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Sustainable Water Supply Practices in Housing Estates in Umuahia Abia State, Nigeria: A Case Study of Agbama World Bank Housing Estate, Umuahia

[1]Alozie, G. C., [2]Eze, M. U. & [3]Nnsewo, I. I.

[1]Department of Architecture, Abia State University, Uturu
[2]Department of Estate Management, Abia State University, Uturu
[3]Department of Architecture, University of Uyo, Akwa Ibom State

Abstract

Agbama housing estate is under World Bank housing project in Umuahia Abia State due to increasing population. Water supply in every estate in the state remains a challenge because governments have failed to do so. The paper studied water supply and management practices and how to imbibe sustainability, using Agbama housing estate as case study. Four out of six areas (1,2,4,6) were selected through balloting, four hundred questionnaires representing 10% of the population of the areas were administered and retrieved on spot. Respondents views on water supply, management and sustainability were sort, and interviews held with leaders of the areas, to clear doubts arising from respondents, this became the primary data. Secondary data came from review of related literature. Data was analyzed using descriptive statistics, result showed that 98% approved borehole as the primary means of water supply and expressed their satisfaction with it. Homes with no boreholes, buy from retail source and do not waste water, and have developed sustainable tendency of reusing their waste. Majority of the respondents rejected the idea of sustainable water supply if it involved recycling or reuse, due to safety reasons. The study recommended that government, private sector and NGO's be involved in water supply and management, that enlightenment on water recycling be done to educate the people, and that boreholes be limited to four to six in each zone, and that the management trusted o water committee., This will reduce cost and pressure on geology of the area. The study concluded that to realize sustainable water supply and management in residential estates in Abia State, collective collaboration of state, private sector and NGO's is needed, THE study requested that architects and other professionals in the built environment, are consulted at the design stage of future estates.

Keywords: *Sustainability, Water supply, Housing estates,*

Corresponding Author: Alozie, G. C.

Background to the Study

A resource is anything that has value and is needed by man; water is seen to be a major element of man's living environment and a resource whose value ranks next to the air. Water is of utmost importance to life (chima 2018). An average human being can last for three (3) months without food, but nobody can last for 72 hours without water as over 70% of our body is water (Chima, 2018)

Today more than a billion poor people in the world lack access to edible water, more than 12 million of the population mostly from developing nations dies annually from consuming contaminated water. More than a billion contact water related diseases due to inadequate water usage. (Allan, Danvila and Hofmann 2006). Among the problems facing us today especially in Africa and other developing Nations is the impact of urbanization to the availability of such natural resource. Fresh water is one of such resources (Alabi Oyalowo and Oke, 2014).

The notion of sustainability is a global phenomenon, which like renaissance is poised towards solving problems of nature. The development of sustainable water resource management would entail the engagement of environmental friendly means for water supply improvement and distribution (Alabi *et al.*, 2014).

Ademiloye and Odugbesan (2008), expressed their views that the sustainable options for water supply does not lie in increasing water supply by constructing new dams and conveyance system, sinking new boreholes, constructing desalination plants, but that the solution must be found at use and the pipe, that is improving water use productivity, reducing conveyance loses, reducing water and optimization allocation.

Alabi *et al., (*2014), is of the opinion that for residential estates to contribute to city sustainability if social infrastructure, such as educational and health care facilities and physical infrastructure including water supply, sanitation, drainage, urban roads and solid waste disposal. In public residential estates like government agencies are expected to be responsible for the capital investment of water purification and distribution (Chogail, 1999).

Agbama housing estate is a typical case: The aim of this paper is to add further value to the existing knowledge on how to integrate sustainability to urban infrastructure. It is an assessment of the sustainable water supply method in Agbama housing estate, Abia State.

The study hinged its purpose on the theory of ecological citizenship, in similarity to Alabi et al., (2014) with objectives to examine problems with familiar methods of water supply in the state's housing estates, using Agbama housing estate as case study. It also examined existing methods of sustainable water supply and management in order to determine if the method is socially environmentally and economically sustainable. In pursuit of answers to doubts raised in the study, it became necessary to review literature in the area.

Literature Review

Properties of Water

Water is a transparent, tasteless, odorless and nearly colorless substance, which is the main constituent of Earth's streams, lakes and oceans, and fluids of most living organisms. It is vital for all known forms of life even though it provides no calories or organic nutrient. Water has some characteristics which are specifically unique to it. The main properties of water are as follows: (Chima, 2018).

Water is a universal solvent, because of its ability to dissolve many substances. This allows water to be the solvent of life. Water dissolves more materials than any other liquid – even the strongest of acid. This of course, has some implications for many other things especially in terms of quality of water. Due to water being a very good solvent, it is rarely pure and some of the properties of impure water can vary from those of the pure substance. Water is also described as a chemically inert solvent. This is because water dissolves materials and does not combine with them. Water is a renewable resource. You can distill water and condense it back.

Water is cohesive. It can stick to itself. It can be poured. It can flow/channeled along/through the pipes maintaining itself, while reviewing the polarity nature of water molecures, states that water is cohesive. This is otherwise known as water attraction to other water molecules. Water polarity lends it to be attracted to other water molecules. The hydrogen bonds in water hold other water molecules together, and this brings about surface tension and the liquid's moderate temperature. Water is adhesive. Water adheres to any molecule it can form hydrogen bonds with. It sticks to the surroundings of its container. Due to water's adhesiveness, it allows for capillary action to make place. This enables plants to absorb water.

