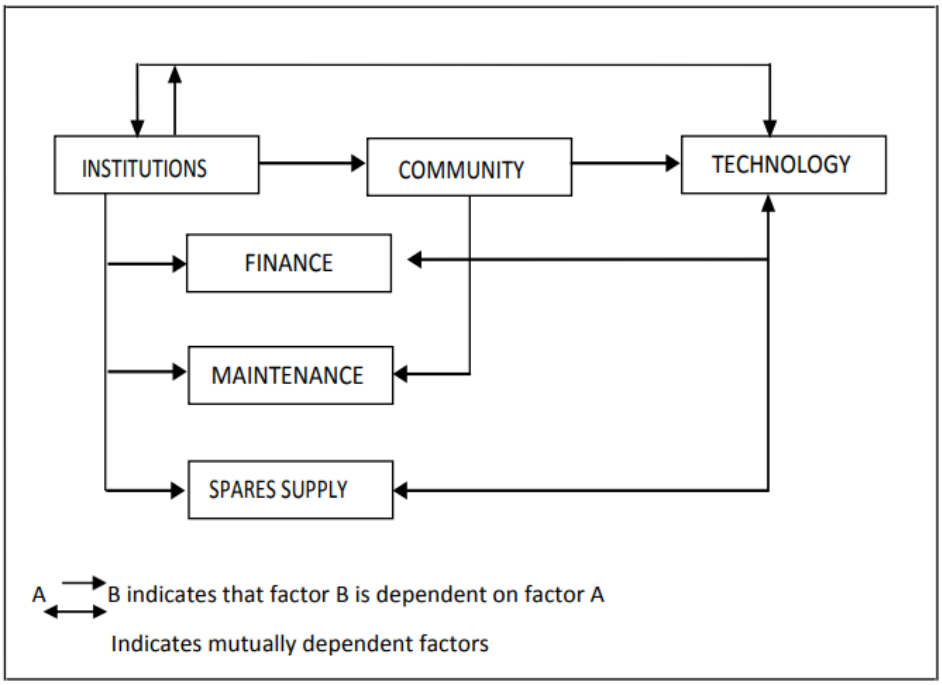


Figure 2.1 Source: WEDC Sustainability Matrix

The methods of analysis in the five studies also varies significantly. Hodgkin, (1994) and WSP South Africa, (1998) relied on simple scoring systems commonly referred to as tabular analysis. The global studies (Sara & Katz, 1998 and WSP, 1998) utilized larger sample sizes and regression analysis to verify a relationship between variables. The MPA methodology uses highly participatory approaches to obtain qualitative data that can be analyzed using regression analysis. The sustainability snapshot is new approach that uses a simple but robust analytical framework which attempts to remove barriers to participation caused by more formal surveys and data analysis methods.

Methodology

The methodological approach in this study adopted the combination of qualitative and quantitative method of investigation. Firstly, it established the water situation in Nigeria in general and in Anambra State in particular. Thereafter, it followed in sequence; sets of investigative procedures using appropriate data collection tools ranging from questionnaires, semi-structured interview technique, and focused group discussions in an attempt to unlock vital issues militating against having sustainable water projects in the state and the way forward. Thus, this study includes a mixture of case study and survey in order to achieve more appropriate and flexible necessary information and criticisms concerning issues associated with sustainable water management performance. And, to obtain a triangulation of data which can be seen usually when a semi-structured group interviews are used to triangulate sets of data obtained using a questionnaire.

Four semi-structured interviews were conducted among the selected professionals at their offices and at their chosen locations, and the effects/influence of these selected stakeholders on the sustainability of the specific project is presumed to be equal. The semi-structured interview questions were developed and was centered on the water supply situation, so to have an insight into the water related problems. Basically, what the study aimed to address was narrowed to six issues that are associated with sustainable water, and all the necessary information as regards to the sustainability of water supply was collected by means of semi-structured interview. Furthermore, the discussions with a focus group were conducted in the three zones with the key personnel from the region saddled with the responsibility of water initiatives. And, women folks were encouraged to take part in the focused discussion.

The discussions with the selected focus group from the demographic region of study was engaged to capture~~d~~ some unanticipated issues that might emerge in terms of water use, awareness of water sustainability, groundwater depletion issues, legislation reform and implementation, issue of the water quality, and environmental issues, barriers to sustainable water management, institutional and financial issues to sustainable water management. More so, a questionnaire was designed in an attempt to identify all the critical issues and success factors to attainment of sustainability of water supply and management in the subject region. The questionnaire was administered to a reasonable number of persons from the study locations by choosing an appropriate sampling technique using a purposive sampling framework. The target respondent for the questionnaire was the indigenes from the subject location as well as stakeholders in water management schemes, and a total of 21 questionnaires were administered, while a focus group which includes five women from various fields of water and agriculture were interviewed. This form of assessment provided the quantitative data that was analyzed statistically for adequate generalization using SPSS 23 statistical software.

