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Patterns and problems of domestic water supply to rural communities in Enugu State, Nigeria

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This study investigated the patterns, problems and options for improved domestic water supplies to the rural communities of Enugu State, Nigeria. The purpose of the study was to determine the gap between supply and demand, physical and socio-economic variables that influence the supply situation and suggest options for improved water supply in the area. Data on water use habits were collected from 340 households, in 17 autonomous communities through the use of questionnaire and oral interview. Additional data were collected though field observations, from three FGDs and from relevant records at the offices of the Enugu State Water Corporation. The data were analyzed through the use of inferential and descriptive statistical tools. The results of the study revealed that wide gaps exist between water supply and demand in all the sampled communities. The water schemes developed by governments and NGOs are largely non-functional. The quantities of water demanded and supplied vary widely. The mean household water demand was found to be 13685.5 lpd against the supply 9028.8 lpd, leaving a daily household deficit of 4656.9 lpd. Over 50% of the population access less than halve of the 115 L per person per day recommended by the federal government of Nigeria. .32% of the respondents rely on private boreholes for their water needs; 26.5% depend on water vendors, while the rest depend on contamination-prone streams, rivers, unlined and unprotected wells, harvested and stored rain water etc. Principal Components Analysis reduced the 20 physical and socio-economic variables accounting for water supply problems in the area to five underling dimensions which accounted for 85.9% of the problems, leaving 14.1% to other variables not used in the study. Suggestions for improved household water supply in the area were advanced.

Key words: Rural communities, water supply, supply deficits, constraints, policy options, Enugu state.

INTRODUCTON

According to WHO (2015) about 663 million people worldwide had no access to adequate drinking water supplies, and nearly half of the people using unimproved water sources live in sub- Saharan Africa (UNICEF, 2015). Although, Nigeria is blessed with abundant water resources (estimated at 226 billion cubic meters of surface water and about 40 billion cubic meters of ground water) her rural populations are largely deprived and lack access to adequate water supplies (Adah and Abok, 2013). About 65 million Nigerians have no access to safe

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Plate 1. Abonyi River-a major source of water for many rural communities in the study area.

and adequate water supplies; the number rose dramatically to 90 million in 2015 (UNICEF, 2015).

Nigeria did not meet the MDG target of halving by 2015 the population without adequate access to improved drinking water sources. She ranks behind many other sub- Saharan African countries such as Ghana, Rwanda, Botswana, and Sierra Leone in access to potable water (Marks et al., 2013). A significant proportion of the Nigerian rural population continue to use rivers, ponds, lakes and harvested rain as their main sources of water supply (Ezenwanji, 2012) (Plate 1). This category of Nigerians faces great risks to their health and wellbeing (Obeta and Chukwu, 2013).

Nigeria has a large rural sector and relatively a small urban population (Utube, 2002). The rural areas generally exhibit great poverty, decayed infrastructure, poor health conditions, low access to social facilities and ignorance as a result of varying degrees geographical and political isolation (Obeta, 2009). The rural areas have long been neglected and deprived (FAO, 2005). According to Goni (2006), the negligence has led to rural-urban migration which in turn has created problems for both urban and rural areas. The current situations in some states and communities of Nigeria, serve as tragic examples of pains and sufferings experienced by people. In Yobe, Borno, Adamawa Zamfara and Jigawa states, for instance, water shortages have aggravated the refugee and food crises, forcing some residents to migrate southwards (Goni, 2006; Abaje et al., 2009). In Bama community (Borno State) polluted water remains the most important cause of poor health, food insecurity and low pace of socio-economic development (Toyobo and Taniowo, 2011).

The limited access to water supplies by a significant proportion of the Nigerian rural population has been blamed on institutional and socio-economic factors (Ezenwaji et al., 2016). Toyobo and Tanimowo (2011), attributed the prevailing water poverty in many rural communities of Nigeria, to poor sustainability of water infrastructure, paucity of funds, inadequate technology and lack of political will. Adah and Abok (2011) and Ezenwanji (2004) blamed engineers for poor quality construction while Gbadegesin and Olorundemi (2007) attributed the problem to inadequate community participation. Nyaba (2009) attribute the general poor service delivery in the Nigerian water sector to rent-seeking and poor governance of safe drinking water to a large segment of the Nigerian rural population to inefficient system management which does not take into cognizance the sustainability of the supply system for future generations.

Our study area is predominately rural with about 78% of the population living in rural areas. For a sizable proportion of the population, the major sources of water are unprotected wells, streams, ponds, private boreholes and harvested rain water (Plate 2). Drinking water from these sources are not regulated by federal and state agencies and typically do not receive same level of monitoring and treatment as drinking water supplied by public water supply agencies. These sources harbor water-borne disease because they are also exposed to contamination by both natural and anthropogenic factors.

Plate 2. Adada Stream; another source of water for many river bank communities.

Nwankwo (2014) studied the adverse effects of these sources on inhabitants' health and found that they constituted an important hindrance to their productive abilities. Ezenwanji (2012) studied the community-based water service providers in the state and discovered that they lack the capacity to carry out administrative operation and maintenance functions and that these adversely affect the sustainability of water supply services in the area He observed that service providers in the state need regular and structured support that goes beyond ad-hoc technical assistance. The existing situation should not continue the way they are since it will adversely affect national development. Therefore, this study is set out to investigate the pattern, problems and strategies for rural water supply in the state in order to characterize them and to suggest measures which can improve water services delivery in the area.