Water acts as a heat store. It stores heat. This is the principle of radiator in car engines. It can be used to cool down objects and it can also be used to heat up materials. The concept of land and sea breeze is also based on this principle. During the day, land and sea warm during the early hours of the day. Water has its boiling and freezing points within atmospheric range. Water can be condensed, frozen, vaporized within the atmosphere. Its boiling and freezing points are not too extreme. The boiling point of water is 100oC while its freezing point is 0oc. Both the boiling and freezing points of water are within the normal atmospheric range, water expands when frozen (Chima, 2018).

Water as a Resource

A resource is anything that has value and it is needed by man. Water is seen to be a major element of man's living environment and a resource whose value ranks next to air. Water is of outmost importance to life. An average human being can last for (three) months without food, nobody can last for about 72hours without water. Over 70% of our body is water, it is said to be the vehicle of water supply (Hinrichsen, 1990, Chima, 2018).

Supply and Use of Water Resources

Water use varies considerably around the world depending on availability of water and degree of industrialization. It has been estimated that withdrawals from freshwater sources have

increased tenfold this century and tripled since 1950. In the United Kingdom, for example, water use has increased by 70 percent in thirty years, largely due to such things as dishwashers, washing machines, car washes, garden sprinkles, and industrial processes (Pearce, 1992) Globally, it is estimated that approximately 3,500 km3 of water are now withdrawn annually for human use. Of the total, some 2,100km3 is for consumptive use. The remainder is returned to the surface and groundwater systems, more often than not in a polluted state (Hammond, 1990). Generally, water use can be classified into four broad categories: Domestic use, Agricultural use, Industrial use, and In-stream use. It is important to remember that some uses of water are consumptive, while others are non-consumptive.

Domestic use of Water

Some of the most important uses for water are in our homes. Domestic water use is water used for indoor and outdoor household purposes – all the things you do at home: Drinking, preparing food, bathing, washing clothes and dishes, brushing your teeth, washing the pet animals (USGS, 2015). After the United Nation's Water Supply and Sanitation Decade (1981-2000), major increases are taking place, especially in the developing countries. World-wide, domestic and municipal uses account for about 7 percent of all water withdrawals, but in the developed world the figures are in the 13-16 percent range (Crabb, 2002, USGS, 2015). The quantities involved increase with rising living standards, from around 201itres per capita per day to over 500 (USGS, 2015). Two-thirds of the world's population mainly in Asia and Africa, use less than 50 litres per capita per day (Chima, 1995, Crabb, 2002; USGS, 2015).

Although domestic use of water is a relatively small component of the total water-use picture, urban growth has created problems in the development, transportation, and maintenance of quality water supplies. In regions experiencing rapid population growth, such as Africa and Asia, domestic use is expected to increase sharply (Chima, 2018).

Agricultural use of Water

The use of water for agriculture has changed the production of crops dramatically in the 20lh century. Water use is dominated by irrigation, globally and on a continental basis. Long established in virtually every country, it is an extremely water intensive activity. Though accounting for a declining proportion of total withdrawals, the quantities are increasing, especially in the developing countries of Asia, Africa and Latin America. Agricultural use of water accounts for nearly 70 percent of the water use throughout the world, and the majority of this water is used for irrigation. (Chima, 2018).

Methods of Providing Water Supply

All through the ages, man has tried to provide water for his use, domestic, agricultural and/or industrial purposes. In seeking for water, man has gone through the processes of water fetching, rainwater harvesting, hand dug wells, borehole drilling, dam construction and desalination. These kinds of water supply range from the simplest individual or collective systems based on rivers or wells, to large and sophisticated ones providing water to large number of users for all kinds of purposes. The former meets no more than the basic needs of countless people in developing countries, though often with a very low degree of reliability in

terms of quantity and quality. The later provide a high quality and reliable water supply for most of the populations of the developed world, especially those living in the urban areas. These various methods of providing water for domestic and other activities include;

Water Fetching

Man in the primitive, early civilization era and even now in developing and under developed nations, access water through fetching from surface water bodies. Water fetching involves going back and forth to bring water from a water source to a desired destination of the individual in the fetching. According to Davis and Pickering (2012), currently, more than two-thirds of the population of Africa must leave their home to fetch water for drinking and domestic use. Although, fetching water in the modem era does not literally mean getting water from surface water body, it only talks about going out of your home with a container to get water from where it is available. Back in the early days, when surface water bodies were the only source of water for use, settlements were located near surface water bodies such as streams, rivers, lakes and springs and the inhabitants in their communal settlements go to these water bodies to fetch water to their homes for the household use.

Rainwater Harvesting

Rainwater harvesting is the process of collection of rainwater from surfaces on which rain falls, filtering it and storing it for multiple uses. Rain water harvesting is an ancient practice that is becoming more important than ever before. Rainwater can be collected from roofs and in many cases the water collected is redirected to a deep pit such as well, shaft, or underground storage tanks. Rainwater harvesting is one of the simplest and oldest methods of self-supply of water for households usually financed by the user. Rainwater harvesting has many advantages which include; providing an independent water supply during periods when the public water works do not supply water, as a result or system breakdown or power failure, and in most developing countries to supplement the main supply. Rainwater harvesting can help mitigate flooding of low-lying areas, and it reduces demand on wells which may enable groundwater levels to be sustained. Many countries especially those with an arid environment use rainwater harvesting as a cheap and reliable source of clean water and for irrigation (Chima, 2018).