Data Presentation and Analysis

Both the qualitative and quantitative data obtained from the field were subjected to different measurement scale that were later analyzed with a combination of statistical tools using SPSS version 23 and Excel. The information obtained are presented on a tabular format, and analyzed to captured the objective of this study.

Table 3.0: Water Demand by Agricultural/Irrigation and Domestic/Industrial Water Users.

Daily water demands	Frequency	Percentage (%)	Mean
Agriculture/Irrigation water users (liters)			
≤ 200	-	0	
201 – 400	12	57.14	
401 – 600	6	28.57	**400.57**
601 and above	3	14.29	
Total	21	100.00	
Domestic and Industrial water users			
≤ 100	5	23.81	
101 – 200	2	9.52	**207.55**
201 – 300	13	61.90	
301 and above	1	4.76	
Total	21	100.00	

Source: Field Survey Data. April 2019.

Table 3.1: Water Supply in Anambra State.

Stakeholder	Question	Response	Frequency	Percentage	Mean	Std. Dev.
Domestic/Industrial water users	Are you satisfied with the water services provided by the suppliers?	Yes	-	-		
		No	21	100.00		
		Level of satisfaction				
	In relation to the water supply to your property, assess your level of satisfaction	Length of time water supplies are available every week.			1.62	1.244
		Water quality			2.29	0.845
		Your involvement in local water management decisions			2.19	0.814

		Water price			2.29	0.644
		Cluster mean			**2.098**	
	What is the main source of water in your area?	Well	4	19.0		
		Borehole	1	4.8		
		Spring water	-	0		
		River	6	28.6		
		Stream	5	23.8		
		Rain water	4	14.3		
		Tanks	2	9.5		
	Which of these water facilities is mainly constructed in your area?	Well	7	33.3		
		Borehole	4	19.1		
		Tanks	10	47.7		
Agriculture/Irrigation water users	How many water wells are located on your farm?	≤ 2 wells	13	61.9		
		3 – 4 wells	7	33.3	**2.54**	
		5 wells & above	1	4.8		

Source: Field Survey Data. April 2019.

Table 3.2: Key Challenges to Attaining Sustainable Supply of Water and Management

Stakeholder	Question	Response	Frequency	Percentage	Mean	Std. Dev.
Agriculture/Irrigation water users	To what extent are you aware of water issue in Anambra State?	**Item of awareness on water issues**				
		Increasing number of farm water demand.			3.57	1.165
		Groundwater scarcity due to excessive pumping.			3.19	1.365
		The amount of fertilization used on crop			2.33	1.017
		Increasing number of well.			3.14	1.236
		Cluster mean			**3.06**	
		Radio	17	81.0		

	How did you become aware of the issues?	Television	11	52.4		
		News Paper	4	19.0		
		Others (Friends and family)	9	42.9		
		Note: for this particular question, the respondents were allowed more than a single response				
	Are you satisfied with the current water supply situation in your farm	Strongly Satisfied	-	-		
		Satisfied	-	0		
		Neutral	3	14.3		
		Unsatisfied	10	47.6		
		Strongly Unsatisfied	8	38.1		
Domestic/Industrial water users	Do you consider the policy as adequately enforced?	Yes	-	0		
		No	21	100.0		
	How would you rate the training you have had on water use/management?	Strongly enough	-	0		
		Enough	-	0		
		Barely enough	2	9.5		
		Not enough	16	76.2		
		Strongly enough	not	3	14.3	
	Do you think the natural environment in Anambra State has been adversely affected by water abstraction?	Yes		20	95.2	
		No		1	4.8	
	Are you aware of any problems associated with water sustainability in Anambra State?	Yes		17	81.0	
		No		4	19.0	

	Rate your awareness of water problem.	Extremely Aware		3	14.3	
		Aware		12	57.1	
		Somewhat aware		5	23.8	
		Not at all		1	4.8	
		Slightly aware	-	0		
	What do you perceive as water misuse by other property owner?	Loss due to breakdown of pipe	11	52.4		
		Uncontrollable use	6	28.6		
		Wastage of water	4	19.0		
	Rate the level of natural environment deterioration in Anambra State.	Group			3.00	0.22
		Municipal Private			3.48	0.20
		Households			3.19	0.11
		Farms			3.29	0.12
		Cluster mean			**3.24**	
Matured house-wife	What is the biggest problem you think water consumption poses?	Pollution because of health issues.	13	61.9		
		Death of aquifer	5	23.8		
		Water contamination	3	14.3		
Water Engineering and Consultants	What do you view as the reason for water pollution in Anambra State?	Human activities	5	83.3		
		Refuse disposal	2	33.3		
		Sewage	3	50.0		

***Source**: Field Survey Data. April 2019.*

Table 3.3: Rating of the amount of Environmental Damage caused by water abstraction.

