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Spatio-Temporal Variability in Domestic Water Demand and Supply in Calabar Metropolis

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Abstract: *Water is vital for the sustenance of life and the economic development of a country. In Nigeria, the government has put in place different programmes aimed at improving and stabilizing the water supply condition of its populace. Unequal temporal and spatial variability in water demand and distribution in the area is due to change in climate, high demand for drinking water, urban expansion and population explosion. The situation becomes aggravated by corrupt practices exhibited by heads of Municipal water boards saddled with the responsibility of managing the process of water supply in Calabar metropolis. A total of ten (10) wards were selected for the study and two hundred and thirty (230) questionnaires were distributed to the respondents inhabiting the study area. Private boreholes were the highest source of water supply with 41.3% and streams was the lowest with 4.3%. Also people residing at parliamentary Road trekked a distance of 5.5km to access potable water. The research revealed that domestic water demand and supply varies spatially and temporally among households within the study area. It was recommended that development in the study area should take into account projected population growth and finite water resources. Government should provide more water sources and pumping stations with independent water connection networks in all the wards within Calabar Municipality. Government should also augment the existing pipes and fix the dilapidated ones in order to increase the quantity of water supplied in the area.*

Keywords: *Water Consumption, Variability, Water Supply, Population Growth, Household Size.*

1. INTRODUCTION

Water is considered as the basic substance from which all matter is made up of since it supplies a large portion of the hydrogen and oxygen needed in the body. Natural water sources depend on the environment and geographical location, while man-made sources are location specific and supply driven. The concept of domestic water is based on the assumption that a rational house would like to satisfy all its water needs. Water is an essential resource for lives as 70% of the human body weight is made up of water. The spatial and seasonal variability of water supply and demand are causes of water scarcity in Calabar metropolis.

A study on water supply carried out in Wukari town by World Bank, (2005) through partnership approach, observed that the water demand for the northeast part of Nigeria was 301 litres by individuals for daily metabolic and hygiene. This figure is slightly above the national water requirements for Nigeria fixed at 231 litres per day per person for rural dwellers and 601 litres per day per person for urban inhabitants.

Uneven distribution of water may be attributed to precipitation, geographical landscapes, accessibility, population distribution and socio-economic factors. Clean water is potable, aerated, odourless, tasteless, colourless and reliable. Water occurs naturally in three states namely gaseous, liquid and solid. The use of water by man is all nearly concerned with the liquid state, and it is certain then that man can survive longer without food but not without water because he uses water for cooking, drinking, irrigation and industrial purposes. Uneven spatial distributions of water with very wide geographical variation at some regions have been experiencing catastrophic floods while many vast areas suffer water scarcity. This situation is increasingly intensified by the widespread quality deterioration and land degradation resulting from mismanagement of these resources as well as the highly published negative effects of climate change.

Water is continually reprocessed and delivered to the land by hydrological cycle in its liquid state for man's utilization. This is due to the fact that during the wet season, water supply from the various

sources hardly meets the water need of the urban populace. In developing countries such as Nigeria, water is a necessity for socio-economic survival. The inadequacy of supply results in long distance trekking in search of water and in most instances where these sources are reached; there is also the problem of poor quality and sometimes polluted with household waste as well as other impurities (Weligamage, 1998). Scarcity of water makes taking of regular baths and washing of cloths a "luxury as the little quantity procured is reserved for drinking and cooking".

The provision of water for the populace is mainly the responsibility of the government. Variation in supply only occurs when the supply at certain period of the year (dry season) does not meet the demand at such season, and this could either be with the total quantity supplied, quality and the reliability of supply. The total available quantity of water in Calabar Metropolis shows that there is variation in time and space with regard to the quantity of water demanded by the populace and the quantity supplied. With the problem of variation in quantity of water supply, which in most cases is not adequate, people have resorted to fetching water from broken pipes, leaking water pipes, streams, ponds and rivers which are unhygienic for human consumption. Occasionally, unconfined aquifers are formed during periods of heavy infiltration into the soil and downward movement of infiltrated water is restricted by the deeper layer of relatively low permeability. The water then "pond" on the restricted layer and form perched groundwater with a perched water table. When infiltration of the surface has ceased, perched ground water disappears as it moves down through the perching layers to the underlying aquifer. This perched water table results in dryness of such boreholes after pumping for some time (Eni, 2011).