Hand dug Wells

Hand dug wells and other manual methods to dig a well have been in existence for thousands of years. Though mechanized methods arc more efficient and effective, there are often no options for people and communities in need of water. According to Proby (2015), digging a well by hand, using simple tools like a pick and shovel, with a bucket on a rope to remove cuttings, is the oldest and probably the most frequently -used method of getting access to groundwater. Advantages of hand digging of wells include; that it requires only common tools and skills, so it can be done by anyone. In many areas men have specialized in this as a business. Where labour costs are low, this is usually the least costly method of well construction. In an aquifer with low permeability, a large diameter hand dug well may produce more water than a borehole in the same aquifer. In areas where the surface water is not easily accessible or polluted and the water table is high, the hand dug well becomes most sort after to provide the most needed water for use in low income households and

neighborhoods. Hand dug wells are usually constructed during dry season when the water level is at its lowest, both for safety and to determine the necessary depth of the dug wells to obtain adequate water supply (Chima, 2018).

Borehole Drilling

A water borehole is a specially engineered hole in the ground, making provision for water to flow into this hole and allowing for a pump to be installed inside the hole to other abstraction of water (Aqua Earth, 2010). It can also be described as a narrow shaft bored in the ground, either vertically or horizontally. Typically, a borehole used as a water well is completed by installing a vertical pipe (casing) and well screen to keep the borehole from caving. This also helps to prevent surface contaminations from entering the borehole and protects any installed pump from drawing in sand and sediment. Water borehole drilling are typically created using either top-head rotary style, table rotary, or cable tool drilling machines, all of which use drilling stems that are turned to create a cutting action in the formation (Chima, 2018).

The purpose of water borehole is to access groundwater in the underground aquifers. The water borehole is drawn by a pump. Water borehole can get water from a much deeper level than hand dug wells, and are powered by electric pumps. Groundwater access by water borehole has many benefits over surface water to human beings. It is usually cheap to develop and it is generally of good quality and of widespread occurrence. Being stored underground where evaporation is minimized, it is a more reliable source than surface water in times of drought (Chima, 2018).

Water Supply: Sustainability and Ecological Citizenship

While writers such as Merlo-Escihuela (2008), use the terms environmental citizenship' and 'ecological citizenship' synonymously; Dobson (2000) provides a major difference between the two: environmental citizenship focuses on the rights of the people in promoting sustainability (by an outline of the responsibility of external agencies such as government for instance); while eco-logical citizenship focuses on one directional duty of citizenship; that is the responsibility of citizens that occur without expectation of mutual benefits from the state. Dobson identifies the virtues of ecological citizenship as justice, care, compassion and taking responsibility for the vulnerable. It might be possible to ask what mechanism could best be suited for water supply: the government, the community or the private sector. Responses would show residents' alignment with the ecological citizenship theory; and hence their readiness to accept possible changes in government's policy with respect to (billed) private sector participation in water supply. It might also be possible to ask how residents perceive different methods of sustainable water supply. This would be useful to determine the broad strategy for intervention areas in water supply by government agencies.

The overall concern of this paper is on the incorporation of the principles of sustainable development in everyday life. In this study, sustainability will refer to the ability of a system to operate in such a way as to ensure that the negative externalities of human activities are minimized to the barest levels, in order to ensure that the further generations have access to the crucial productive capital needed for their own all-round development (Oyalowo & Alade,

2013). It is generally accepted that the dimensions of sustainability can be categorized basically into environmental, social and economic dimensions. Studies such as Bond, Mortimer and Cherry (1998), Dooris (1999), Kelly and Moles (2002), Oyalowo (2009), Oyalowo & Alade (2013) and UNCHS (1999) all offer detailed analysis into the definitions and operationalization of these dimensions. Oyalowo (2009), categorizes the sectorial fix of urban settlement sustainability to encompass the environment (Ecology, physical form, Services and infrastructure), Social (Social Justice) and Economic Activities (Access to employment and Basic Services). Water resources management could be seen to encompass these three dimensions. Thus, the adoption of the concept of sustainability as the basic framework for this study enable an analysis of the process of water supply, access and management as governmental responsibility, or as a private sector driven enterprise. It would also enable a discussion of the role and responsibilities of the community in ensuring inter-generational equity in water service provision.

Water Supply, Management and Production

A number of studies have examined the issue of sustainable water resources from the perspective of management effectiveness. For instance, Gbadegesin and Olorunfemi (2009) carried out a review of the Nigerian national policy framework for water resource management and emphasized the need for a change from a supply management approach to a demand management approach, which has the advantage of focusing on end-users and so bring more people centered. Ademiluyi and Odugebsan (2008) argued that community action in water supply production and maintenance rarely works without government presence and/or NGO support.

The authors promote the notion of all stakeholders' ownership of water projects to ensure sustainability. Durham et al (2002) present the implementation of this notion in their account of an Integrated Water Resource Management (IWRM) project in Kwa Zulu-Natal region of South Africa. The project involved the participation of the government (providing legislation and regulation), NGOs (specializing in community liaison and education) and a private water provider which supplied water and financed the project. The paper presents the IWRM system as one that could also be economically beneficial to communities. Nwakwoala (2011) advocates the principles of a single community borehole to replace the system of a borehole per household. He advocated for the utilization of boreholes as sources of drinking water only, while household sourced for water for other domestic use elsewhere. He also advocated for the payment of water charges for water sourced from the borehole as a means for preventing wastage.

In terms of access, Budds and McGranahan (2003) argued that water privatization would not necessarily means access to water by low-income people, because privately operated utilities are not well suited to serving the low-income majority households in developing countries. They argued for the reformation of public water utilities as a means of increasing access, while also arguing for an expanded role of local community networks in water provision and management. Orubu (2006), examines water resources availability and access in Nigeria in the context of environmental sustainability and thereafter suggests the adoption of a policy framework for water management, environmental sustainability and development.