Adverse rating	Mean threshold	Std. Deviation	Decision
Municipal	3.14	0.478	Somewhat Deteriorated
Private	3.43	0.676	Somewhat Deteriorated
Farm	3.05	0.805	Somewhat Deteriorated
Grand mean	**3.21**	**0.653**	**Deteriorated**

Source: Field Survey Data, April 2019

Table 3.4: Institutional, Technological, Environmental and Financial Issues.

Stakeholder	Question	Response	Frequency	Percentage	Mean	Std. Dev.
Domestic/Industrial water users	**Institutional Issues**					
	Identify the problems of which you are aware. Identify the problems of which you are aware.	Lack of will to enforce policy	11	52.4		
		Poor policy implementation	7	33.3		
		Lack of project continuity in government	3	14.3		
		Poo maintenance issues	17	81.0		
	If, no, identify deficiencies in the water services provided by the water suppliers?	Totally not working.	7	33.3		
		Breakdowns and abandonment of services.	14	66.7		
	Is Government making any serious effort to provide sustainable water supply?	Not strong efforts.	6	100.0		
	Technological Issues					
	What type of Irrigation technique do you use?	Traditional Flooding System	16	76.2		
		Modern System	1	4.8		
		Both Traditional and Modern System	4	19.0		

	What informed your choice of preference?	Solar powered borehole is expensive to maintain/manage.	13	61.9		
		Spare part not readily available.	15	71.4		
		Theft/vandalization of solar panel.	8	38.1		
		Theft and vandalization of Sumor.	10	47.6		
		Inadequate electric power supply for the motorized borehole.	19	90.5		
		Poor maintenance culture.	15	71.4		
		Borehole is expensive to construct especially in a place where the depth of water is far.	13	61.9		
	Are you aware of water misuse by other property owners?	Yes	17	81.0		
		No	4	19.0		
	Rate the level to which you find the use of old private water wells for	Strongly acceptable	-	0		
		Acceptable	-	0		
		Somewhat Acceptable	4	19.0		
		Not Acceptable	9	42.9		

	sewage or latrines disposal or Waste water disposal?	Strongly not Acceptable	8	38.1		
	Environmental Issues					
	On a scale of 1 – 5, how would you rank reuse of water?	Strongly acceptable	-	0		
		Acceptable	-	0		
		Somewhat Acceptable	2	9.5		
		Not Acceptable	3	14.3		
		Strongly not Acceptable	16	76.2		
	Are you aware of water contamination problems from sewage within your property?	Yes	7	33.3		
		No	14	66.7		
	How do you deal with water contamination problem if it happens?	Do nothing	3	42.9		
		Abandon well and build new one	4	51.1		
		Clean and use again	-	0		
		Call water suppliers	-	0		
	What do you consider the reason for not using sewage for agricultural crop irrigation in Anambra State?	Ignorance of concept to use sewage as a fertilizer	4	19.0		
		Not a priority	16	76.2		
		Treatment not important	1	4.8		
	Which of the following do you consider as a major	Water abstraction	4	19.0		
		Global warming	5	23.8		

	cause of deterioration of natural environment in Anambra State?	Domestic waste disposal	1	4.8		
		Waste water pollution	13	61.9		
		Industrial pollution	2	9.5		
Agriculture/Irrigation water users	**Financial Issues**					
	Would you accept the metering of water from your well?	Yes	-	0		
		No	21	100.0		
	If no, identify why you would not accept metering of water from your well.	Cost	14	66.7		
		Large farm	2	9.5		
		Many wells	5	23.8		
Matured house-wife	Is re-cycled Water acceptable?	Yes	-	0		
		No	21	100.0		

Source: Field Survey Data, April 2019

Transcript of Interviews Conducted

Semi-structured interview with hydrogeologist in Anambra State

Table 3.5: Discussion with Hydrogeologist

Question	**Response**
What do you understand by term Sustainability? Are you aware of any challenges associated with sustainability of water in this place?	**Hydrogeologist:** It is being satisfactory with water availability for long time. **Hydrogeologist:** There are some significance elements that has very bad effect on water sustainability in Anambra area that would be the barrier to water Sustainability as follows: excessive water wells used for both domestic purposes and irrigation farming the number of farm settlement projects in the state may affect the groundwater level and availability of water. The improving of standard of living which make farmers and water users employ technology that take more water from the aquifer for example water pumping.