Olaleye (2010) and Akpomunie (2010), have noted that the provision of adequate, clean, reliable, and potable water in Nigerian rural areas remains a challenge which needs to be tackled considering the fact that a larger percentage of the population live in rural areas. When the water is inadequate, people are compelled to use contaminated water which may later create health problems, including the outbreak of diseases (Marks and Davis, 2012). As the population and the demand for safe drinking water increase in Enugu state, it is important to advance strategies that may lead to more efficient and sustainable supplies. The findings of this work will, in addition, contribute to the knowledge base for future research and development of water supply systems in the state and, indeed, to the successful implementation of the post-2015 rural development agenda.

Area of study

Enugu state, is located approximately between latitudes 05.55` and 07.08` and longitudes 06.35` and 07.55`. The state is bounded in the east by Ebonyi State; in the west by Anambra State; in the north by Benue and Kogi States; ad in the south by Imo State. Currently, the state is composed of seventeen local government Areas, namely Igbo-Eze north, Igbo Eze South, Nsukka, Uzo-Uwani, Udenu, Isi-Uzo, Nkanu East, Nkanu West, Awgu, Ani-Nri, Enugu di, Ezeagu, Oji River, and Igbo-Etiti local government areas (Figure 1).

The state has an area of about 9,102 square miles or 14,563.2 km^2, and a 2014 projected population of 4.3 million, 78.2% of which live in the rural areas (Nwankwo, 2014). The study area lies within the Koppen Tropical Rainy Af climatic zone of the Koppen classification (Oformata, 2002). The climate is tropical with high temperatures and high humidity as well as marked wet and dry season; though there are variations between north and south. The average temperature for every month is above 18.5^oC and there is adequate moisture in the area between March and November. The highest temperatures are recorded between the months of March and April. Precipitation varies widely in both time and space, ranging from less than 850 mm per annum in the extreme north to 1050 mm in the south (Oformata, 2002).

The state is drained by numerous rivers, principally the Ebonyi, Adada, Ajali, Ivo and their numerous tributaries. Many of the tributaries are seasonal. The vegetation varies mainly with the rainfall and with topography. Natural vegetation is denser in the south and at the valleys and sparse at the north and at the top of the

Table 1. Respondents indentified causes of water shortages in the area.

S/N	Reported causes of water shortage in the area
1	Long distances to the main source of water for the households.
2	Long waiting tie for water collection in the area
3	Limited number of O & M activities performed at the community level.
4	High Number of technical faults that occur in reported in the area.
5	Long waiting time for faults to be restored
6	Few number of times public raps run in a weak
7	Limited number of public water taps available at community level
8	Limited number of functional public boreholes
9	Poor yields from wells
10	Limited number of public functional storage facilities at the community level
11	Long distances travelled to get spare parts.
12	Limited number of water source caretakers at community level
13	Limited number of public water supply facilities at the community level.
14	Few numbers of times public water facilities are maintained in the area.
15	Limited number of functional public water taps
16	Few number of elected Village Water Community (VWC) members
17	Large number of abandoned public water facilities at the community level
18	Limited number of water projects sponsored by Donor Agencies
19	Non provision of up-front capitals for O&M of facilities at the community level
20	Inability of pubic water projects to function satisfactorily for a long time

highlands (Nzeadibe and Ajaero, 2010). Generally, the rural areas have similar physical and socio-economic characteristics. For instance, many of the rural residents have easily accessible, nearby, clean or hygienic water sources. Sources of such water vary widely from direct rainfall to water from runoffs, rivers, streams, boreholes, wells, and seepage. Many suffer from avoidable water related diseases (Mozie, 2011). Despite a process of industrialization extending to the creation of the state in 1986, agriculture remains the fundamental economic activity in all the local government areas. The leading economic crop is the oil palm which is grown in every part of the state. Cassava, yam, rice and maize are the most important food crops. The average life expectancy in the mid-1990s was 47 for men and 49 for females.

METHODOLOGY

Qualitative data were generated through a combination of primary and secondary sources. Household water use habits and the factors limiting water supply were sourced through questionnaire administration, oral interviews, personal observations, three focus group discussions (FGDs) and from records in state's Water Corporation headquarters. We visited all the three rural water supply zones in the state at Enugu, Nsukka, and Udi to extract useful information from official records, observe existing water supply infrastructure as well as to interview the principal zonal officers of the State Water Corporation. A total of 340 households from 17 rural communities were sampled. The main selection criteria for the communities were: (1) The existence of a public water scheme, and (2) A population between 1000 and 2500.

Relevant data on the perceived causes of water supply shortages in the area were collected through in-depth interviews with household heads and the zonal staff of the State Water Corporation (Table 1). The information generated is connected with a wide range of historical, institutional, organizational, managerial, social, technical, and environmental factors. The reported explanatory variables for the prevailing water shortages in the area are defined and parameterized in section four.

Principal Component Analysis (PCA) was employed to analyze the above variables. PCA is a data reduction tool that is frequently employed by scholars to summarize and analyze large data set (Anyadike, 2009). In this study PCA was employed to identify the principle dimensions of the selected variables responsible for water shortages in the study area. PCA was executed using the Statistical Package for the Social Sciences (SPSS) version 16, based on the Kaiser's normalization and rotated variable maximization (va Analysis (PCA). PCA is a data reduction tool that is frequently employed by scholars to summarize and analyze large data set (Marks et al., 2013). In this study PCA was employed to identify the principle dimensions of the selected variables responsible for water shortages in the study area. PCA was executed using the Statistical Package for the Social Sciences (SPSS) version 16, based on the Kaiser's normalization and rotated variable maximization (varimax) principle. Only variables Eigen-values above unity with 5% or more explanatory powers were considered in this work.