While these studies highlight issues of management, access and water supply in various settings around the country, they are not empirical studies. Apart from Nwankwoala (2011), the studies have also not examined sustainable water supply alternatives that could be utilized by communities outside government intervention. However, the studies all stressed the need for more local community involvement and improved public supply. Implicit in the literature has been a consideration of the role of the private sector and the government in water provision. This consideration is founded on underlying definition of water as either a public good to be supplied at social costs by the government for all citizen or as an economic good to be supplied by a profit-making private sector entity at an economic cost. This raises interesting issues.

Where water is regarded as a nature-given resource; it is seen as a social good wherein little economic cost is to be paid to access it. Similarly, where water is perceived as a semi-public good and access cannot be limited to few paying customers; provision could be through municipal provision; and access determined by ability to pay to the metered service.

It can be argued that in the context of achieving sustainable water supply and access; the question of whether water is an economic or public good is to be given lesser emphasis. The issue confronting stakeholders is how to support group and individual effort as they accept their responsibility, the adoption of sustainable water supply practices on the one hand. On the other hand, is the issue of ensuring that water abstraction (by community, government or the private sector); management and distribution is done without causing economic hardship to users and damage to the environment as to endanger the continued abstraction from the source.

Environmental and Social Issues in Conventional Sources of Water Supply

Increasing water demands associated with rapid urban development and expansion of irrigated land have led to overexploitation of both surface and groundwater resources (Changming et al., 2001).

For instance, ground water supplies have been used faster than they can be replenished by natural means. It would appear that anyone who can afford drilling costs simply goes ahead to tap groundwater sources without recourse to geophysical tests or obtaining necessary permits from regulatory bodies, moreover households in various communities can obtain water from shallow underground sources with the help of locals with good knowledge of aquifers and small contractors who can dig wells or drill shallow boreholes (Allen et al., 2006). The over abstraction by and over concentration of wells and boreholes in relatively short geographical ranges has occurred in many parts of Nigeria, and the consequence of this is numerous. There is danger of reducing base flows to rivers, (Orubu, 2006) thereby reducing future water volumes. Changming et al. (2001) report groundwater depletion in the North China Plain (NCP) region of China; as well as development to cones of depression in various areas; has profoundly affected the environment; all as a result of intense groundwater abstraction.

In addition, seawater was also reported to have intruded into previously freshwater aquifer in coastal plains, and groundwater quality has deteriorated due to salinization and untreated urban and industrial wastewater discharge. Notably, depletion rates were generally noted to be greatest in areas beneath cities. Further, Durham et al. (2002) notes that over abstraction of groundwater results in rising salinity of the produced water due to aline ingress. Allen et al. (2006) also pointed out that, as has occurred in Cairo, underground sources may also become contaminated through leaks from nearby sewerage or septic tanks nereby (Allen et al. 2006). As a result of these problems, there is a need to adapt more sustainable options in water supply systems.

Sustainable Water Supply Systems

Rain water harvesting, in-situ and community water recycling have been identified as conventional methods of water supply system. Rain water harvesting can be utilized to recharge the local groundwater aquifer by directing the rainwater into natural systems such as swales and bio retention structures that have the capacity to reduce the velocity of the water and infiltrating the water into the ground (Daigger, 2011).

As far as domestic use is concerned, the system for harvesting rainwater is relatively easy and cheap to construct. It involves the utilization of rainwater-harvesting system such as gutters running along roof-eaves to collect rainwater and thereafter directing the water to covered reservoir for later use. Untreated harvested water from the reservoir could serve sanitary needs for toilet flushing for instance, as well as for laundry, gardening and car washing. Rainwater can also be treated with local methods such as filtration and chlorination to make it potable. Household harvest systems are appropriate in areas with an average rainfall greater than 200 mm (7.9in) per year, and could be used in any region of the country.

In an estate setting, individual homes can easily install harvesting systems with no running cost although they would be responsible for ensuring that roof gutters are cleaned out regularly to prevent the accumulation of waste arising from bird faeces for instance. It would be the duty of government to ensure, through building standards and bye-laws; that unsustainable building materials such as asbestors are phased out in the building construction process. The appropriate government agency could also carryout geographical rain tests to determine the possible existence of chemicals such as mercury in rainwater, this is especially necessary in urban areas or residential areas include proximity to industrial areas. Importantly too, rain water harvesting can be utilized as an alternative water supply system to be utilized in periods of downtime in local piped supply.

From China to North-East Brazil, Senegal and Guinea-Bissau and the United Kingdom, the practice of rain water harvesting has gained prominence and has also received legislative backing in Bermuda and The U.S. Virgin Islands water recycling is also another alternative that would alleviate water scarcity in urban areas as a whole and in residential estates in particular. Water recycling has become necessary as there are few new sources of urban water supply that can be developed in a cost effective manner. It can be carried out in two ways. The 'in-situ' water recycling is household based, and allows the recycling of water from baths and sinks for other

uses such as toilet flushing, after some home based treatment. This can be achieved with adaptive changes to the plumbing system in each household unit.