The growth of services from domestic and industrial sectors in terms of demand for water is on the increased. The situation has escalated due to the high rate of urbanization and increasing demand per person. Presently, excessive groundwater use and its effects on some part of the metropolis like Calabar South are already of major concern. The spatial variation of water availability is crucial in proper demand management due to the increased in the Calabar metropolis population and should be captured in future water needs projections. In Calabar metropolis, high water demand is as a result of rapid population growth, unplanned urbanization, and the high rate of water extraction from the ground for different uses without replacement which is more problematic when extraction exceeds the restoration capacity. High population growth has accelerated water demand tremendously within the study area cum the demand for freshwater meant for domestic use and processing of food for consumption purpose.

Moreover, researches carried out by different scholars have shown that water supply problems affect food production environmental protection, sanitation and economic development of that locality. The problem of water scarcity can be compounded by high rate of water exploitation from the ground without replenishment, increase urbanization, expansion of mechanized agriculture, increased population size and high industrial revolution. These problems enumerated are aggravated in the developing countries such as Nigeria where there are faced with the problem of inadequate capital and backward technological development utilization in this sector. Therefore, the effort in this paper to analyzed supply and demand of water in Calabar metropolis is an important step forward and this is even more important in today's measuring focus on integrated water resources management in river basins.

2. STUDY AREA

Calabar Metropolis is located on longitudes $08^0$21"E and $08^0$25"E and Latitudes $04^0$15"N and $05^0$15"N. Calabar is bounded by the great Kwa River on the East, Calabar River on the west and the mangrove swamp forest. The study area is located at a distance of about 35 kilometres from the Atlantic Ocean and covers a total area of about 333.92km, (Effiong-Fuller, 1991). Geologically, Calabar is composed of two major formations which are the coastal plain sands and the alluvial deposits, and the entire formation makes good aquifer which means that its water bearing capacity is high. The groundwater condition is variable in time and space. There are areas in which the water table is almost at the surface rendering the areas marshy and swampy mainly during the rainy season such as the University of Calabar area, but other areas exist at Diamond hill area.

There are two major drainage systems in Calabar, namely the Calabar River system and the Great Kwa drainage system which are associated with other ten minor drainage systems. Calabar has a sub-equatorial type of climate with its maritime position exercising great influence. The mean annual

temperature is about 25^0c and the average annual rainfall is 300mm. The relative humidity is high all year round, with the highest values recorded between July-August and the lowest value in February. During the wet season Calabar does not experience water shortage but when the dry season sets in, the quantity of water supply drops, due to dryness of some boreholes and the variation in the intensity of rainfall within Calabar metropolis caused by climate change.

The population census for 2006 conducted by the National Population Commission of Nigeria (NPC) puts Calabar metropolis population figure at 371,020 and projected to 453,203 in 2014. The city is expanding towards the suburbs, with rural-urban migrants settling at the suburb, this has further mounted pressure on the natural environment and the demand for potable water for consumption and domestic activities. The major sources of water for domestic use vary from one neighborhood to another. For instance residential districts of Anantigha, Edibe-Edibe, Henshaw Town and 8 Miles rely on streams and ponds, while in Goldie, Uwanse, State housing, Marina, Yellow Duke and Efio-Ette axis, people there depend on public stand pipe as source of domestic water supply. The need for borehole water came to stay within the 1980s when the inhabitants of Calabar lost confidence in the pipe borne water supply due to insufficient supply and population growth. People now picked interest in sinking personal boreholes as typified in areas such as Satellite town, Ikot Ishie, Diamond and Etta Agbor axis.

3. METHODS AND PROCEDURE OF DATA COLLECTION

The study relied on both primary and secondary data. Primary data were collected from questionnaires, and it was designed by a combination of various techniques to accommodate close ended questions and open ended questions simultaneously. The household was the major focus group from which the basic information needed for the study was gathered. The study area was divided into strata based on the wards and from here systematic random sampling was then employed to identify the household heads who now served as the respondents. Questions asked in the questionnaires were focused on (a) The existing water supply system, (b) Water variation with space and time and other sources of domestic water supply in the study area (c) Quantity of water required by each household per day (d) Problem of water scarcity and the remote causes. A total of 250 questionnaires were distributed to respondents at the selected residential areas. A Global Positioning System (GPS) was used to take the co-ordinates of all the water sources present in the study area.

