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FACTORS RESPONSIBLE FOR RURAL RESIDENTIAL WATER SUPPLY SHORTAGE IN SOUTHEASTERN NIGERIA

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Abstract

Efficient water supply is very crucial to sustenance of socio-economic growth, poverty attenuation, and food security. In most rural areas of developing countries including Nigeria water supplies are not commensurate with demand leading to a shortfall in water use and many people suffer from this scenario. This research investigated the factors responsible for rural residential water supply shortage in Southeastern Nigeria. Data were collected through the use of four mixed but complimentary methods namely questionnaire survey, interviews, focus group discussions and secondary data sources. The data generated were analyzed through the use of descriptive and inferential statistical tools. Principal Component Analysis was employed to combine the variables accounting for water supply shortage into a few underlying dimensions. The results indicated that physical environment and inadequate water supply infrastructure; socio-economic and geographical location; management and socio-cultural problems are responsible for water supply shortage in the area. Residential water supply can be sustainable in the area by regulating the influence of these factors impacting on water supply as well as lessen the implications of water deficiency. The research concludes that the process of water supply development should be stepwise in accordance with the participatory and managerial capacity of communities.

Keywords: water supply constraints, sustainability, service delivery, community participation

INTRODUCTION

Clean, safe drinking water is scarce. Matter (1984) have recognized that water supply has been a primary logistical challenge since the beginning of civilization and balancing water demand and supply has been a major concern of all human society of all times. The objective of water supply is the provision of potable water on a constant basis which addresses security of supply across seasons, and between wet and dry years, and is also imperative if health and wider poverty mitigation benefits are to be met and sustained (Getis et al., 2008; Nwankwoala, 2011; Obeta and Chukwu, 2013). Worldwide, 663 million people lack access to safe water although there is regional variation. The populations without access to safe drinking water are mainly in Sub-Sahara Africa and Asia accounting for 84.33% of total. Of the 663 million people, 319 million people (51.88%) are in Sub-Saharan Africa while 260 million people (39.22%) are in Asia (WHO/UNICEF JMP, 2015; USBC, 2015). Sub-Sahara Africa has the largest population without access to safe water. Millions of people in rural communities and poor urban centers throughout this region suffer from lack of clean, safe water (The Water Project, 2015).

Safe drinking water provision in rural areas of Africa and Asia is a major challenge. Rural water supply is stalled by poor coordination, poor maintenance culture, poor technical institutional structure, multiple programs, lack of data for planning, overbearing bureaucratic control by various supervising ministries, lack of professional inputs in projects, lack of community participation, inadequate funding, irregular disbursements of subventions, inappropriate infrastructure as well as lack of clear policy direction, lack of focus in terms of goals and objectives which resulted in the country's inability to achieve full coverage of the rural population with safe water supply (Katz and Sara 1997; Ajayi et al., 2003; Offodile, 2003; Oteze, 2006; Oyebande, 2006; Lockwood and Smits, 2011). In Africa, it is not easy to set up institutional arrangements that will ensure that drinking water facilities are provided, maintained, and managed in a well-organized, fair, and sustainable way (Bakalian and Wakeman, 2009; Sun et al., 2010). Providing safe drinking water in rural areas are mired by both market and government failures. The lack of incentives often shelve the private sector to invest in rural water supplies due to the high costs of infrastructure development and the high transaction costs of collecting fees for drinking water in such areas, especially if the awareness of the value of safe drinking water is limited and if people can easily opt for other water sources (Sun et al., 2010). Ensuring that government staff has sufficient funds and incentives to manage rural water facilities in a sustainable way are main challenges when government provide safe drinking water (Sun et al., 2010). To address these market and government failures, community-based ap-

proaches have been widely adopted yet, it is well-known that communities may also fall short of providing services effectively due to problems such as elite capture and limited capacity (Katz and Sara, 1997; Sun et al., 2010; Lockwood and Smits, 2011).

A fundamental shift from centralized ownership of water supply systems to local ownership and control has been experienced over the past decades (Harvey and Reed, 2003). Along with the shift comes a deviation from "supply-driven approaches" to demand based approaches". The transition follows the market place economics principles: people pay for the upkeep of valued items while unvalued commodities are not paid for. Water systems deteriorate because they are installed in communities that do not value them. Katz and Sara (1997) analyzed the performance of water supply systems in six countries (Benin, Bolivia, Honduras, Indonesia, Pakistan and Uganda) and found that community participation significantly increased sustainability of water supply project.

However, despite the widespread application of community management of rural water supplies in Sub-Saharan Africa, the sustainability of such programs remains unsatisfactory (Harvey and Reed, 2007). Dewilde et al (2008) opined that the deep reliability of water systems and the capacity of communities to maintain and manage the systems need to be evaluated before you can make judgment on the effectiveness of safe water programs.

Analyzing the Economic Community of West African States (ECOWAS), Olokesusi (1990) noted that water supply situation in this region is unsatisfactory. The reasons for this have been the growing population and the water engineers' shortfall in terms of scaling water projects in conformance with purpose. Most often water projects in this region are build beyond the capacity of the engineers to manage and maintain. Although the Millennium Development Goals (MGDs) target of reducing by half the population not having access to safe water supply have been achieved, figures are still high in Nigeria especially in rural areas (WHO/UNICEF JMP, 2015).

Policies to improve water supply in the country have been recommended. For instance, Obeta (2013) suggested that institutional reform, network rehabilitation, improved tariff, support by Local government authorities, human resource development, use of simple technology, setting up a rural development commission among other things are key actions to improve the water supply in rural areas. Nwankwoala (2011) emphasize the need to practice traditional approaches to water supply, the breakdown of sector boundaries and a search for new practical solutions. Uwazie et al. (2009) called on government to decentralize ownership and management of water supply systems to involve optimal community participation and support from the private sector. Onyenechere (2009) indicated that the participation of the private sector in water provision is necessary but needs strong regulations for public protection.