	Hydrogeologist: In Anambra the water is available and the recharge is ever good **Hydrogeologist**: It is adjudged that agriculture activities does not affect sustainability in Anambra state because of availability of ground water.
Can you suggest any solution to help prevent the misuse of water?	**Hydrogeologist:** Education of water users as one of very important element to sustain water in Anambra.
	Hydrogeologist: Educating water users and telling them the truth about the water situations and helping them to understand all issues involving misuse.
Do you think there is necessity for legislative policies to make sure ensure water supplies sustainability in Anambra State?	**Hydrogeologist**: Legislative reform for water is already available but we need to strengthen it by implementation.
Are you satisfied with water services provided by the suppliers?	**Hydrogeologist**: The service provided by the water sectors in Anambra is bad. They problem is the way to delivered the services for example in case of drinking water most people do not get potable water.
Do you accept the use of old private water wells for sewage disposal? what the reasons for not using sewage water treatment for agriculture in Anambra?	**Hydrogeologist**: People are not aware of sewerage water issues with respect to the sewerage water contamination problems. There is individual cases and geological formation factors of lithology, showing that the Anambra area has high infiltration because of the sandy nature, we have to be careful of these cases because the possibility of water contaminations.
Should farmers only be allowed to extract water if they can pledge that they will use it in an efficient way?	**Hydrogeologist**: it is very difficult to apply this to Anambra since the water is relatively free. Because the water price is cheap and the value of money that it takes about the track that carry the water. Water is not expensive but the charge on transportation makes it be remarkable.
What do you feel about implementation of water tariff, and water device installation inside the properties?	**Hydrogeologist**: Regarding to water tariff and water device installation inside the properties: the people will see this idea as unreasonable. It is yet to receive popular approval and good will from the people.
How would you describe the water quality abstracted this year compared to 10 year ago?	**Hydrogeologist**: Water quality challenges are mostly anthropogenic as water polluting mineral and metals are rarely existing in the soil formations.
What do you feel of Water availability in Anambra?	**Hydrogeologist**: Historical the water in Anambra is great in groundwater which is a part of Anambra Basin. Ground water exploitation maybe difficult in areas where Imo Shale is dominant or where drilling is up to 300m but the aquifer is prolific in most cases.

What is your opinion of groundwater depletion and increasing number of water wells in Anambra State?	**Hydrogeologist**: It is certain that the level of groundwater is declining in last 10 year and all farmers do not know experimentally that groundwater is declining year by year, without the hydrogeological parameter we cannot predicted how much is the drawdown exactly the farmer does not notice it in their wells yet.
Do you think the natural environment in Anambra area has deteriorated during the last 10 years? and by who?	**Hydrogeologist**: There is too much water used in Anambra area in unwise ways. There is pollution from human activities.
what do you think about technical methods used to abstracted the water?	**Hydrogeologist**: The technical methods that used to get the water in Nigeria is generally drilling rigs of various type especially rotary rigs.
Do you agree water facility should be constructed in Anambra state and why?	**Hydrogeologist:** water facilities such as borehole, well, overhead tank should be constructed because of - Water sanitation - Safety of the users - Cost in uses Borehole is a capital-intensive project and should be undertaken by the government.
What are community sustainable measure you will advise for water sustainability?	**Hydrogeologist: (1)** Formation of O/M team. (2) Formation of water user's association. (WVA)

Table 3.6: Interview with Agricultural Director

Questions	**Response**
What do you think about incensement in the aggregate of employees and how will that affect the water in Anambra State?	• Because the economic situation has gone bad, people and corporate bodies are returning to the farm. • The big ones, have many wells and they pump unlimited amount of water, almost 24 hours a day. I think also the number of employees in Anambra State is dramatically increasing and it needs to be controlled. The reason for this is because they are trying to capture the whole food market. Secondly there is no rule for water wells and it is easy to drill water wells in most coastal areas where agriculture thrives.
Do you consider farmers in Anambra using water efficiently? State the reasons?	I think the quantity of water we use in our farm in a daily basis it is too much, and really in unsustainably way, and really need to do something to stop such behaviors.