On an estate community or municipal scale, water that has been supplied to households can be captured as waste water through sewage networks to higher potable standards and resent through the water distribution networks for agricultural, industrial and commercial purposes (Biswas, 2006). This method requires considerable financial and technical input in the design of channels for passing off of waste water, management of treatment facility and distribution. However, as the method is adopted on a wide scale; it might be possible for a tradeoff to be made that would be economically beneficial to the stakeholders. This might be in the form of charges being laid on the treated water distributed to nearby industrial areas from residential areas; with such funds being committed to community projects. The treatment of waste water, allocation of purchase price of the treated water to the industrial and commercial sectors can be done by a private sector investor; or the water authority.

Methodology

Agbama housing estate, is in Umuahia South Local Government Area of Abia State, Nigeria. It is one of the fastest developing estates in the state, supported by World Bank. The estate comprises of Six blocks known areas One to Six (1-6). Each area has two hundred (200) units. There is no prototype building design, rather residential building not exceeding three storeys of four floors are approved, hence bungalows, duplexes and blocks of flats for tenants, make up the built area. There are a few plots that have been converted to other uses, such as churches, schools and mini factories, however the estate is predominately residential (Alozie, odim and Alozie 2016).

Data Collection and Analysis

The study was conducted in the summer of 2017-2018 between November and March. This was so in order to limit the incidence rain as a means of water supply, affecting respondents. Four areas namely 1,2,4 and 6 were selected for study by balloting, and four hundred questionnaires, which formed 10% of the population of the four areas under study were distributed by trained research personnel, and retired on spot.

Semi-closed questionnaires were utilized and inquired about water supply and management methods. It also asked questions on problems associated with existing sources of water supply. Interviews were held with leaders of the four (4) areas under study. This became necessary to clear queries arising from respondents. Data was analyzed with descriptive statistics and presented in tabular format as primary data. Relevant literatures were reviewed as secondary data. In similar manner as Alabi et al., (2014); a pilot survey became necessary to enable in the restructuring of some of the questions, particularly those involving sustainability to become open ended. This removed bias and incidence of leading questions, while increasing objectivity of the research.

Questions were considerably easy to enhance respondents understanding. The pilot study involved one of the six blocks in the estate. Forty (40) respondents were selected, and as

observed by Alabi et al (2014) enabled in the restructuring of the questions for the study. The small sample size of the pilot study implies it is an exploratory study, and as rightly noted by Alabi et al (2014), exploring studies chart the course for future with ranging studies.

In the first part of the questionnaire, questions on respondents data were obtained table 1.There were more female respondents than male. 62% female, 48% male. The basic academic criteria was secondary school certificate. Only respondents who have lived for at least three years in the area were allowed to participate. Family size ranged between four and six (4-6). The study revealed a fairly educated society, and involved people living together as family, the population of the area under study has 16% retired citizens 38% active adults and 52% children.

Water Supply in the Estate

The estate has been existing for twenty years (1999-2019), interviews with the executive members of the residents association revealed that, when people moved into the estate, the only social infrastructure in place were roads and electricity. Water supply in the estate on take off was a great challenge, as there was no provision of any form of water supply but rainfall which was periodic, unreliable and difficult to harvest, and not safe for consumption, unless treated. A difficult situation. There was no streams, or rivers, the only source available after rainfall was water tankers, which provided water at exorbitant cost.. Most of the early water supply to the area was for construction. and storage f was plastic, and metal tanks or in underground tanks..

Boreholes gradually became dominant and today about Six hundred residences have boreholes as their major supply of waters. 100% of the residents depend on this for their daily water supply. Water is pumped to overhead plastic tanks and reticulated down.. Families or residences without boreholes purchase water from commercialized outlets at the rate of ten Naira (N10) per twenty (20) liters. Water tankers and rainfall still provide water to some households, Boreholes and accessibility determine the value of properties in the estate.

Water Management Practices

In residences where the landlord lives amongst the tenants, he manages the provision and distribution of water and sees to repairs. In most cases the water rate is factored into the house rent. In block of flats where the landlord does not reside, a caretaker is appointed to see to daily supply of water and repairs, and depending on tenancy agreement, the landlord or tenants finance repairs. In the situations where electricity fails, alternative energy is sourced. Most homemakers in buildings with boreholes, study revealed are wasteful with water, and do not have sustainable practices. This is because they do not have to pay for as their rent covered it. This not so among families that purchase water. Families that purchase water have learnt to reuse their waste, which is a sustainable approach.

Analysis of Finding

Personal Data of Respondents

Section 1 of the questionnaire was on information relating to the respondents. This is shown in Table 1.58% of the respondents has Secondary School Certificates, 34% has National Certificate of Education, Higher National Diploma, B.Sc/BA, and equivalent degrees. 8% has either second degree of Ph.D degrees. 10% of the sample populations are retired. 54% are Civil Servants, 26% traders and skilled labour, while 10% are unemployed.

The house hold size is averagely 4 – 6. The survey shows relatively educated and enlightened populations, who have lived in the estate for not less than three (3) years.

Table 1: Personal Data Respondents

Gender	**Frequency**	**Percentage**
Female	240	60
Male	160	40
Academic Qualification	**Frequency**	**Percentage**
WASC, GCE	232	58
NCE, OND, HND, B.Sc, BA	136	34
PGD, MA, M.Sc, B.ED, Ph.D	32	8
Employment Status	**Frequency**	**Percentage**
Civil Servants	216	54
Traders & skilled labour	104	26
Unemployed	40	10
Retired	40	10
Residency in the Estate	**Frequency**	**Percentage**
1-3yrs	68	17
4-6yrs	72	18
7-9yrs	98	24.5
Above 10 years	162	40.5
Household size	**Frequency**	**Percentage**
1-3	154	38.5
4-6	210	52.5
7-9	30	7.5
Above 10	6	1.5

Source: Fieldwork 2017/18

Sources of Water Supply and Management in the Estate

The estate was opened to development in 1998, but it was not until 1999 that the first group of developers started. Interview with the executive members of the four areas selected for study (1, 2, 4, 6) revealed that the only social infrastructure on ground when the estate opened was roads, and electricity however the roads were un-tarred and with no drainage system or refuse disposal plans. The estate is not served by any water bodies, streams, rivers or lakes, and the topography made it difficult for boreholes or wells to be sunk in the west hilly area.