However, the implementation of recommended policies has been problematic. The reasons for this have been largely due to lack of political will and misappropriation of fund (Adewuyi, 2013). Despite the many agencies and programs for water supply in Nigeria, Nigerians still lack access to adequate water supply. In Southeastern Nigeria for instance, 80% of people in rural communities lack adequate access to potable water supply, they still depend on unprotected sources. The people trek long distances to fetch small quantity of water from the streams and springs (National Bureau of Statistics, 2008). Based on the foregoing, it is important to investigate the reasons why access to safe water supply remains inadequate in Southeastern Nigeria. This paper, based on principal research in six rural communities in Awgu local government area (ALGA) of Enugu State, Nigeria will attempt to access the nature of water demand and supply in the domestic sector, ascertain whether water demand is satisfied by supply, identify the factors responsible for water shortage and search for possible alternatives to the current water supply strategies.

STUDY AREA

This study was carried out in Awgu local government area of Enugu State, Southeastern Nigeria. Geographically, the area is located between latitudes 06° 00' and 06° 19' north of the equator and longitudes 07° 23' and 07°35' east of the Greenwich Meridian (Fig. 1). The area is bounded in the north by Udi and Nkanu west local government areas, in the west by Oji River local government area and share boarder with Isochi local government area of Abia State in the south. Currently, Awgu local government area is composed of 20 autonomous communities, namely, Agbogugu, Agbudu, Amoli, Awgu, Awgunta, Ezere, Ihe, Isu-Awaa, Ituku, Mbgidi, Mgbowo, Mmaku, Nenwenta, Nkwe, Obeagu, Ogbaku, Ogugu, Owelli, Ugbo and Ugwueme (Enugu State Government, 2014). Awgu local government area derived its name from Awgu town one of these autonomous communities which also serves as the headquarters. Awgu is a town in Awgu local government area.

The climate of the study area falls under the Tropical Wet and Dry Climate 'Aw' of Koppen climatic classification scheme (Anyadike, 2002; Lutgens and Tarbuck, 2004; Getis et al 2008; Mozie, 2011). The atmospheric condition of the study area depends on the position of the overhead sun and the Inter Tropical Discontinuity (ITD) (Anyadike, 2002). The average daily minimum and maximum temperature of the area are about 23.3° C and 27° C respectively while its average monthly maximum temperature is about 31.5° C (Anyadike, 2002). Rainfall in ALGA is very high and intense. The average monthly rainfall ranges from 250mm in April to 380mm in October, with a mean annual total of 1500mm (Anyadike, 2002).

The geology of the area is marked by coal, shale and sandstone. The shale is bluish, grey, and well-bedded and is occasionally intercalated with calcareous sandstones and limestone (Ofomata, 2002). Also, fine to coarse grained, massive sandstone, locally cross-bedded with some pebble beds and subordinate bands of siltstone and carbonaceous shale are present. The Awgu formation is the youngest of the folded sequence in South-eastern

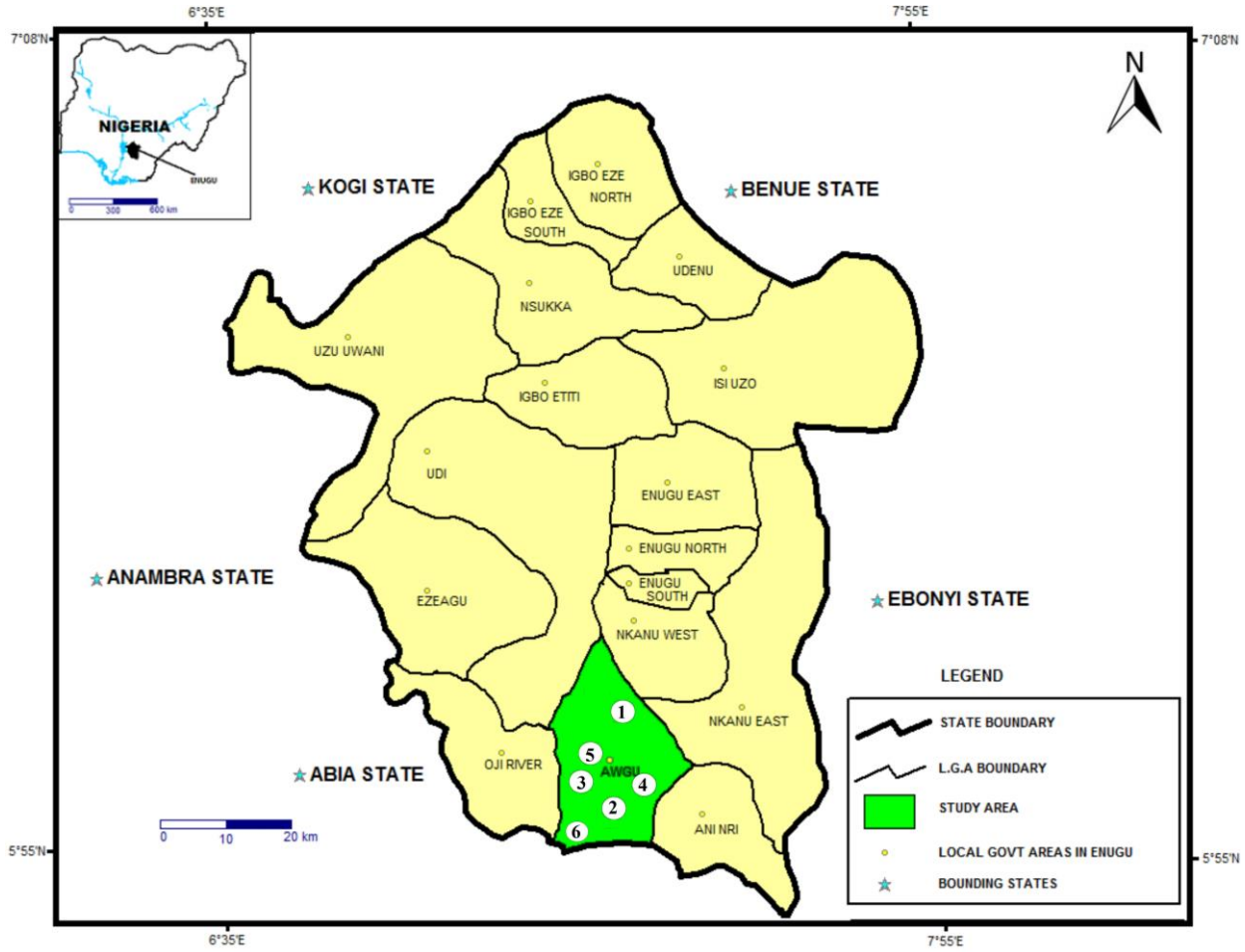

Fig. 1 Location of the study area and the investigated autonomous communities:
1: Agbogugu, 2: Awgu, 3: Mgbidi, 4: Mgbowo, 5: Mmaku, 6: Ugwueme