What are the most important issues you are aware of regarding to the water sustainability in Anambra State?	It is logical to think, the number of the farmer getting increasing and it will contribute to increasing the number of the water wells and this will influence the groundwater security
	due to excessive pumping.
Groundwater depletion issues and increasing of water wells in Anambra State	There is no evidence of groundwater depletion scientifically. Maybe with time it will happen.
Are you comfortable with your current water supply situation in Anambra State?	The water situation in Anambra is good even with increasing farmers and farms still do not know about water issues much. The water situation is related to changes in behaviors and attitude with the farmers but more water is available now.
How would you describe the water quality abstracted this year compered 10 year ago?	Quality of the water is on the average and also depended to the depth of your water wells. The deeper you go the better quality you get. It is average, I guess.
Should farmers only be allowed to extract water if they can explain that they are going to use it in an efficient way?	• This is possible if the existing laws are implemented actively but farmers may offer some resistance. The farmer does not pay for water it consumes and the only cost incurred is the running cost of pumps fuel and maintenance and it is very hard to apply such idea. The reasons is that we did not know how much water available and also farmer would not give a correct information about the real situation.
Do you think there is need for legislative reform to ensure the sustainability of water in Anambra State**?**	• I don't think we need to reform in the existing legislation, what is really needed is to implement and make it active. Lack of a central planning, policy formulation and mechanism is an issue to talk about. Most of farmers do not know about existing legislation,
What do you think about the current irrigation policy and how is acceptable enforced? And what do you think about farmers being regulated?	Indeed, there are laws and regulation used for agriculture, but framers can drill any number of wells they want according to their financial ability. At the present laws have not regulated them.
Do you provide necessary training to farmers on how to use water and maintain its sustainability**?**	There is no organized training for farmer that is very serious. There should be some because it increases awareness about water conservation issues.
Are there provisions for O/m i.e., maintenance culture entrenches in your system?	Government has not taken maintenance culture seriously.

Findings

This study adopted a triangulated research approach to capture similar data from different (Agricultural/Irrigation and Domestic & Industrial) water users. This approach was adopted to give the research sound evidence for a logical judgment.

Current water Demand

The daily water demand by Agricultural/Irrigation water users in the study area was presented in table 3.0 of chapter above, finding indicates that majority (57.14%) of the water users under agricultural and irrigation category uses 201 - 400 liters on a daily base. The remaining 28.57% and 14.29% uses 401 – 600 liters and 601 & above respectively. None of the users recoded a daily water use of < 200 liters. The mean daily water use was found to be 400.57 liters in the study area. The implication is that the volume of daily water use is high. On the other hand, the domestic water uses suggest that majority (61.90%) of them uses 201 – 300 liters daily. The remaining 23.81%, 9.52% and 4.76% use < 100 liters, 101 – 200 liters and 301 liters & above respectively. The mean daily water use for domestic and industrial water users was fund to be 207.55 liters. Thus, the implication of the research is that agricultural and irrigation water user's demands more water on a daily basis than the domestic and industrial water users in Anambra state. Furthermore, the researcher interviewed mature house wife in the study area to ascertain what they actually use water for on a daily base, the result asserts that the greater number (52.4%) of the house-wife/women used water on a daily bases for washing and cooking, while the remnants 47.6% said they use water on a daily bases for household issues and agriculture. This implies that water is being properly utilized in Anambra state.

Sources of Water Supply in Anambra State

Having identified well as one of the main sources of water for the Agricultural/Irrigation water users, data on the number of well available to the users, and also the number located in their fam. Findings made showed that majority (61.9%) of the agricultural/irrigation water users have less than 2 wells on their farm while the remaining 33.3% and 4.8% have 3 to 4 well and 5 wells and above respectively. The mean number of wells was found to be 2.54 (3 on the average) in the area.