RESULTS AND DISCUSSION

Sources of water supply in the area

Field evidences revealed that private boreholes, water

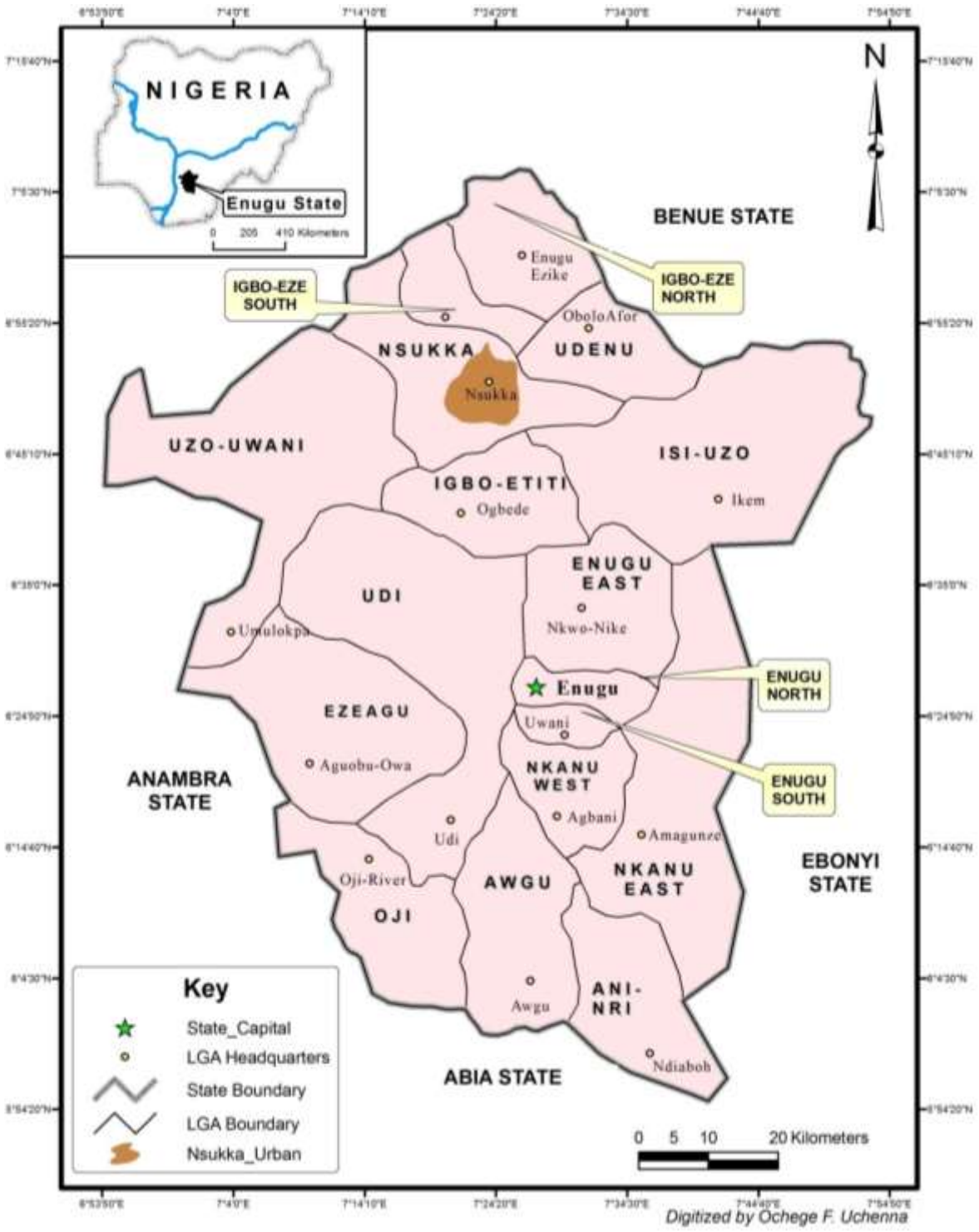

Figure 1. Map of Enugu State showing the local government areas. Source: GIS Unit, Department of Geography, University of Nigeria, Nsukka.

vendors, hand-dug wells, natural springs and rivers, harvested and stored rain water and public water schemes are the major sources of water supply for the rural population in the study area. Most of the communities in the area where perennial streams are available (Ikem, Eziagu, Isi Uzo Iwollo) depend on streams, and rivers for most of their water needs (Figures 1 and 2). Majority of the sampled communities are