Nigeria (Ofomata, 2002). The area is also marked by long, broken hills especially in the western flank and lowland in the eastern side. These hills have steep slopes and could attain an altitude of about 350-400 meters above sea level with mean slope angle of 15° and a modal class of 11° (Mozie, 2011).

The study area is drained mainly by numerous finger-like springs and streams. Most of these streams are seasonal. They dry up during the dry season (November- March) and discharge large volume of water in the wet season.

Most of the streams have their source from top of the hills and flow downhill. The vegetation of the area varies with topography. Natural vegetation is denser at the valley and sparse at the top of the hills. Phil-Eze (2005) observed that graminoids cover the top of the hills while trees are dominant in the valley. The top and slope face of the hills are more covered by grasses such as *Andropogon gayanus, Ctenium spp, Hyparrhenia barteri* etc (Ofomata, 1997). The common tree species found are *Isoberlina doka, Anona senegalensis* etc. (National Resources Conservation Council, 1992). Awgu Local Government Area has a population of 198, 134 people as at 2006. Out this, 95, 421 are males while 102, 713 are females (Federal Government of Nigeria FGN, 2009). The distribution of population is uneven; a few areas are densely populated while many others areas are virtually uninhabitable. Majority of the population settle at the foot of the hills because of the difficulty posed by the rugged terrain and because the lowland have fertile soil that support high crop yield. The settlement pattern on the hills is clustered with a nearest neighbor index of 0.82 while settlement pattern on the lowland area is dispersed with a nearest neighbor index of 1.72 (Mozie, 2011).

METHODS

Six of the 20 autonomous communities in ALGA were randomly selected for this study namely *Agbogugu, Awgu, Mgbidi, Mgbowo, Mmaku and Ugwueme* (Fig. 1). A combination of instruments for data collection including questionnaire survey, field observation, key informant interviews and focus group discussions was used to generate data for this research.

Questionnaire Survey

A total of 300 questionnaires, 50 questionnaires in each of the six sampled communities were randomly distributed to households to acquire data on the factors affecting water supply in the area. Trained research assistances administered the questionnaires. The respondents (head of households) were asked to identify the factors that are

responsible for water supply shortage in the study area. Of 300 questionnaires that were administered, we recovered 290 (96.67%). The indicators were predefined as shown in Table 1. The main question was "which of these factors affect water supply in your community"? Data on quantity of water demanded and supplied were obtained through household water budgeting using daily water need and water use based on household sizes.

Table 1 Water supply shortage indictors

Factors	**Label**
Rapid Population Growth	RPG
Seasonality of Water Sources	SWS
Absence of Water Infrastructure	ABWI
Long Distance to Stream/Spring Water Sources	LDSSWS
Non-protection of Stream/Spring Water Sources	NPSSWS
Inadequate Community Participation	ICP
Lack of Political Will	LPW
Politicizing Water Project	PWP
Limited Financial Capacity	LFC
Aging Water Infrastructure	AGWI
Misappropriation of Water Supply Projects Funds	MWSPF
Topographic Constraints	TC
Poor Maintenance of Water Supply Facilities	PMWSF
Tradition and Culture	TNC
Urbanization	URB
Vandalism and Damage of Water Facilities	VDWF
Geographical Location	GL
Absence or Inadequate Water Storage Facilities	AIWSF
Geological Factor	GF
Ownership of Water Supply Facilities	OWSF

Key Informant (Stakeholders) Interview

Interview as a tool of data collection is very important. This is because it allows us to interact with the people allowing them to express their thoughts about the water problems they are facing (Timmer et al., 2007). The following stakeholders were interviewed; traditional rulers (*Igwes*), the water department officials, community representatives, women leaders and youth leaders. A total of seven (7) interviews sections were done. In each of the six communities, one interview sections was held. Those interviewed were the traditional rulers, ward councillors, community representatives, women leaders and youth leaders. Meanwhile, another interview section was held at the local government secretariat. Those interviewed are the water department officials and Enugu State Rural Supply and Sanitation Agency (ENRUWASA) officials. The information gathered from these interviews was used to comprehend and confirm the responses from the questionnaires for better understanding of the problems.

Focus Group Discussions (FGDs)

Focus group discussion (FGD) is a good way to gather people from the same background or experience to talk about a particular topic of concern (Nzeadibe and Ajaero, 2010). A focus group allow participants to talk to one another and build on one other's comments rather than continually responding directly to the moderator unlike interview (Krueger and Casey, 2002). Focus Group Discussions (FGDs) was conducted in each of the six randomly selected communities in the study area. The participants included the stakeholders and head of households. The research participants for the FDGs participated voluntarily and comprised between 6 - 10 participants in each community. The views expressed by the FGDs participants are incorporated into the findings of this research.

Analysis of Data Collected

The analysis of the factors responsible for water supply shortage in the study area was first done using descriptive statistics (frequency and percentage). Principal Component Analysis (PCA) of Statistical Packages for Social Sciences (SPSS) program version 20.0 was used to combine these factors affecting water supply into a few underlying dimensions.