Table 1. *Questionnaire distribution per wards*

Sampled locations	**No of questionnaires distributed per ward/street.**	**No of questionnaire returned**
Diamond Hill	25	20
Ikot Ishie	25	25
8 Miles	25	21
Parliamentary Road	25	25
IBB Way	25	23
Afokang	25	22
Goldie Street	25	25
Yellow Duke	25	24
Mayne Avenue	25	23
Palm Street	25	22
Total	**250**	**230**

A total of 10 wards were selected from the study area and within the 10 wards, 10 streets were selected randomly from which the household heads were interviewed and questionnaires distributed to the inhabitants of the area. A total of 230 questionnaires were returned by the respondents.

The sample chosen is large enough to serve as an adequate representative and small enough to be chosen cost-effectively in terms of both time and difficulty of analysis.

4. RESULTS AND DISCUSSION

Adequate water supply is supposed to be equivalent to development whether it is urban or rural. In some city peripheries water is either scarce or costly when it is available. Many urban dwellers trek several kilometers every morning and evening in search of potable water while others depend on

polluted springs, rivers, streams and shallow boreholes for domestic use. Although there are private boreholes spatially located within the study area the problem of water supply and demand still persist due to high population explosion and the failure of the government to integrate the principle of sustainable development into the country policies and programmes. The results obtained from the field were recorded in tables and charts as shown on table 2:

Table 2. *Domestic water sources*

S/No	Water sources	Frequency	Percentage
1.	Public tap	40	17.4
2.	Private tap	60	26.1
3.	Water Tanker	25	10.9
4.	Private borehole	95	41.3
5.	Streams/River	10	4.3
		230	**100**

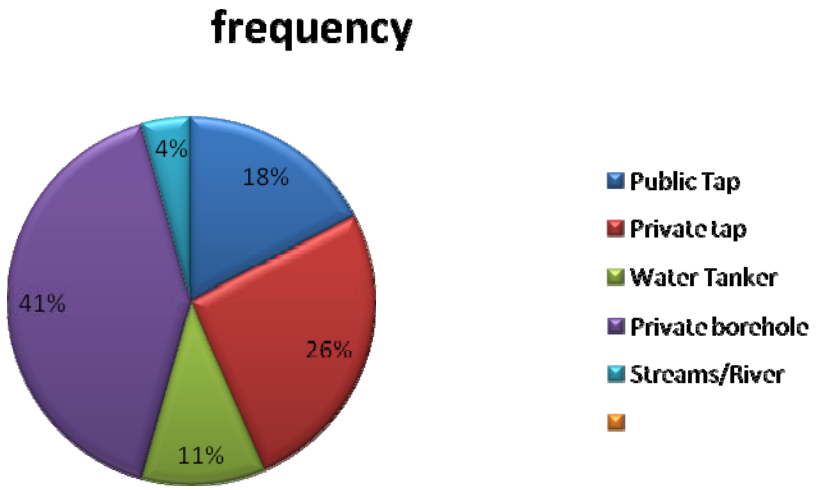

Fig. 1. *Domestic water sources*

It was deduced from table 1 that 41.3% of the respondents sourced water from private boreholes, 26,1% from private tap, 17.4% from public tap, 10.9% from water tanker and 4.3% from streams and River. The research revealed that most of the inhabitants sourced their water from the private borehole, which attracts a cost. The findings agrees with the works of Mac Donald et al, (2005), who opined that, the main sources of water for households are piped supply from treated water sources, untreated piped water from groundwater sources, shallow boreholes, wells, and pond, springs, lakes, rivers and streams. Water supply and demand development of any country requires a long-term process which has to do with careful planning and implementation, geared towards achieving improved conditions of life. Consequently, there is need for effective integration of theory and practices peculiar to our state in planning for urban and rural water supply scheme using local experts.