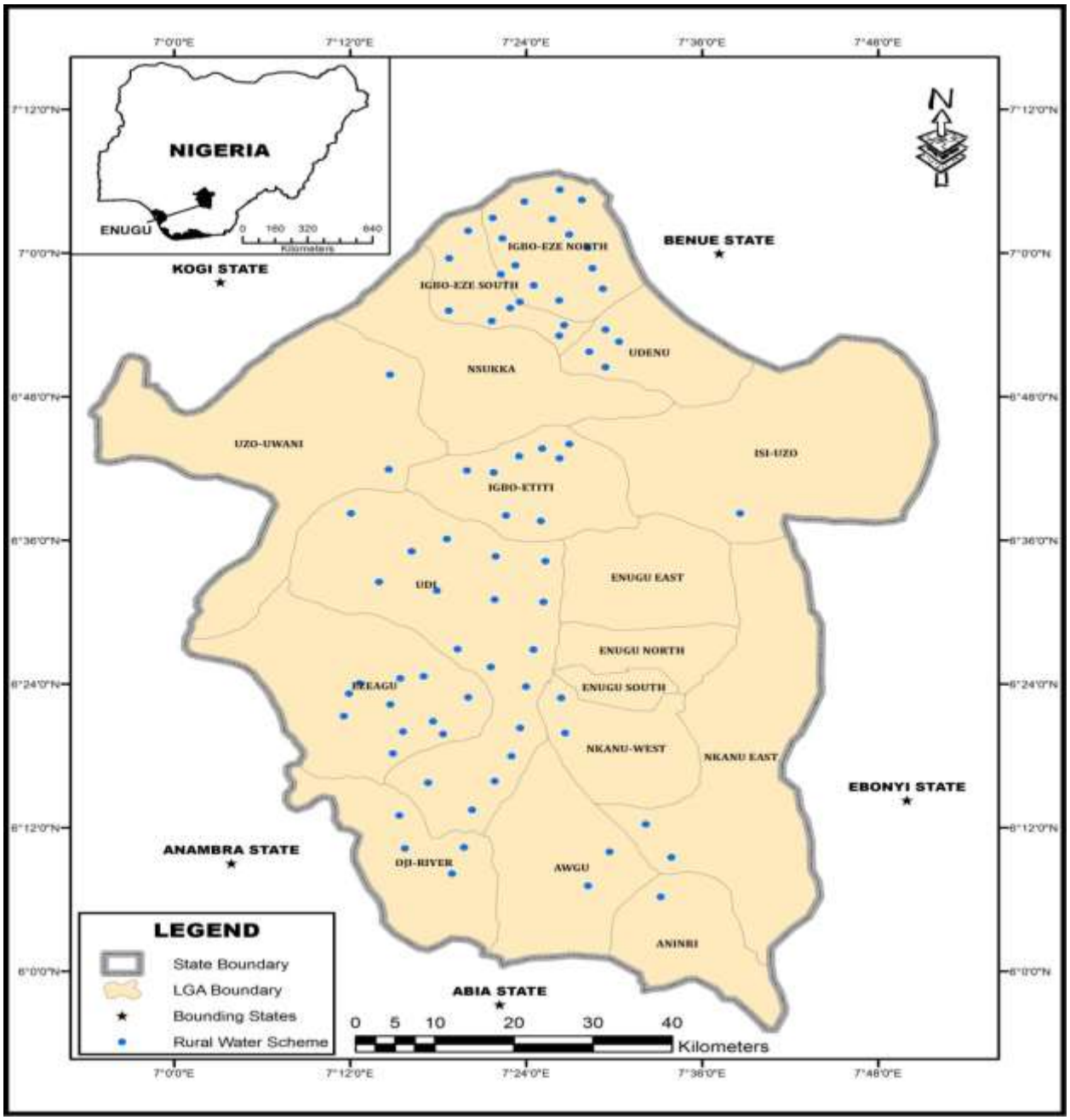

Figure 2. Location of rural water supply schemes in Enugu State. Source: Enugu State Water Corporation, Headquarters, Enugu (2014)

deficient in surface water resources (streams) and few available ones are unreliable, especially during the dry seasons. The hand-dug wells are unlined and unprotected. The pattern of dependence on the water sources in the area is illustrated in Figure 3.

As shown in Figure 3, private boreholes are the primary source of water for majority of the respondents (32%). Many of the respondents would have preferred public taps from government-developed boreholes but majority of them are not functional (only 3 of 17 schemes are functional). Therefore, they turn to private boreholes which are readily available, yield relatively high quality water, located within trekking distances and are generally affordable .About 26% of the respondents percentages availed other sources such as water vendors, 12% from rivers/streams/lakes, 10% from wells, 8% from public taps and 6% each for harvested/stored rain water and ponds respectively. It was clear from personal

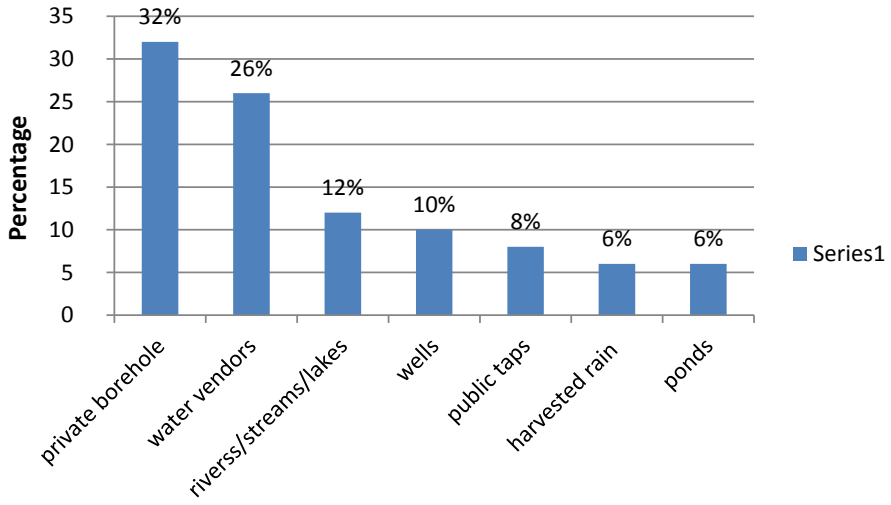

Figure 3. Pattern of dependence on available water sources in the study area.

observations that most of the wells are unlined and shallow. Also the streams, having thick brown colour, are not good water sources, but they are the only sources available in some communities; in such areas women and children use plastic buckets to collect water for domestic uses.

The rural water schemes in the area were developed by Enugu State government through the State Water Corporation. The schemes are located mostly in the central, surface water deficient Local Governments Areas of Igbo Eze North, Igbo Eze South, Udenu, Igbo Etiti, Udi, Ezeagu, and Oji River (Figure 2).

Out of the 76 rural water schemes shown in Figure 2, 17 households were sampled as, explained above and used in this study. Table 2 shows the statistics of the communities hosting the schemes, their population range and their prevalent sources of water supplies to the citizens.

Four of the Local Government Areas (Enugu North, Enugu South, Enugu East and Nsukka) are largely urbanized .Interviews held with the zonal water engineers revealed that Enugu State Water Corporation has, historically, been more involved in developing and maintaining water supply schemes in these urbanized local governments than in the rural communities. Consequently, many households at the periphery of these urban areas prefer water sources from the near-by urban areas mainly determined by several interesting factors such as previous experience with rural water schemes, financial status, gender, and distance from the source and weather conditions.