PCA is statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of lineally uncorrelated variables called principal components (Anyadike, 2009; Vialle et al., 2011; Orakwe and Chukwuma, 2015). PCA combines large number of indicators into fewer, more analogous groups, each group defining the underlying dimension in the contributing variables forming the group (Anyadike, 2009). To do this, it is essential to estimate the number of significant factors present in the data. Specifically, a matrix of pair-wise correlations among indicators is collapsed into eigenvectors, which, in turn, are sorted in descending order of their corresponding eigenvalues (Vialle et al., 2011). The analysis is based on the correlation matrix, which is the covariance matrix of the synchronized indicators, to eliminate the scaling effect. The indicators have been computed as the sums of squares of deviations divided by N-1 (where N is the valid number of cases). Significant principal factors (PCs) with eigenvalues greater than unity (i.e., PCs explaining more than the variance of one indicator) were extracted (Orakwe and Chukwuma, 2015). Orthogonal rotation using variance maximisation varimax was used to maximise the variance of the squared component loadings for each component, repartitioning the loadings towards higher components, thus improving interpretation (Anyadike, 2009). The basic calculations were adequately and speedily done using the SPSS program as suggested by Anyadike (2009).

The responses were coded as 1= identified and 0 = not identified. The number of observation was N = 290 for all indicators. For example, ABWI was identified 189 times in 290 observations hence the column for ABWI in the SPSS data entry window will have 189 "1s" and 101

"0s". The 0s will fill up the remaining rows after the 1s to sum to 290 observations. Significant component loadings are considered from an arbitrary threshold of 0.70, based on the size of the component loadings.

RESULTS

Characteristics of Respondents

95% of the respondents are male while 5% are female.1.4% of the respondents are between the ages 20 and 29, 2.4% are between 30 and 39 years, 58.9% are between 40 and 49 years, 12.8% 70 and 79 years and 0.69% are older than 80 years. 2.41% of the respondents have no education, 6.2% have primary school education, 65.5% have secondary school education, and 25.9% have post secondary education. Of this 25.9% of the total, 5.5% have National Certificate of Education (NCE), 7.24% have National Diploma (ND), 12.1% have Bachelor's degree/Higher National Diploma (HND), 0.69% has Master's Degree and 0.34% has PhD. 67% of the respondents are farmers, 12% are artisans, 8% work in the civil service, 9% are traders and 4% has other occupation.

Assessment of Water Demand and Supply in the Study Area

From our findings water supply is not commensurate with demand in ALGA. On average a gap of 28.52% of water demand is not satisfied by supply in the study area. The gap in quantity of residential water demand and supply is presented in Table 2. According to Table 2 the quantity of water demanded l/person/day is greater than the quantity of water supplied. Although water demand is low (48.85 liters) on average, it is not satisfied by supply (34.54 liters). The quantity of water consumed by an individual in the study area is very small and indicates inadequate access to water supply.

The gap between demand and supply is not the same for all communities sampled. Mgbidi recorded the highest water shortage followed by Mmaku because movement in these two communities is difficult such that people find it difficult to access the various sources of water. Mgbowo however, has the least water shortage because the people depend mainly on wells that are very accessible. Also as shown in Table 2, there is water supply shortage in all the sampled communities. A total of 71.48% of water demand was satisfied by supply leading to a gap of 28.52% in the study area.

Descriptive Analysis of Contributing Factors

Table 3 summarizes the various indicators and the frequency of how the respondents perceive them as factor affecting water supply in the study area. These indicators have been classified into three groups based on the percentage of respondents that identified them as influential. From 50% and above are classified as most important, 49% - 25% as important and less than 25% as less important.

Table 3 shows the percentage contribution of the six communities studied to the factors responsible for water supply deficiency in the study area. The three groups of indicators are discussed as follows.

Most Important Factors

Absence of water infrastructure is the most important factor affecting water supply in study area. 65.17% of respondents attest to this. In all the sampled communities, water supply infrastructures are lacking. Although some communities such as Awgu, Ugwueme and Mgbowo have mini water supply system none of them are functional as at the time of this research. Awgu water scheme was constructed about six decades ago but it has not been functioning regularly since Nigeria's independence in 1960. The Ugwueme water scheme is as well not functional just two months after it was completed. Also, Mgbowo water scheme which is the largest water scheme in the study area has not been commissioned since 2003 when its construction started. Other communities lack water scheme but some communities such as Mgbowo, Mgbidi and Mmaku have been provided with boreholes although these boreholes are plagued by constant breakdown and some of them yield water of poor quality. The irregularity of the water schemes and boreholes is attributed to absence of personnel with the technical skill to maintain them in the area.

In the rainy season, rainfall is present and stream discharge is high while in the dry season, the opposite is the case. The consequence of this is that the people are short of water in the dry season and have more supply in the wet season. SWS is considered by the people as the one most important factor responsible for water shortage in the study area. 61.72% of the respondents attested to this condition. In severe conditions water shortage in dry seasons could pose great danger. For example, in Ethiopia, access to safe water in drought is always a major problem, and water-related disease resulting from re-

Table 2 Gap between daily household water demand and supply in the study area

Sampled Communities	No. of Sampled Households	Average Size of Household N=290	Water demand l/day/person	Water Supply l/day/person	Gap between Demand and Supply l/day/person	% of water demand satisfied by supply /day/person
Awgu	49	7	39.14	27.59	11.55	70.49
Mgbowo	48	6	45.89	40.21	5.68	87.62
Agbogugu	46	7	41.06	27.16	13.90	66.15
Ugwueme	49	6	47.04	37.86	9.18	80.48
Mgbidi	49	6	63.09	39.05	24.04	61.89
Mmaku	49	6	56.85	35.37	21.48	62.22
Mean		**6**	**48.85**	**34.54**	**14.31**	**71.48**

stricted water availability and access often causes fatalities (Coulter et al., 2010).