The earliest forms of water supply in the estate, especially during the construction of buildings was, water vendorship by tankers, and rain during rainy seasons. Storage was and still remains in P.V.C. and galvanized iron tanks, which today are situated on steel stanchions, raised well above the building roof. Boreholes became fashionable and expensive then after. There are about six hundred boreholes in the estate presently and a total of four hundred and five (405) in the four areas (1, 2, 3 and 6) selected for this study. 100% of the residents in Agbama Housing Estate depend on borehole for their daily water needs.

The residences are classified into owner occupier and tenement block of flats. Only bungalows, and two to three storeys (4 floors) block of flats are permitted in the estate. The block of flats ranges from one room self-contained, two bedrooms, three bedrooms and four bedrooms' flats. In some cases, the landlord lives with the tenants in which case he takes responsibility for daily supply of water to his tenants and repairs of the borehole. The cost of water is factored into the annual rents. Boreholes have become almost a standard for apartments, to be rented. The landlord provides water and maintains the borehole.

Residences without borehole buy water from others with retail outlets, while buildings under construction and buildings in the west, where topography have inhibited the drilling of boreholes still buy from water tankers. Twenty (20) litres of water cost ten naira (₦10), while a tanker of 1000litres is sold for six thousand naira (₦6,000s) presently. 95% of the respondents are comfortable with this arrangement.

Study revealed that families residing in buildings with borehole are wasteful with water; this is because there is no means of determining the cost of water having already been factored into their rent, while families who purchase water, are more prudent, and have learned to preserve their waste water for other uses, such as flushing the toilet, washing of cars. When waste water is used in washing cars it reduces the quantity of fresh water used in cleaning it. This is good management, which preserves water. This technically is reusing of water.

Table 2: Sources and Adequacy of water supply

Current source of water supply	**Frequency**	**Percentage**
Borehole	244	61
Purchase from sale outlets	156	39
Adequate of water supply	**Frequency**	**Percentage**
Adequate	280	70
Not adequate	120	30

Source: Fieldwork 2017/18

Management of Water Supply System

Respondents were requested to indicate the type of water supply management operated in their estate; water management is personal; 75% in the hands of landlords or owners of such boreholes. 25% is managed by caretakers appointed by the landlords. The obligation to operate, repair and distribute water is in the hands of either the landlord or his caretaker.

However, respondents noted that overworking of the borehole, failures arising from poor maintenance impair the effective delivery of water. 75% complained that poor management, arising from the landlords or their caretakers and epileptic power supply defeat the purpose of regular water supply. Table 3 explains.

Table 3: Management of Water Supply System

Nature of the Borehole		
Is there arrangement for water management?	**Frequency**	**Percentage**
Yes	300	75
No	100	25
Challenges of Existing Wat er Management Arrangement	**Frequency**	**Percentage**
Overworking of the borehole	6	1.5
Constant collapse of borehole	8	2.0
Poor management of borehole	20	50
Poor power supply	168	42
All of the above	18	4.5

Source: Fieldwork 2017/2018

Information on Environmental Issues Arising with Numerous Borehole

Despite the fact that 72.3% of the homemakers who responded to the questionnaire accepted to be aware on possible environmental issues arising from the drilling of numerous boreholes close to each other, 25.7% believed that there is no danger passed by their distribution, while 2% claimed ignorance of such possible hazards. This result could have been so due to the level of literacy of the study population. 85% of the population is of the opinion that physical and social infrastructure such as water, electricity and roads should be the responsibilities of government. 5% believed that since the government is not responsive, individuals should take responsibilities of providing water. 5% preferred estate community participation, 3% NGOs while 2% preferred all being involved. The result signifies that water is still a very necessary public utility that should be made available by the government.

And open-ended question was used in determining the feeling of respondents to employing sustainable water supply systems. 90% approved of this. In order to probe further, specific questions were asked relating to the use of piped rainwater, recycled household water and community water re-use system, it is important to mention that at the description of these ideas, respondents perception on sustainable water supply and management system, considerably changed. Two themes were discernable, cost and safety (Portability). On the usage of piped rainwater 75% disagreed with it, even though it is cheaper; due to safety reasons. On recycled household waste-water 84% believed it was neither safe nor cheap. On community water re-use system, the response was low as the respondents believed it was not feasible due to factors that include sabotage, only 28% of the population approved of it, if only the government will be dedicated to meaningful development of such. This results are similar and in harmony with Alabi et al (2014).

Table 4: Awareness of Environmental Challenges of proximity of borehole to each other

	Frequency	Percentage
Yes	289	72.3
No	102	25.7
Ignorance	9	2.0

Table 5: How sustainable water provision could be achieved

	Frequency	Percentage
Estate community participation	20	5
NGOs	12	3
Government	340	85
Individual	20	5
All of the above	8	2

Table 6: Who should be responsible for water management?

	Frequency	Percentage
Estate community participation	20	5
NGOs	12	0
Individual	20	42
Government	340	58
All of the above	8	2%

Table 7: Would you use sustainable water supply methods?