Patterns of water demand and supply in the study area

The general patterns of water demand and consumption in the sampled communities were examined here. Table 2 provides a summary of the demand-consumption characteristics, the quantities demanded and supplied, the supply deficits as well as the percentages of demand satisfied by supply in the 17 sampled communities.

As shown in Table 2, the quantity of water demanded is more than the supply in all the sampled communities; indicating shortage of water supply generally in all the sampled communities. Also the quantity demanded vary widely among the 17 communities, this may be due to the variations in the intensity of natural and socio-economic conditions. Ngwo community has the highest of water demanded while Umundu has the lowest. This could be due to large concentration of functional and high yielding boreholes, owned largely by the private sector (firms, religious organizations, wealthy individuals, NGOs, etc) in Ngwo and the near absence of such facilities in Umundu. Households in Oji River and Ovoko communities also demand relatively high amounts of water. Both communities have many households that engage in local industrial activities (garri, cassava), processing of oil palm products, wood works, clay products etc). These could make them demand more water than other communities.

The amount of water supplied to the sampled communities also varied (also as amount demanded), but are generally below demand. None of the communities was supplied the quantity it needs. Again Ngwo community has the highest mean household and per-capita water supply while Umundu and Obukpa had the least. The differences in amount supplied could emanate from a variety of factors such as variations in water availability. For instance, Ngwo community has the highest concentration of functional boreholes (52) in south eastern Nigeria; so the quantity supplied to the community is relatively high. Again many residents of Ngwo are top-civil servants and businessmen who have money to develop private boreholes or engage the

Table 2. Statistics of communities visited and their water sources.

Local government area	Sampled community	Opulation served*	Available Water Sources**	Leading or primary water source**
Igbo Etiti	Ukehi	14,165	River, well ,harvested rain, public taps, private boreholes, vendors	Private boreholes
Igbo Eze South	Ovoko	9,890	Well, harvested rain, public taps, private boreholes, vendors ,ponds	Private boreholes
Igbo Eze North	Ogurute	6,217	Well, harvested rain ,public taps, private boreholes, vendors ,ponds	Private boreholes
Nkanu West	Agbani	11,495	Wells, private boreholes , streams ,ponds stored, rain water, vendors	Private boreholes
Oji-Rriver	Oji-River	16,668	River, well, harvested rain, public taps, private boreholes, vendors	Private boreholes
Udi	Udi	9,424	Public taps, water vendors, private boreholes ,stored rain water	Public taps
Isi-Uo	Ikem	13,814	Public taps, streams, water vendors	Streams
Nkanu East	Nnenwe	6,847	Public taps, streams, water vendors, private boreholes	Water vendors
Awgu	Maku	6,877	Public taps, streams, water vendors, private boreholes	Water vendors
Nsukka	Obukpa	7,997	Public taps, water vendors, private boreholes	Private boreholes
Udenu	Umundu	2,684	Public taps, water vendors, private boreholes	Private boreholes
Uzo-Uwani	Nimbo	4,737	Streams, water vendors, private boreholes	Water vendors
Ani-Nri	Mpu	3,657	Streams, water vendors, private boreholes	Water vendors
Enugu North	Ngwo-center	12,778	Public taps, water vendors, private boreholes	Private boreholes
Enugu East	Ugwugo Nike	2,548	Public taps, streams, water vendors, private boreholes	Water vendors
Enugu South	Amechi –Agu	7,238	Public taps, water vendors, private boreholes	Private boreholes
Eziagu	Iwollo	12,212	Public taps, streams, water vendors, private boreholes	Private boreholes

Source: *Enugu State Water corporation, Records and Statistics Department (2014). **Field work (2014).

services of big time water vendors or develop other alternative sources of supply. Because of these, they demand and consume more water. Similarly, residents of Oji River community are supplied with relative high quantity as the community is located close to a very large river .The river is perennial and less than 0.5 km from most parts of the community. In contrast, Umundu and Obukpa communities are located on the central, dry, surface water-deficient Nsukka plateau surface with few functional boreholes; people in this area demand and consume little water. Residents of these communities often trek over long distances (between 1 and 2.5 km) to access the water they need from commercialized private boreholes.

The spatial patterns of water demand and supply characteristics for the entire area shows that the total household water demand is 261,706 lpd, against the total household water supply of 180572 lpd, leaving a daily deficit of 81,134 L. The mean household water demand was found to be 13685.5 lpd against the mean household water supply of 9028.6 lpd; while the mean per-capita water demand was found to be 75.5 lpd against the mean per-capita water supply of 60.1 lpd, representing 84% of the per capita water needed but not met by the supplied. .The overall picture shows that the people generally do not demand much water. The level of water deficiency in the area can be appreciated in the last Colum which shows the percentage of the Federal Government of Nigeria recommended minimum of 115 lpd, satisfied by supply in each of the sampled communities. The percentage of the recommended minimum satisfied by supply in the communities were generally low and for the entire area was found to be just 52.3%.

Analysis of the factors affecting the water supply pattern in the study area

Table 3 highlights the water shortage situation; the mean per-capita water supply was found to be only 60.1 lpd, which is just 52.3% of the Federal government of Nigeria recommended minimum of 115 lpd. As Table 3 shows, over 50% of the sampled

Table 3. Water demand and consumption characteristics in the study area.