Awgu local government area groundwater resources have not drained even though boreholes are being sunk by ENRUWASA in partnership with the United Nations Children's Fund (UNICEF) in some communities. In three communities (Mgbowo, Agbogugu and Awgu) the people reported that the borehole water is not suitable for drinking because of its salty taste and odor. The Awgu local government area water department officials stated that the poor quality of the UNICEF-Assisted borehole water is due to the geology of the area. 59.65% of the respondents confirmed this situation. It was reported also that several attempts to sink boreholes in some villages was not successful due the underlying rocks (coal) that prevented them from reaching the water table. A comprehensive study of the geology of the area will reveal places to be explored for water and also help in data gathering (Fagoyinbo, 2015). The variation in groundwater quality in geologically complex area is caused by variation in mineralogy and rock chemistry (Fagoyinbo, 2015). In addition, water well yield and groundwater quality are determined by an intricate interplay between fractures in the aquifer, the local soils and saprolite which provide storage and recharge to the bedrock fractures (Toth, 1993).

Government efforts to supply water to the villages have yielded no laudable result. Although water schemes are provided, none of them is currently functional. They are poorly maintained. 58.96% of the respondents attested to this state of affairs. Water storage facilities are inadequate in the study area. 58.27%of the respondents agreed that the absence of storage facilities contributes to water supply shortage in the area. The tanks that were provided by the colonial masters are no longer in used. These tanks are connected to springs such as the *Ngeneofia* in Mmaku, *Nkwo* in Awgu but most of them are no longer available. Storage facilities are indispensable to store up water to be used in the dry season particularly in countries that experience protracted period of drought. FAO (2012) indicated that the level of infrastructure development that controls storage is one of the three main dimensions that typify water scarcity.

Non protection of stream/spring water sources have left most water sources polluted. 51.38% of the respondents confirmed this. Many streams are polluted by villagers who bathe inside the streams, wash their cloths and farm produce as well as defecating along and beside the streams channel which are washed into the stream by runoff rendering the stream water not safe for drinking. Open defecation is highly practiced in the area and this is one of the major pollutant of surface water bodies. FAO (2012) noted that protection and efficient management of freshwater resources (streams, rivers, lakes, and springs) would guarantee their long-term sustainability thus water supply sustainability. To achieve this, WHO (2006) and US EPA (2008) noted that stakeholders should be engaged in formulating and implementing source water protection policy.

Majority of the people in the study area are poor and economically weak. They have low adaptive capaci-

Table 3 Respondents Identified factors affecting water supply in the study area

		Percentage of households that perceived the factors as problem (%)						
Indicator Label	**Nr of households that perceived the factors as problem (N=290)**	**Awgu**	**Mgbowo**	**Agbogugu**	**Ugwueme**	**Mgbidi**	**Mmaku**	**Total**
Most Important								
ABWI	189	12.41	6.55	16.20	14.14	7.59	8.28	**65.17**
SWS	179	12.41	13.79	18.97	4.14	5.17	7.24	**61.72**
GF	173	12.41	14.48	12.07	6.20	6.89	7.59	**59.65**
LGW	171	7.59	7.24	12.07	14.48	8.28	9.31	**58.96**
AIWSF	169	7.24	11.38	14.83	10.00	7.93	6.89	**58.27**
NPSSWS	149	10.00	9.31	12.07	5.86	7.59	6.55	**51.38**
LFC	148	6.55	6.89	9.31	12.41	8.28	7.59	**51.03**
Important								
LDSSWS	140	10.69	9.66	7.93	4.48	5.86	9.66	**48.28**
RPG	139	11.72	8.97	9.66	5.17	6.20	6.20	**47.92**
TC	132	7.93	1.38	0.51	14.14	11.38	10.00	**45.34**
ICP	127	6.89	6.20	10.34	9.66	5.17	5.52	**43.78**
GL	123	9.66	8.96	10.00	3.45	4.83	5.52	**42.42**
AGWI	111	7.24	7.59	4.83	5.86	6.20	6.55	**38.27**
PWP	98	7.24	6.55	5.52	5.86	4.14	4.48	**33.79**
OWSF	96	6.20	8.62	3.10	7.93	3.45	3.79	**33.09**
PMWSF	85	7.24	4.48	4.14	3.45	3.79	6.20	**29.30**
Less Important								
MWSPF	72	5.86	3.79	4.14	5.17	2.76	3.10	**24.82**
VDWF	66	8.28	4.48	1.72	1.72	3.10	2.76	**22.06**
TNC	61	1.72	5.17	5.86	2.41	2.76	3.10	**21.02**
URB	54	6.55	3.10	5.86	0.34	0.51	1.03	**17.39**

ty to cope with water supply shortage consequences. They are also unable to participate in the water projects constructed in the area as a result of their low economic base thereby denying them the ownership of these projects. The people are also unable to buy vended water and self supply is practically limited because it is capital intensive. 51.03% of the respondents confirmed this situation. Financial instability causes a major setback to water development in developing countries (FAO, 2012). The National Bureau of Statistics (NBS, 2008) indicated that about 80% of Southeastern Nigeria rural population is poor as against 20% rich people. This means that most of the people may not be able to pay for water supply services.

Important Factors

Streams and springs are far from majority of the households. Most often they have to climb hills to fetch water from the springs. The long distance to these water sources makes it difficult for the villagers to fetch the quantity of water needed for their domestic activities. 48.28% of the respondents attested to this situation. Uwazie et al. (2009) remarked that reducing the distance to water supply source in rural areas will reduce the stress of women and children who can now devote more time to income generation and education, and will improve the health of community members being ravaged by water related diseases.

For decades even before the colonial period, people in the study area depend on springs and stream and till date, they still depend largely on these traditional sources of water. However, while population is growing rapidly, these sources are not increasing. As a result, the proportion of people depending on each spring and stream has increased by more than ten times. Consequently, there is pressure on these limited water resources and the resultant effect is water scarcity. The disproportionate level of population growth and water supply can be balanced if the available water projects and facilities in various communities in the study area are made functional and population growth checked. 47.29% of the respondents confirmed this situation. Similar situation abound in many parts of the world. Getis et al. (2008) observed that water is essential for development but its demand frequently exceeds supply in many parts of the world especially as population rapidly increases. As a result, regions with high population growth rate are expected to have water supply shortage if proper measures are not taken to equal demand and supply. For example, Glass (2010) noted that the water crisis in Yemen is caused by high population growth and exhaustion of water. The situation is severe and may cause mass fatalities due to dehydration of its people unless immediate action is taken.