	Frequency	Percentage
Yes	360	25
No	40	75

Table 8: What is your perception of the following? Pipe rainwater, which is rains into your house?

	Frequency	Percentage
Not safe, cheap, but I can't use it.	64	16
Not safe, not cheap, I can't use it.	336	84

Table 9: Recycled house water from kitchen, toilet and bathroom and distributed back to your house

	Frequency	Percentage
Not safe, cheap, but I can't use it.	336	84
Not safe, not cheap, I can't use it.	64	6

Table 10: Recycle community and treatment plant and redistributed back to homes

	Frequency	Percentage
Not safe, cheap but I can't use it.	288	72
Safe, cheap, I can use it.	112	28
Not safe, not cheap I can't use it.	0	0
Not safe, not cheap I can't use it.	0	0

Source: Fieldwork 2017/18

Discussion of Findings

As predicted in the literatures (Allen *et al.,* 2006, Chaming *et al.* 2001), ground water abstraction was the option adopted to satisfy water demand in the area; its installation was deemed affordable and water supplied often without treatment. Thus, boreholes were dug by individual residents. This resulted in the existence of several boreholes in the estate. Needless to say, the existence of multiple boreholes within the estate holds future risks in terms of the possibility of reduction in water aquifers and saline ingress. The possibility of ground water contamination due to close proximity of boreholes and waste-water soak-away pits is also a reality. Unfortunately, limited government presence in both water provision and regulation has ensured that residents can sink boreholes as the need arises and there is no regulatory disincentive to this. Nwakwoala, (2011) revealed that an alternative to individual boreholes is the central boreholes system that could serve the whole estate. This method can be adapted in future new estate development as another sustainable option in water supply.

With regards to management, the existence of individual participation in water supply has been borne out of necessity owing to lack of government supply failure to do so. The fact that residents were quite satisfied with the individual service provided. The strength of this effort proves right the assertion of Ademiloye and Odusgbesan (2008) that community action in water supply production and maintenance work without government's presence and NGO's support.

It was noted that amongst respondents, water was generally perceived as a public good to be provided by the government. If Dobson's principle of ecological citizenship is applied; this perception would have meant a low level of individuals' sense of responsibility in achieving sustainability. However, the self-help effort of estate landlords in the provision of these facilities aligns favourably with the modifications of ecological citizenship proposed by critics such as Dobson (2000) and Merio-Escihuela (2008). However, the perception of government as the principal provider of water supply also raises the question of payment for water in the estate. The study found that there is a limited private sector activity in this sector as only a few residences derived their water supply from vendors. This could be a negative indicator with tariffed water supply alternatives: will residents be willing to pay for any arrangement that requires continual financial payment? This area as rightly indicated by Alabi *et al;* (2016) requires further investigation.

However, as far as environmental and economic sustainability are concerned, there are mixed results. Although respondents claimed to be aware of the environmental impact of current practices, and also they claimed at the first instance to tolerate sustainable water alternatives; subsequent questions revealed that the two methods (rain water harvesting and in-situ household recycling) which are almost cost free in maintenance and whose safety can be controlled at the household level were rejected by respondents ad being either not safe or not cheap enough. In addition, as recommended in the literatures, there is enough scope to utilize some type of partnership in water supply. While residents believed that water should be supplied by the government, they also strongly though that the management of the installed supply system should be with the residents. This could be because of their prior experience in water supply management.

Survey revealed that due to lack of government presence in water supply, residents had resorted to ground water extraction by drilling boreholes to satisfy their water supply demand needs. In addition, there is low perception of the advantages of environmentally sustainable alternatives in water supply, even though there is a high perception of the consequences of current practices on the environment. The cost effectiveness of these alternatives is also not appreciated. However, individual have risen up to the challenge of providing water while government have failed. This is evident in the numerous boreholes drilled close to each other along all roads and streets in Agbama Housing Estate.

Finally, underlying this paper has been the question of the theories surrounding sustainability, what we need to know and how we need to use knowledge of sustainable water methods. It is doubtful that estate residents would welcome policy shift in the direction of private sector provision, as water supply is socially constructed as a public good: to be supplied by the government. This perception might hold future challenges in the event of government advocating through building standards and planning regulation for instance for individual sustainable water supply system. Added to this is the reality that residents have generally relied on individual effort to solve their water supply problems.

Conclusion and Recommendations

In Conclusion, the incorporation of sustainability in the water supply systems of residential estates requires the joint-working of all stakeholders. The knowledge systems surrounding the various actors (Estate community, households and individuals, Government and her agencies, the built environment professionals etc. need to be redefined, sustainably pursued, implemented and monitored at all times. Thus, the situation calls for extensive public enlightenment campaigns and is a challenge for built environment practitioners and academics. The design and construction of rain water collection system which can be treated internally and piped for further household use challenges the Architects and Builders professionals. Town planners are charged with enacting building regulations and bye-laws that promotes single water abstraction plants per estate of a designated size, with concurrent planning approval requirement before installation. Quantity Surveyors are charged with the costing of these facilities as an initial outlay and also the future running cost implication of such facilities. Real estate properties are asset which owners can rely on as hedge against

inflation and form the basis of wealth of most households. The value added to homes in residential communities as a result of adopting sustainable practices in water supply system needs to be ascertained and incorporated in valuations as the need arises. This is the challenge that estate surveyors and values have to address. The built environment professionals therefore stand in a particularly integrative role; utilizing well researched, comprehensive processes to deliver projects that are cost effective and resource efficient over their life cycle, while also consistent with community sustainable goals and objectives. Accordingly, this study calls for further study into how built estate professionals could promote through research and consultancy, sustainable alternatives in the design, planning, costing and management of residential estates. This study acknowledges and appreciates similarities to Alabi *et al* (2014).