S/N	Community	T/HH water demand in lpd	T/HH water supply in lpd	Mean HH water demand in lpd'	Mean HH water supply in lpd	Per-capita water demand in lpd	Per-capita water supply in liters	% of per-capita demand satisfied by supply	% of 115 lpd. satisfied by supply
1	Ukehi	18922	11872	946.1	593.6	118.3	74.2	62.7	64.5
2	Ovoko	22084	10592	1104.2	529.6	130.0	66.2	50.9	57.6
3	Ogurute	13204	9536	660.2	476.8	82.5	59.6	72.2	51.8
4	Agbani	14446	10096	722.3	504.8	90.3	63.1	69.9	54.9
5	Oji-River	23 886	13232	1194.3	661.6	149.3	82.7	55.4	71.9
6	**Udi**	18603	12832	930.2	641.6	116.3	80.2	69.0	69.7
7	Ikem	13490	10560	674.5	528.0	84.3	66.0	78.3	57.4
8	Nnenwe	16261	12364	813.1	618.2	101.6	68.8	67.7	59.8
9	Agwu	10264	9088	513.2	454.4	64.2	56.8	88.5	49.4
10	Obukpa	9786	8544	489.3	427.2	61.2	53.4	87.3	46.4
11	Umundu	8609	7872	430.5	393.6	53,8	49.2	91.4	42.8
12	Nimbo	12764	9440	638.2	472.0	79.8	59.0	73.9	51.3
13	Mpu	18112	11568	905.6	578.4	113.2	72.3	63.8	62.9
14	Ngwo-center	24142	14160	1207.1	708.0	150.9	88.6	58.7	77.0
15	Ugwugo Nike	15006	9840	750.3	492.0	93.8	61.5	65.6	53.5
16	Amechi –Agu	10686	93360	534.3	468.0	66.8	58.5	87.6	50.9
17	Iwollo	11441	9616	572.1	480.8	**71.5**	**60.1**	**84.0**	**52.3**
Total		**261,706**	**180,572**	**13685.5**	**9028.6**	**1627.8**	**1119.6**		
Mean		**15394.47**	**10621.9**	**805.1**	**531.1**	**95.8**	**65.9**	**72.2**	**57.3**
SD		**4887.9**	**1768.0**	**244.4**	**88.4**	**29.99**	**10.7**		
VARI.		**2.4**	**3.1**	**5.97**	**7.8**	**899.3**			

Source: Authors Fieldwork (2013-2014).

communities recorded high deficiencies of over 50% of their water needs. Evidences indicate that the effects of low access to potable water supplies are directly felt by the uses, notably women, children and young girls who spend more time travelling to collect water, often of doubtable quality and from distant sources. Reduced water availability in the area also affects the poor who do not have enough money to develop private boreholes or patronize water vendors.

The analysis of the reported explanatory variables for the prevailing water shortages in the area through the use of Principal Component Analysis (PCA) is focused here. The identified causes of water shortages were defined as shown in Table 4.

Variables x^2, x^3, x^4, x^5, x^6, x^7, x^8, x^9, x^{10}, x^{12}, x^{13}, x^{14}, x^{15}, x^{16}, x^{19} and x^{20} were abstracted from the questionnaire; variables x^1 and x^{11} were measured based on estimated distances between households and named water sources; variables x^{17} was obtained through field observation while variable x^{19} was obtained from relevant records at the Enugu State Water Corporation. The PCA analysis generated the rotated components matrix (Table 5), in which only components with Eigen – values above unity with 5% or more explanatory powers were considered as separate orthogonal dimensions or factor components (Anyadike, 2009). As shown in Table 5, Component I has the

Table 4. Causes of water shortages in the study area.

Variable code	Variable label	Variable name
X1	DIST	Mean estimated distance in kilometer to the main source of water for the household.
X2	TIME	Mean estimated waiting time for water collection in minutes
X3	LOCAP	Number of O & M activities performed at the community level.
X4	TEFAT	High Number of technical fault reported in a month at the community level
X5	FULT	Estimated waiting time for fault to be restored in days.
X6	TAPS	Number of times public taps run in a weak
X7	NOTAP	Limited number of public water taps available at community level
X8	NOPUB	Limited number of functional public boreholes
X9	NOWEWA	Number of months wells yield water per annum
X10	NOFAS	Number of public functional storage facilities at the community level
X11	GESPAP	Estimated distance in kilometer for getting spare parts.
X12	WACAP	No of water source caretakers at community level minutes
X13	WUSUFA	Number of public water supply facilities at the community level.
X14	MAIT	Estimated number of times public water facilities are maintained in a month.
X15	NOFUP	Number of functional public water taps
X16	NOWAC	Mean number of elected Village Water Community (VWC) members
X17	ABAWA	Number of abandoned public water facilities at the community level
X18	DOWAA	Number of water projects sponsored by Donor Agencies
X19	CAPUF	Number of times up-front capitals are provided for O&M of facilities at the community level in 2015.
X20	COWAP	Number of times pubic water projects functioned satisfactorily for one month in 2015

highest number of loadings, with high positive and negative loadings on eight variables. The strongest loadings are recorded on variables 4, 7, 8, 10, 13, 14, 15 and 20. These variables relate to the limited number of public water supply facilities, poor functioning of and inadequate maintenance of water infrastructure in the study area. This component has an Eigen value of 10.400 and contributed 51.4% explanation to the variance .It is tagged the influence of technical and infrastructural shortcomings. Quality construction and regular maintenance of public water supply facilities in the rural communities under study is generally lacking. This leads to frequent breakdowns and leakages in the supply system. Evidences from the field reveal that the physical components of water infrastructure in many of the communities are inadequate, not regularly checked, maintained and repaired. The intake and reservoir structures at Oji River, Agbani and Ikem are unprotected, non- functional and dilapidated. The treatment and pump-houses at Ukehi, Umundu Iwollo, Ogurute, Obukpa and Achi experience frequent functional problems; users in these communities make their own arrangements to secure water for their families. Technical training received by VWCs members in these communities is insufficient to effectively solve existing technical problems of the water infrastructure. The old rural water supply schemes at Ovoko, Amechi, Udi and Agwu exhibit perennial technical problems which, according to the State water engineer, need partial or entire redesigning and replacement.