The rugged terrain that occupies the study area's landscape hinders not just water development but other aspect of development. The topography of the study area hinders the distribution of water via pipe. In Ugwueme for example, the water scheme that was developed by the Anambra-Imo River Basin Development Authority was not successful in terms of distribution of water to villages because of the rugged nature of the area. Topography is a major challenge if large scale water scheme is developed to supply water to many communities in Awgu Local Government Area because piping will be difficult and expensive. 45.34% of the respondents confirmed this condition. In line with this, Bakalian and Jagannathan (1991) noted that the installation of conventional water infrastructure in complex topographic conditions is very costly. Furthermore, the study area is located where climatic condition does not favor water supply for all the months of the year. In the wet months (April-September) water is available in springs, wells and streams. Also, harvested rain water serves some purpose such washing, cleaning, bathing etc. However, in the dry months (October-March), streams are dry, springs become finger-like, some wells yield small quantity of water and there is no rain water to harvest. 42.42% of the respondents attested to this situation. This situation is typical of the Tropical Wet and Dry climate of the Humid Tropics (Wohl et al., 2012).

The level of community participation in water provision is low in the study area and has led to the abandonment of water facilities and projects. 43.78% of the respondents confirm this. The absence of water committee to manage the projects after they have been constructed has left most the water project dysfunctional. Similar scenario was discovered in Benin Republic, Bolivia, Honduras, Indonesia, Pakistan and Uganda (Katz and Sara, 1997). Also, because there is no regulation on the use of stream water which is supposed to be coordinated by village water committee to ensure the proper use of water e.g. preventing stream pollution by placing sanctions on washing, bathing inside the streams and defecating along the stream channel has left most of the streams polluted all seasons limiting available water especially to people living at the lower course of the streams. In addition, some water projects in the area are initiated no attention to the physical environment parameters of the area before sitting the projects. This is particularly so for the newly installed public boreholes. Water is a very pressing need of the people and can be used for political goals. However, the reverse has always been the case. 33.79% of the respondents attested to this situation. In developing countries especially in Africa, (Briscoe, 1999; Ünver et al., 2012) acknowledged politicizing of water projects as reflected in where to site the project. Water projects are sited based on political affiliations of community leaders.

The study area has some water facilities that are provided by the federal and state government however, most of these facilities are aging. They have been neglected by both the facilities providers and the local authorities while others under construction have been abandoned. Similar situation is obtainable in other developing regions (WWC, 2015). The problem of ownership of the water projects has led to the neglect of some water supply facilities. 33.09% of the respondents confirmed this. Most of the public boreholes are installed by state government in partnership with UNICEF while some are installed by the federal government. The federal government boreholes are beset with incessant break-

down. When they stop functioning, it takes about 1-2 years before they are repaired depending on the administration's priorities. The situation is such that some federal government's water facilities are not maintained by the state government. For instance, the water supply schemes in Ugwueme and Mgbowo are provided by the federal government and because their ownership has not been transferred to the state government, they are abandoned. As a result of the irregular maintenance of the facilities provided by the federal government, communities that have only federal water facilities such as Ugwueme are greatly affected. 29.30% of the respondents attested to this state of affair. As noted by (FAO, 2012; WWC, 2015) poor maintenance of water infrastructure is a growing concern for water supply sustainability in developing countries.

Less Important Factors

Misappropriation of water supply project funds might occurred according to the opinion of 24.82% of the respondents, however, there is no clear evidence to uphold this claim. Moreover, as FAO (2012) noted, a lack of transparency and poor accountability breeds fraud and are reasons for poor performance, resistance to change and unbalanced delivery of water services. Vandalism is a problem that beset water facilities in the area. For instance, in Umuhu village, Awgu autonomous community, the absence of village water guards gave room for some youths to vandalize the pipe connecting the *Ogbuma* stream and the Awgu Water Supply Scheme. They also extort money from villagers who come to fetch water from the stream. 22.06% of the respondents attest to this. This situation reflects the findings by Water and Sanitation for the Urban Poor (WSUP), a non-profit organization based in Zambia and Nkana Water and Sewerage Company (NWSC) in Zambia in 2014 which indicated that water and sanitation utilities often experience vandalism and theft of their property. The study showed that the acts of vandalism take a number of forms: they include water theft leading directly to a loss of revenue for the utility, and the vandalism and theft of valuable metal pipes, fittings and manhole covers leading to an increase in the utility's maintenance costs (WSUP and NWSC, 2014).

Tradition and cultural factors does not have much influence on water supply shortage in the area but it has helped some villages to protect their drinking water sources. For instance, in Awgu autonomous community, there is a tradition that the fishes in *Ogbuma* stream is not to be harvested and no any form of activity is allowed in the upper course of the stream. This tradition has helped preserved and protected the stream for centuries. *Ogbuma* stream is still the most relied source of water in the community. Another example is the *Oviangu* spring. As the tradition states, "there is no tourist activity in the vicinity of the spring" to avoid contamination. In communities such as Agbogugu where such tradition does not exist, their streams and springs are often polluted. 21.02% of the respondents attested to this. From an African perspective, water is of social, cultural, spiritual and economic importance (Zenani and Mistri, 2005). Against this background, Mathew and Le Quesne (2009) indicated aligning culture and tradition with institutional and legal water management strategies could solve water problems better in rural areas. In many rural settings in Africa, access, use and management of resources e.g. water is generally informed by customary rules that form part of a complex system of traditional governance (Kapfudzaruwa and Sowman, 2009).

Finally, urbanization has the least percentage (17.39%) of the respondents attesting to it. The influence of the factor in the study area is felt mostly in Awgu and Agbogugu autonomous communities where there is gradually urbanization. The result is that some households are now far from major springs and streams; they have to take very long distance to these water sources fetching small quantity of water because earliest settlements are found in areas close to streams in the eastern communities and areas close to springs in the western communities of the study area. Urbanization can put unparalleled pressure on a renewable but finite resource, principally water (FAO, 2012).