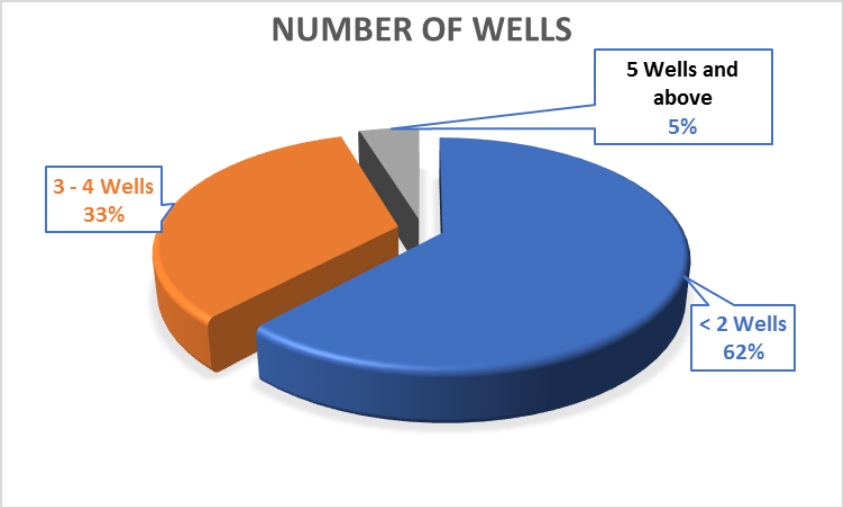


Figure 4.1: Number of wells

Also, findings made showed that the main source of water for majority (28.6%) of the domestic and industrial water users is the river, while the remaining 23.8%, 19.0%, 14.3%, 9.5%, and 4.8% indicates that, their major sources of water were stream, well, rain water, tanks and borehole respectively. Equally, 47.7% of the water users suggest that water facility mainly constructed in their area is tanks, while the remaining 33.3% and 19.1% suggest well and borehole respectively. The overhead tanks are used to harvest rain water in Anambra state. Furthermore, data from the stakeholders suggest that 100.0% of the domestic and industrial water users were not satisfied with water supply service in Anambra state despite the sources. Thus, 5-point Likert scale was used to capture and weight the level of water use satisfaction. The mean threshold 3.0 and above was captured as satisfied with water service, while the mean threshold less than 3.0 was captured as not satisfied. Thus, the result shows that the water users are not satisfied with length of time water supplies are available every week, water quality, their involvement in local water management decisions, and water price. The clustermean of 2.098 is an indication that the water users are generally not satisfied with water supply in Anambra state.

4.3 Key Challenges to Attaining Sustainable Supply of Water and Management

The key challenge to attaining sustainable water supply management is presented in table 3.2 of chapter two above. Some key challenges were: policy enforcement, inadequate training on water use/management, adverse effect of water abstraction, adverse effect on natural environment, and natural environment deterioration were discussed below.

- **Awareness of water issues in Anambra state**: majority (95.8%) of the farmers reported to be aware of water issues in Anambra state, while the remaining 4.2% reported that they are not aware of water issues in the state.

This high number of awareness is an indication that water problem is almost a state wide problem in times of water availability.

- **Extent of awareness of water issues in Anambra State**: in order to ascertain the strength and level of farmers' awareness on water issues in Anambra state, the researcher subjected the 95.8% of the farmers that were aware of water issues in the state to 5-point Likert scale to determine the mean threshold. This was later interpreted as greater than or equal to 3.0 as aware and less than 3.0 as not aware. Based on the four (4) items of awareness on water issues in Anambra state, 3 were mean threshold of 3.0, while 1 was below the mean threshold of 3.0. thus, 95.8% of the farmers were aware of Increasing number of farm water demand, Groundwater scarcity due to excessive pumping and Increasing number of well. The cluster mean of 3.06 is an indication that the 95.8% of the farmers were aware of the water issues in the study area.
- **Source of awareness of water issues in Anambra state**: Agricultural water users were allowed more than one selection, majority (81.0%) of the users became aware of water issues in Anambra State through radio, while the remaining 52.4%, 42.9%, and 19% of the users became aware of the water issues in Anambra State through television, friends & family, and newspaper respectively.
- **Adequate enforcement of water policy**: 100.0% of the water users considers it that the policy on water/irrigation is not adequately enforced in Anambra State.
- **Training on water use/management**: The importance of training of water use and management cannot be overemphasized. Thus, the study discovered that majority (76.2%) of the farmers assert that they have not had enough training on water use & management, 14.3% strongly admit they have not had enough training on water use & management, while the remaining 9.5% assert that they barely have had enough training on water use & management.
- **Adverse Effect of Water Abstraction in Anambra State:** Natural environment means living organisms and non-living ones in nature. Often, the term "natural environment" only means nature on Earth. And, theadverse effect on natural environment by water abstraction shows that majority (95.2%) of the farmers think that natural environment in Anambra State has been adversely affected by water abstraction, while the remaining 4.8% thinks that natural environment in Anambra State is not adversely affected by water abstraction in the study area.