Component II contributed 13.8% explanation to the observed variance. The component has an Eigen value of 2.763 and loads highly on three variables, namely, variables 2, 12 and 16. Generally, these variables describe the institutional weaknesses of exiting water supply projects including the failures of VWC members in discharging their duties and responsibilities. Evidences suggest that the general poor performance of existing water supply projects at the community level is a major cause of failing water supply services in the area. This component is tagged the influence of institutional and managerial shortcomings. The capacities of existing rural water projects were found to be so limited and the workers are not motivated; leading to a general poor quality performance.

Component III contributed 8.3% to the variance. It has its strongest negative lading on variable 5, “long waiting time for faults to be restored” and an Eigen value of 1.668. The negative relationship shows that the longer the waiting time the lower the level of access to domestic water supplies .This popular observation agrees with the findings of previous workers such as 2012 and 2013. This component is tagged the influence of inefficiency in system repairs.

Component IV is defined by variable 18 (limited number of water projects sponsored by NGOs and other agencies in the area) and has an Eigen value of 1.446. The component contributed 7.2% to this variance. This component explains the impacts of limited assistance to

Table 5. Rotated component matrix scores of the variables analyzed.

Variable	Component				
	1	2	3	4	5
X1	-0.590	-0.474	-0.354	0.062	0.359
X2	-0.429	**0.764***	0.173	0.236	-0.120
X3	0.693	0.496	0.215	-0.145	-0.039
X4	**0.933***	-0.008	0.125	0.244	-0.116
X5	-0.180	-0.064	**-0.774***	0.018	0.075
X6	**0.857***	0.139	0.393	-0.030	0.057
X7	**0.909***	0.095	-0.014	0.074	-0.211
X8	**0.960***	0.045	0.057	-0.046	-0.076
X9	-0.441	-0.631	0.276	0.200	0.342
X10	**0.919***	0.267	0.073	0.076	-0.181
X11	-0.173	0.622	-0.280	0.130	0.471
X12	0.335	**0.856***	0.035	0.056	0.124
X13	**0.825***	0.238	0.175	0.345	0.127
X14	**0.965***	0.103	0.087	0.104	-0.069
X15	**0.827***	-0.035	-0.011	0.372	-0.141
X16	-0.337	**-0.736***	-0.219	-0.134	0.239
X17	-0.096	-0.088	-0.035	-0.047	**0.926***
X18	0.303	0.182	0.024	**0.879***	-0.015
X19	0.186	0.018	0.648	0.555	0.009
X20	0.**926***	0.069	0.238	0.155	-0.01008
Eigen value	10.250	2.763	1.668	1.446	1.025
% of variance explained	51.400	13.814	8.338	7.229	5.123
Cumulative % Explained	51.400	65.215	73.552	80.781	85.904

rural water services delivery in the study area, It is therefore tagged the influence of low external assistance.

Finally, component V has an Eigen value of 1.025 and contributed 5.1% to the variance. The variable has a positive high loading on variable 17 (high number of abandoned water facilities at the community level). Generally, this variable describes the insufficient capacities of exiting water supply providers in the area. Capacity constraints relate to limited resource availability (particularly skilled, experienced staff and finance) to initiate, complete and maintain rural water projects. Evidences suggest that the Enugu State government and other development agencies tend to focus more on projects completion than on the entire life cycle of rural water supply projects and that generally the communities maintenance workers rarely succeed in operating and adequately maintaining the water projects to ensure their longevity

The way forward

The factors identified and analyzed above have considerable negative effects on the sustainability and functionality of the public water projects and on the development of new ones in the study area. Evidences show that 82.4% of the existing public water projects in the study area are partly or totally defunct. No public water project is functioning up to the designed capacity; 70.6% of the projects lack user committees. Abandoned water supply projects exist in all the sampled communities. Table 6 provides more information on the status of water supply projects in the area.

To reverse the sorry state of affairs in the rural water supply sector of the study area, the Enugu State Government needs to take a number of urgent actions.

First, the government could address the problems of functionality and sustainability of supply infrastructure in the area by initiating, implementing and institutionalizing an effective post- construction support programme. The programme must provide for effective monitoring as well as for regular repairs, maintenance and prompt replacement of parts.

Secondly, although many of the rural water schemes need repairs and rehabilitation, those described as ‘too old” (Awgu, Ovoko and Amechi), ought to be reconstructed. New constructions have better chances of winning the goodwill of users and of attracting the attention and support of donors. Donors generally prefer to focus on new constructions which they consider more rewarding and easier to satisfy.

Thirdly, Enugu State Government needs to train rural

Table 6. Functional status of sampled water projects in the area.

S/N	Functional status of sampled community water projects	Number	% of the Total
1	No. of public projects functioning up to design capacity	1	5.9
2	No. of public projects requiring minor repairs	5	29.4
3	No. of projects requiring major repairs	11	64.7
4	No. of sampled households depending on public water projects		08
5	No. of sampled households depending on alternative sources		92

Source: Fieldwork (2014).

water users in system operation and maintenance and equip community-based technical operators to handle daily operation and maintenance activities of the rural water supply schemes. The existing community user committees were reported to lack the required engineering skills and knowledge to handle even minor repairs; also the zonal staffs of Enugu State Water Corporation do not carry out needed repairs promptly. Prompt and regular system repairs are necessary to ensure regular sustainable of water from public taps.