PCA Analysis of the Contributing Factors

From our analysis, we have been able to identify three unique factors which can be used to explain the causes of water scarcity in the study area. Thus, we have successfully transformed our 20 predictor variables to 3 underlying dimensions (Table 4), which, in order of importance are as stated below:

1. Physical Environment and Inadequate Water Supply Infrastructure
2. Socio-Economic and Geographical Location
3. Management and Socio-cultural Problems

Physical Environment and Inadequate Water Supply Infrastructure

With an Eigen value of 6.519 and 32.597% of variance explained, the first component loads heavily on SWS (seasonality of water sources), GF (geologic factor), LGW (lack of government will), AIWSF (absence/inadequate water storage facilities), and ABWI (absence of water infrastructure). There is positive relationship between this component and the variables. It is described as the effect of physical environment condition and inadequate water supply infrastructure. The study area is in a location that the geology has not favored water supply development. The area is underlain by coal, limestone, clay and shale which have made borehole sinking quite difficult. The boreholes sunk in areas underlain by coal do not yield water and those in limestone areas yield water of poor quality. In addition, the area is located where there is two marked climatic seasons. Springs and stream yield more water in the wet season than dry season. Furthermore, the water supply systems and some of the UNICEF assisted boreholes are not effective in supplying water to the people. This is as result of lack of will by government to provide and maintain water supply and storage facilities.

Table 4 Rotated Component matrix from the SPSS

Rotated Component Matrix[a]			
Investigated variables	Component		
	1	2	3
ABWI	*0.883	0.232	0.194
SWS	*0.910	0.280	0.206
GF	*0.904	0.325	0.212
LGW	*0.895	0.345	0.214
AIWSF	*0.879	0.368	0.217
NPSSWS	0.670	0.637	0.244
LFC	0.659	0.649	0.246
LDSSWS	0.568	*0.734	0.274
RPG	0.557	*0.742	0.279
TC	0.483	*0.779	0.321
ICP	0.435	*0.790	0.358
GL	0.401	*0.786	0.392
AGWI	0.318	*0.732	0.509
PWP	0.248	0.635	0.647
OWSF	0.241	0.615	0.667
PMWSF	0.217	0.484	*0.773
MWSPF	0.204	0.314	*0.885
VDWF	0.200	0.241	*0.919
TNC	0.195	0.194	*0.925
URB	0.186	0.152	*0.897
Eigen value	6.519	6.025	5.886
% variance	32.597	30.127	29.429
Cumulative %	32.597	62.724	92.153
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

Socio-Economic and Geographical Location

This second component has an Eigen value of 6.025 and explains 30.127% of the total variance. It loads heavily on ICP (inadequate community participation), GL (geographical location), TC (topography constraints), RPG (rapid population growth), LDSSWS (long distance to stream/spring water supply source) and AGWI (aging water infrastructure). All the variables show that there is positive relationship between the variables and the component. Generally, this component describes the problems caused by socio-economic and physical barriers in the study area. This is because majority of the people in the study area are poor coupled with rapid population growth that further push the dependency level higher leading to more socio-economic weakness (increase in poverty level). The teeming population becomes burden to the individual household, the community as a whole as well as the government such that investment in water infrastructure is limited due to high dependency rate on head of households which limit households' capacity to participate in water supply development. Also, the rugged nature of the area's landscape makes it difficult for water distribution through pipes because of the numerous jointed hills that will obstruct the laying of pipes. This component is therefore, described as the effect of socio-economic and physical barriers.

Management and Socio-cultural Problems

The third component has an Eigen value of 5.886 and explains 29.429% of variance. It loads heavily on VDWF (vandalism and damage of water facilities), TNC (tradition and culture), URB (urbanization), and MWSPF (misappropriation of water supply project funds). This factor is difficult to interpret but it could be described as management and socio-cultural problems. This is because proper management of water facilities is lacking in the area. Vandalism of water facilities could have been prevented if the water department of the local government employs guards to secure water facilities and ensure that damaged facilities are repaired or replaced by judiciously appropriating water funds. The level of education of a society reflect the social status the society accords, their level of thinking and to some extent their economic capability. The level of education in the study area is low with associated poverty of the mind which manifest as vandalism of government property (water facilities) by unemployed youths owing to their thinking that government has not done enough to elevate them from abject penury. In addition, communities that their tradition and culture does not provide for water protection have most of their water sources polluted. Furthermore, urbanization will increase the demand for water because there will be other demanding sectors such as industrial and commercial sector. Also as more buildings are erected, recreation centers built and other social amenities put in place, the natural hydrological system will be altered. Urbanization affects hydrological components such as precipitation, evaporation, infiltration, evapotranspiration (Ezenwaji, 2012; Obeta, 2013). Currently, this factor has less influence on water supply in the area but could be a major problem in the future.

DISCUSSION

Efficient water supply is very vital to achieving sustainable development in the area because water supply has link with rural livelihood system (Houweling et al., 2012). The shortage in water supply could have both direct and indirect impact in the area. Water supply shortage can affect directly some domestic activities such as bathing cooking, washing, basic sanitation and waste disposal. Insufficient water for these activities can result to poor hygiene which spreads water-related diseases such as diarrhoea, cholera, malaria, dysentery etc. (Basu et al., 2015). Consequently, households will have huge part of their income spent on health care leaving them with insufficient money for education, nutrition, better shelter etc. (Pearson et al., 2015).

Water supply shortage could also hinder economic progress of the area. Poverty reduction is linked to water development especially as the economy of the area is greatly dependent on agriculture. Agriculture is the primary prospect for rural economic growth and development and water is very vital to this. Adequate access to water supply can help lift many rural households out of poverty because water is crucial to large scale agriculture especially in dry seasons, crops and animals need water for their growth (Crow et al., 2012). Insufficient water for agriculture could arrest the food security of the area leading to poor nutrition. Poor nutrition could weaken the people that they die from illnesses and infections that are not usually severe (Lenton and Muller, 2012).