Rating of the amount of Environmental Damage caused by water abstraction in Anambra State

A mean threshold of 5-point Likert scale was used to capture the famers rating on damages done to the natural environment due to water abstraction, this was later interpreted as greater than or equal to 3.0 as deteriorated and less than 3.0 as not deteriorated. Based on the three source of natural environment damages caused, 3

were the mean threshold of 3.0. Thus, natural environment has been damaged by Municipal, Private householder, and Farms. The cluster mean of 3.21 shows that natural environment is deteriorating in the area.

Findings made on the Awareness of problem associated with water sustainability in Anambra state shows that majority (81.0%) of the respondents are aware of problems associated with water sustainability issues in Anambra State, while the remaining 19.0% said they are not aware of problems associated with water sustainability issues in Anambra State. Furthermore, rating of level of awareness of water problem showed that majority (57.1%) of the users accepted that they are aware of problems associated with water sustainability issues, 23.8% are somewhat aware, 14.3% of the water users are extremely aware of problems associated with water sustainability issues in Anambra state, while the remaining 4.8% are not aware of water sustainability issue in Anambra state. This means that a good number of the respondent are aware of the problems associated with water sustainability in the area. Though awareness campaign should be intensified in the area to make the domestic users aware of water issues when it arises.

Rating of the major cause of deterioration of natural environment in Anambra State

The researcher used mean threshold of 5-point Likert scale to capture and weight the water user's response on the level of environmental deterioration in Anambra state. The mean threshold of 3.0 and above was later captured as deteriorated, while the mean threshold less than 3.0 was captured as not deteriorated. The findings made indicated that natural environment in the state were deteriorated by municipal, farms, private householders and groups. The cluster mean of 3.24 indicates that the natural environment in Anambra state is deteriorated. For the triangulation of the research, the water engineers/consultant were asked to indicate the challenges they face in their years of work experience in Anambra state. For the question on; in your years as contractor/consultant which area of the state do you find most difficult to find water. The findings reflected that majority (50.0%) of the contractors/consultants assert that Ayamelum local government area in Anambra state proved more difficulty to find water, while the remaining 33.3% and 16.7% believes Awka South and Awka North local government area proved more difficult to get water respectively. For the question on; what is your opinion on the major problem regarding the sustainability of water resources? Multiple responses were recorded, the findings made indicated that majority (83.3%) of the consultants/contractors think~~s~~ that the major problem of sustainability of water resources in Anambra state was poor maintenance culture of the people, while the remaining 16.7% thinks negligence is the major problem sustainability of water resources. Furthermore, the water users were allowed to record multiple responses on the major cause of deterioration of natural environment in Anambra State, and finding made showed that majority (61.9%) of the water user assert that the major causes of deterioration of natural environment in Anambra state is waste water

pollution, while the remaining 23.8%, 19.0%, 9.5% and 4.8% said the major causes of environmental deterioration in the state are global warming, water abstraction, industrial pollution and domestic waste disposal respectively.

Investigation of the Institutional, Technological, Environmental and Financial Issues affecting the Sustainable System of Water Supply

Information on the institutional, technological, environmental and financial issues affecting the sustainable system of water supply is discussed as shown below.

Institutional Issues affecting the Sustainable System of Water Supply Maintenance issues

The domestic & industrial water user's response were allowed to select more than one problem which they are aware. Finding shows that majority (81.0%) of them identified institutional problem of maintenance issue, 52.4% assert that the government lack the will to enforce policy on water use, 33.3% said it is poor policy implementation, while the remaining 14.3% said that lack of continuity in government is an institutional issue. More so, majority (66.7%) of the domestic and industrial water users assert that breakdown and abandonment of facilities informed their level of dissatisfaction, while the remaining 33.3% said water services is totally not working in Anambra state. Also, 100.0% of the contractors/consultants assert that Anambra state government is not putting in enough effort to tackle the issues of water sustainability in the state.

Technological Issues affecting the Sustainable System of Water Supply Irrigation technique used

The finding made showed that majority (76.2%) of the farmers uses traditional flooding system, while the remaining 19.0% and 4.8% uses both traditional and modern system respectively. Dependence on traditional irrigation system will be more laborious and may not supply enough water as demanded. Furthermore, finding showed that majority (90.5%) of the water users preference was informed by inadequate electric power supply for the motorized borehole, while the remaining 71.4%, 71.4%, 61.9%, 61.9%, 47.6%, and 38.1% of the users were informed by Spare part not readily available, Poor maintenance culture, Borehole is expensive to construct especially in areas where the depth of water is far, solar powered borehole is expensive to maintain/manage, theft and vandalization of submersible pumps and theft/vandalization of solar panel respectively were major challenges.