Based on the results of the study, the following recommendations were proffered as measures that will enable sustainable supply of water in residential estates in Umuahia, Abia State and in most developing nations.

1. Individual boreholes should be discouraged and in its place community boreholes developed, for instance in Agbama Housing Estate, each of the major six (6) roads could have a borehole or two serving them instead of twenty to twenty four, sometimes more. This is costly, and exposes the area to geological possible revolution.
2. Government and NGO's should enlighten residents on the sustainable, economic, health and ecological gain of recycling water and group boreholes.
3. As obtainable in more developed societies, government should before declaring any estate ready for development, put in place basic physical infrastructures, like water, electricity, roads and liquefied gas lines.

References

Ademilaye, I. & Odugbesan, D. (2008). Sustainability and impact of community water supply and sanitation programmes in Nigeria: An overview. *African Journal of Agricultural Research, 3* (12), 811-817.

Alabi, A., Oyalowo, B. & Oke, M. (2014). Sustainable water supply methods for residential Estates in Lagos Metropolis proceedings of the GBW107 2014 International Conference Lagos Nigeria. 28th – 30th January, 2014.

Allen, A., Davila, J., & Hofmann, P. (2006). *Government of water and sanitation services for the Peri-urban poor: A framework for understanding and action in Metropolitan Regions*. London, England: The Development Planning Unit University College London.

Aqua-Earth (2010). *Borehole drilling*, www.aquaearth.co.za/…/boreholedrilling (5th may, 2017).

Biswas, A. (2006). Water Management for major urban centres. *Water Resources Development, 22* (2), 183-197.

Buds, J., & McGranahan, G. (2003). Are the debates on water privatization missing the point? Experiences from Africa, Asia and Latin America. *Environment and Urbanization, 15* (2) 87-116. DOI:10.1177/09564780301500222

Changming, L., Jingjie, Y., kendy, E. (2001). Groundwater exploitation and its impact on the environment in the North China Plain. *Water International, 26* (2), 265 – 272.

Chima G. N. (2018). *Water, water everywhere but not enough*. Abia State University Uturu 37th Inaugural Lecture Delivered On 18th April.

Chima, G. N. (1995). *Water supply in some rural communities if Imo state, Ni*geria. Unpublished Ph.D Dissertation, University of Nigeria, Nsukka.

Crabb, P. (2002). *Water; confronting the critical dilemma*. Companion Encyclopedia of Geography. London Routledge.

Daigger, G. (2011). Sustainable urban water and resource management. *The Bridge, 41* (1)

Dobson, A. (2000). Ecological citizenship: a disruptive influence? In Pierson, C. and Torney, S. (eds.) Politics at the edge. London: Macmillan. Pp.40 – 62.

Durham, B., Rinck-Pfeiffer, S., & Guendert, D. (2002). Integrated Water Resource Management through reuse and aquifer recharge. *Desalination, 152* (2002), 333 – 338.

Gbadegesin, S., & Olorunfemi, F. (2009). Changing trends in water policy formulation in Nigeria; Implications for sustainable water supply provision and Management. *Journal of Sustainable Development in Africa, 11* (4), 266-286.

Hammond, A. L. (ed) (1990). *World resources 1990-1991; a report by the world resources inst*itute. New York: Basic Books.

Hinrichsen, D. (ed) (1990). *World resources*. New York; Basc Books.

Kelly, R., & Moles, R (2002). The development of local agenda 21 in the mid-west region of Ireland: A case study in inter*active research and indicator development. Journal of Environmental Planning and Management, 45* (6), 889 – 912.

Merlo-Escihuela, C. (2008) Promoting ecological citizenship: Rights, duties and political agency *ACME 7* (2), 1130 – 134.

Nwankwoala, H. (2011). The role of communities in improved rural water supply systems in Nigeria: Management model and its implications for vision 20:2020. *Journal of Applied Technology in Environmental Sanitation, 1* (3) 295 – 302.

Orubu, C. (2006). Water resources, environment and sustainable development in Nigeria. *Journal of Human Ecology 19* (3), 169-181.

Oyalowo, B., (2009). New settlements in Nigeria: Planning for sustainability? *International Journal of Environmental, Cultural, Economic and Social Sustainability, 4* (6), 9-22.

Oyalowo, B, & Alade, W. (2013). A framework for sustainable land management in peri-urban areas of South West Nigeria*. International Journal of Social Sustainability in Economic, Social and Cultural Context. 8* (3) 15-30.

Pearce, F. (1992). *In hot water: Graphical magazine, 64* (4) 16-20.

Proby, F. (2015). Hand dug wells clean water for layman www.clean-water-for-layman.com/hand-dyg-well (3rd May, 2017).

Sullivan, C., Meigh, J., Giacomello, A., Fediw, T., Lawrence, P., Samad, M., Steyl, I. (2008). Water poverty index, *Natural Resources Forum, 27* (2008), 189 – 199.

UNCHS, (1999). *Resource conservation and waste management:. In the Earthscan Reader in Sustainable Cities. Satterthwaite, D. (ed.)* London; Earthscan publications. Pgs. 247 – 288.

United State Geographical Survey, USGS (2015). *Sustainability of groundwater resources*, www.pubs.usgs.gov/circ/…/html/genfacts.html/on 14th March, 2016.