Generally, the main water supply problems in the study area are related to physical environmental barriers and anthropocentric factors. The physical barriers are geology, climate and relief while the anthropocentric factors are water infrastructure deficit, lack of community participation, population pressure, financial constraints, politics, vandalism, poor maintenance culture, urbanization, tradition and cultural factors. Based on our analysis of the factors responsible for water supply shortage in the study area, the following recommendations are made in the following paragraphs.

Public awareness campaigns have been recognized as effective sensitization program in water management (Butler and Memon, 2006; Willis et al., 2011). Rural people need to be informed that water is very important to their development and they should try to preserve and conserve the water resources they have to avoid further scarcity. The incessant pollution of streams and springs through washing of cloths, bathing and defecation in the stream could be attributed to lack of awareness of the consequences of such activities. Awareness can be done through the use of community town criers, cultural festivals, faith-based organization, school advocacy initiative, radio and television jingles (FAO, 2012), social media platforms and short message service (Nzeadibe and Ajaero, 2011).

The ownership of all the water projects including those installed by politicians should be specified. It will be better to transfer ownership to the state government because it is closer to rural communities than federal government and also, the funding of projects is done by the state government. However, the local government should be made to monitor their water facilities through community water committee. The committee will report any dysfunction, failure and maintenance need of the water facilities in their community to the local government. The water committee in each community should be appointed by the traditional rulers and approved by the local government chairman. In this way, the monitoring of water facilities will be the responsibility of the community it is servicing. Water guards should be employed as substantial staff of the local governments. The guards will have the responsibly of monitoring water facilities and sources of water to ensure that there is no vandalism and pollution of water sources. The water committee in each community will be made to supervise that guards and report to the local government.

The concerned state government institutions should commence the study, design and construction of new water supply systems using technologies that have been developed as appropriate responses to the physical environment conditions in the area. Provision of more boreholes and wells in villages would help reduce the trekking distance to where boreholes are sited as well as streams and spring. Proper study should be done before drilling new boreholes. Wells are quite easier to construct and relatively cheaper therefore, wells should be provided also as alternative to boreholes should they break down. Local craftsmen should be trained on how to drill and repair boreholes and other water facilities. Borehole drilling is still very difficult in the study area because the expertise is lacking. In the Nigerian energy sector, Ajao et al. (2009) advocated for the training of local craftsmen on how to install and maintain power facilities to enhance mass production and subsequent commercialization of power. In line with this, training local craftsmen will reduce costs of labor in the water supply facility installation and maintenance.

Restoration of all village tanks that were formally connected to springs should take effect immediately. These tanks such as the *Nkwo* Spring tank in Awgu autonomous community were provided by the colonial administration however, after independence they were all neglected. Also, addressing the problem of poor service coverage and aging water infrastructure should be targeted. Water supply infrastructures are essential to taping local capacities to contribute to social and economic development and crucial to delivering long-term water security. Sustained investment in water infrastructure is an essential pillar for developing countries (WWC, 2015).

Conserving water to reduce water waste is a first step in water management (Rahman et al. 2012). Thus the communities should adopt various water conservation measures such as installing concrete tanks in springs to avoid the waste of the spring water especially in dry seasons when water yield from these springs are low and to protect it from contamination (Khastagir and Jayasuriya, 2010). Harvested rainwater can be an alternative source in the dry season. Households should install large tank particularly underground tanks for collection of rain water in the wet season which can be used when springs and streams yield small quantity of water in the dry and also household water treatment should be encouraged (Vohland and Barry, 2009).

Private individuals, groups or organizations in the area should also partake in water supply development by placing taps where villagers can fetch water. In addition, government should encourage private water supply development by providing soft loans to those who will to develop the water resources in the area.

CONCLUSIONS

This research has shown that the factors affecting water supply in Southeastern Nigeria are mainly physical environment barriers, water infrastructural deficit, socio-economic problems geographic location and management bottlenecks. The research recommends that

water development in rural communities should be a stepwise process; each stage should correlate with physical environment conditions and socio-economic realities. Sequel to the fact that majority of the people in the study area are engaged in subsistence farming and other extractive economic activities with very low economic and educational base, it will be more sustainable not to install multimillion high-tech water facilities that the community does not have the capacity to partake in their provision and management. No doubt community participation is a precondition for sustainability, i.e. to achieve efficiency, effectiveness, equity, and reliability (Harvey and Reed, 2007) however it requires ongoing motivation for continuing participation (Batchelor et al., 2000). Communities may have participated in the water supply planning process however this does not mean that they will sustain participation in service delivery or that they will successfully manage water supply. Community management is a development plan whereby community members assume control-managerial, operation, and maintenance responsibility for the water system (Doe and Khan, 2004). The beneficiaries of the water supply have full responsibility, authority, and control over it (Harvey and Reed, 2007). Studies in Sub-Saharan Africa showed that communities participated in the planning and provision of water projects when motivated but they are unwilling to manage them and also they lack the education and technical know-how to make an informed decision on management (Batchelor et al., 2000; Doe and Khan, 2004; Harvey and Reed, 2007).

As a first step, traditional sources sustenance intervention should be launched. About 80% of rural households in Sub-Saharan Africa depend on traditional sources (hand dug well, stream, river, pond, spring etc.) some of which they have discovered or occur naturally in their locality (Harvey and Reed, 2007; FAO, 2012), these sources can be developed and upgraded to provide sustainable access to safe water. Full information on all possible options should be provided to community members and private sector in order for them to decide on the most suitable technology and service level for them. Next, government should sponsor the training of the local people on installation and maintenance of mini water systems such as hand pump and borehole. Later, mini water supply system (borehole, hand pump) that can serve small area such as group of households can be introduced. As the community progress along a developmental path and the economic, educational and technical base of the people have improved considerably, high-tech facilities may be deployed. This stance does not infer that all people do not have equal right to water but that water supply in rural areas should be development in stages each stage corresponding with the community's participatory and management capacity so that the water supply facilities will be maintained after installation except if government, donor agencies or private bodies that install them are also willing and ready to make them work regularly.

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