Social Issues affecting the Sustainable System of Water Supply Awareness on borehole water breakdown and vandalization issues

Majority (90.5%) of water users are aware of borehole water breakdown and vandalization issues in Anambra state, while the remaining 9.5% said they are not aware of borehole water breakdown and vandalization issues in Anambra State. More so, findings made on the rating of old private water wells usage for sewage or

latrines disposal or wastewater disposal showed that majority (42.9%) of the water users opined that use of old private water wells for sewage or latrines disposal or wastewater disposal is not acceptable, while the remaining 38.1% and 19.0% said the use of old private water wells for sewage or latrines disposal or wastewater disposal is strongly not acceptable and somewhat acceptable respectively.

Environmental Issues affecting the Sustainable System of Water Supply Ranking reuse of water

Finding showeds that majority (76.2%) of the water users strongly did not accept reuses of water in Anambra state, while the remaining 14.3% and 9.5% assert that reuse of water in Anambra state is not acceptable and somewhat acceptable respectively. Findings made on water contamination problems from sewage showed that majority (66.7%) of the water users are not aware of water contamination problems from sewage within their property in Anambra state, while the remaining 33.3% of the water users are aware of water contamination problems from sewage within property in Anambra state. And, majority (51.1%) of the water users abandon well and build new one when contamination problem happens, while the remaining 42.9% of the water users do nothing when water contamination problem happens in Anambra state. Furthermore, majority (76.2%) of the water users assert that the utilization of sewage for agricultural crop irrigation in Anambra State is not a priority, while the remaining 19.0% and 4.8% attributed it to ignorance of concept to use sewage as a fertilizer and treatment not important respectively.

Financial Issues affecting the Sustainable System of Water Supply Metering of water from your well

The researcher found out that 100.0% of the respondents refused to accept the metering of water from their well in Anambra State. 66.7% of the study representatives assert that their refusal to accept metering of water from their well was attributed to cost, while the remaining 23.8% and 9.5% attributed it to ownership of many wells and large farm size respectively.

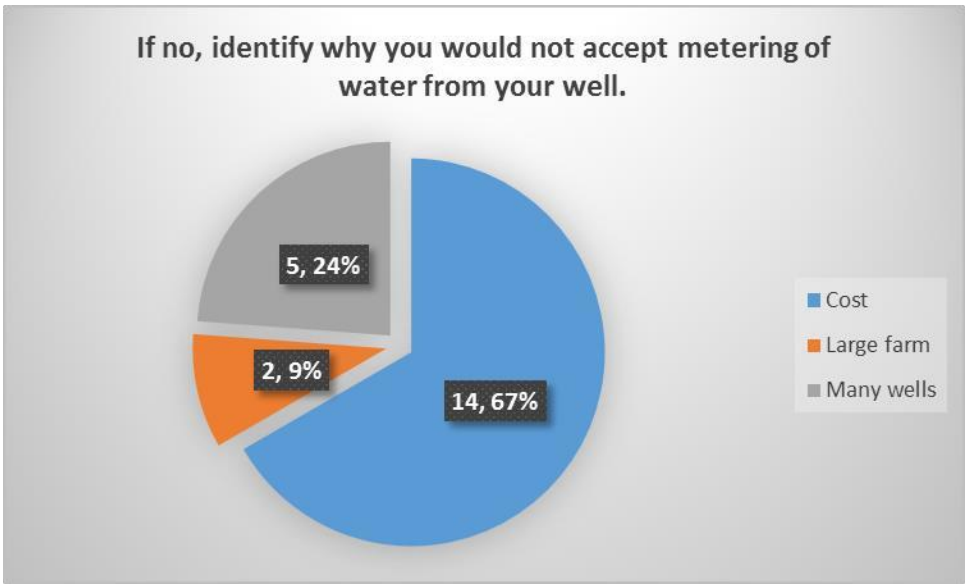


Figure 3.5: Reasons not to accept the metering of water from well

Furthermore, the mature house-wife response on the usage of recycled water indicateds that 100.0% of the house-wives/women rejected the re-cycling of water for domestic usages in Anambra state. Recycling water for use attracts a cost. Thus, the water users are not ready to pay for the cost of recycling water.

Conclusion

This research has found out through examination of documents and journals that Anambra has surplus surface and ground water for its needs yet, it cannot boast of providing water for various domestic, industrial, and agricultural needs. It is then deducted that it is management challenges like technical, operation and maintenance, financial among others that has hindered its goals to achieve sustainably in water supplies. It may be necessary to opt for either mega surface water projects or groundwater programs for urban towns, small towns and rural water projects or a joint surface and ground water programs to achieve sustainable water supply.

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