Finally, the Enugu State government needs to tackle the problems of insufficient resources and capacities in the rural water supply sector. This could be done through closer public and private partnership in water service delivery in the area. Public and private partnership may help to ameliorate the problems of insufficient public budgets and dwindling revenue as well as the problems of corruption and mismanagement which affect the efficient management of public institutions in Nigeria. The state government can develop rural water schemes and hand them over to the private sector to manage. The private sector mechanisms like competition and use of efficient management strategies may just be the panacea needed to forestall the massive and frequent failures of public rural water supply schemes in Enugu State.

Conclusion

This study focused on the patterns and problems of water supplies to communities that are predominantly rural and less industrialized. The results of the analysis show that there is a wide gap between the quintiles of water demanded and supplied and that many of the public water supply infrastructures in the area have failed completely or partially. Principal Component Analysis (PAC) reduced 20 constraining variables to household water supply to five underlying dimension which collectively accounted for 85.9% of the variance, leaving 14.1% to other variables not used in the analysis. The results of this study are important for a number of reasons. First, it provides a framework for development intervention measures in the rural water supply sector of the area. Since majority of the state's population live in rural areas, which has long been recognized to be suffering neglect in Nigeria, any government which is interested in poverty alleviation, in empowering her citizens and in turning round the local economy must strive to find sustainable solutions to problems facing the rural areas. Secondly, the result provides the basis for comparing the rural supply in our study area with water supply situations in other developing countries. Finally, other rural communities which face similar problems in their water supply sector may also benefit from our recommendations.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Abaje IB, Ati OF, Ishaya S (2009). Nature of Potable Water Supply and Demand in Jema'a Local Government Area of Kaduna State, Nigeria. Res. J. Environ. Earth Sci. 1(1)16-21.

Adah PO, Abok G (2013). Challenges of Urban Water Management in Nigeria: The Way Forward. J. Environ. Sci. Resour. Manage. 20:111-121.

Akpomunie OB (2010), "Self-help as a strategy for rural development in Nigeria: A bottom-up Approach" J. altern. Perspect. Soc. Sci. 2(1):88-111.

Anyadike RNC (2009). Statistical Methods for Social and Environmental Sciences. Ibadan: spectrum Books, (Chapter 7)

Ezenwaji EE (2004). Water Supply, as a Strategy for Rural Development in Anambra State. J. Dev. 1(2):71-80.

Ezenwaji EE (2012). Institutional Framework for Public Water Supply and Sanitation Management. In Anyadike RC and Obeta MC. Department of Geography and Meteorology University of Nigeria Nsukka.

Ezenwaji EE, Eduputa BM, Okoye IO (2016). Investigation into the Residential Water Demand and Supply in Enugu Metropolitan Area. Am. J. Water Resour. 4(1):22-29.

FAO (2005). Plan of action for people's participation in rural development: Twenty-sixth session, FAO Conference., Rome, 9-28, Nov.

Gbadegesin N, Olorundemi F (2007). Assessment of Rural Water Supply Management in Selected Rural Areas of Oyo State, Nigeria", ATPS Working Paper Series No 49, Afr. Technol. Policy Studies Network (ATPS), Nairobi, Kenya.

Goni IB (2006). The challenges of meeting domestic water supply in Nigeria. J. Mining Geol. 42(1):51-55.

Marks SJ, Davis J (2012). Does users participation lead to sense of ownership for rural water systems? Evidence from Kenya. World Dev. 40(8):1569-1576.

Marks SJ, Onda K, Davis J (2013). Does Sense of Ownership matter for

Rural Water System Sustainability?: Evidence from Kenya. J. water, Sanit. Hyg. Dev. 3(2):122-133.
Mozie AT (2011). Analysis of settlement distribution Patter in two-terrain tracks: the Udi-Awgu Plateau and the Cross River plain in Enugu state, south Eastern Nigeria. Niger. J. Geogr. Environ. 1(1/2):237-246.
Nwankwo CF (2014). Residential Water Demand and Supply in Awgu Local Government Area, Enugu State, Nigeria. Department of Geography, University of Nigeria: Unpublished B Sc Project.
Nyaba S (2009). Review of Rural Development Policy for Sustainable Development. Presentation at the West African Regional Conference on Smart, Appropriate Technology for Rural Communities. Abuja, Nigeria.
Nzeadibe TC, Ajaero CK (2010). Assessment of socio-economic characteristics and quality of life expectations of rural communities in Enugu State, Nigeria. Appl. Res. Qual. Life 5(4):353-371.
Obeta MC (2009). The Development of Rural Water Supply Infrastructure in Nigeria. in Igbozurike I. and Onyenechere (eds.)., Rural Water Supply Niger., Owerri: Cape Publishers. pp. 402-410.
Obeta MC, Chukwu KE (2013). Water supply and Demand in Nigeria. Anyadike RNC and Obeta MC. Water resour. Dev. Manag. Niger., Merit international publication, Lagos, Nigeria. pp. 155-164.
Oformata GEK (2002). Geology in Ofomata (eds), A survey of the Igbo Nation, Africa. Onitsha: FEP
Olaleye YL (2010). The contributions of the doctrine of citizens' participation in organization and implementation of community development project" Eur. J. Sci. Res. http://www.eurojournal.com/ejsr.htm/.
Toyobo AE, Tanimowo NB (2011). Evaluation of Rural Water Supply Systems in Selected Communities in Oke-Ogun Area,Oye State,Nigeria. Glob. J. Sci. Front. Res. 11(9):1-7.
Unicef (2015). 2015 Update and MDG Assessment Progress on Drinking Water and Sanitation. A Publication of the World Health Organization (WHO) 20 Avenue Appia, Geneva.
Utube JT (2002). Water Demand in Ajegunle Are of Lagos Mainland, Nigeria. J. Dev. 3(2):60-71.