Table 3. *Distance covered to fetch water from private boreholes*

S/No	Sampled location	Latitudes	Longitudes	Distance (km)
1.	Diamond Hill	$04^0$21”	$08^0$26”	3.5
2.	Ikot Ishie	$05^0$15”	$08^0$21”	4.2
3.	8 Miles	$05^0$17”	$08^0$20”	3.0
4.	Parliamentary Road	$05^0$20”	$08^0$22”	5.5
5.	IBB Way	$04^0$21”	$08^0$23”	3.8
6.	Afokang	$04^0$12”	$08^0$27”	4.0
7.	Goldie Street	$04^0$18”	$08^0$24”	5.9
8.	Yellow Duke	$04^0$15”	$08^0$25”	2.3
9.	Mayne Avenue	$04^0$17”	$08^0$28”	3.1
10.	Palm street	$04^0$20”	$08^0$22”	1.8

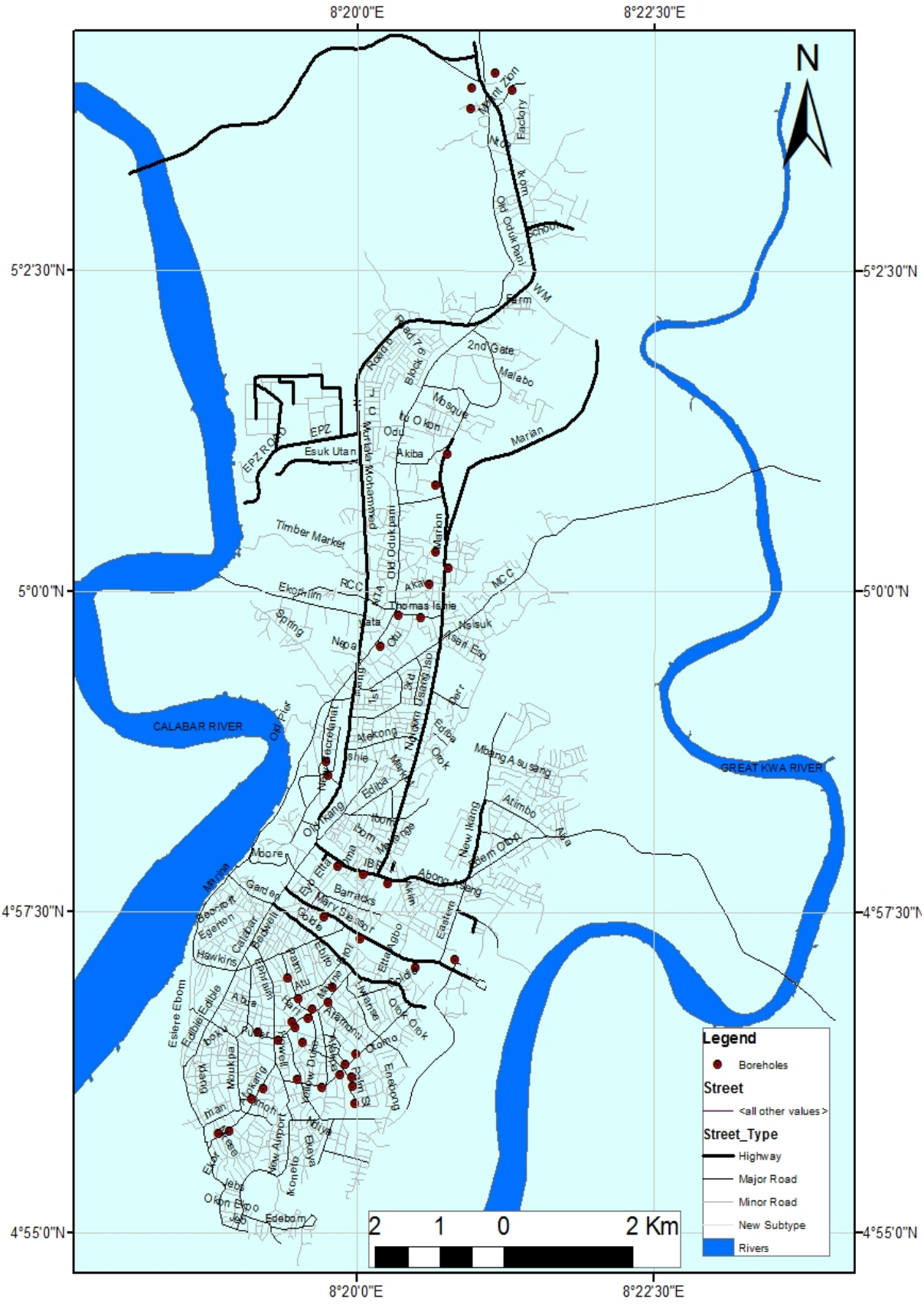

Fig. 2. *Map of Calabar Metropolis showing Borehole distributions*

Table 3 shows that residents of Goldie Street cover longer distances of about 5.9 km in search of potable water while people at Palm Street cover shorter distance of 1.8 km. The problem of water scarcity is more pronounced in the dry season than in the wet season. Household size affects the consumption of water in the study area. This was further buttressed with the pie chart below:

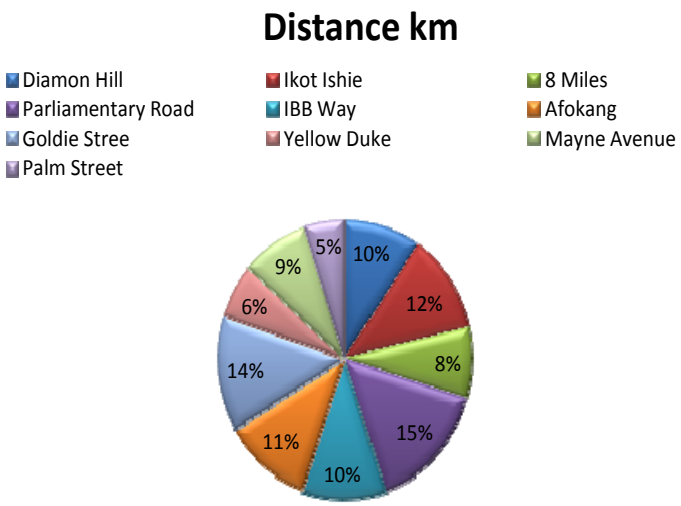

Fig. 3. *Distance covered (km)*

Table 4. *Spatial variability of demand and supply of water based on population*

S/No	Sampled location	Population size	Sources of water supply	Percentage
1.	Diamond Hill	7,890	78	7.95%
2.	Ikot Ishie	12,560	105	10.70%
3.	8 Miles	14,340	210	21.40%
4.	Parliamentary Road	8,570	140	14.27%
5.	IBB Way	6,980	98	9.98%
6.	Afokang	11,450	86	8.79%
7.	Goldie Street	10,800	90	9.17%
8.	Yellow Duke	6950	68	6.93%
9.	Mayne Avenue	7950	49	4.99%
10.	Palm street	6300	57	5.81%

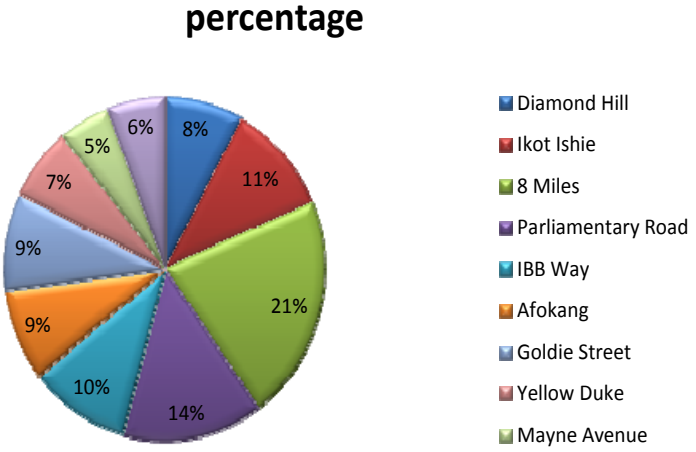

Fig. 4. *Spatial variability of demand and supply of water based on population (percentage)*

Water supply has temporal variability as revealed in table 3. The highest supply was seen at 8 miles with 21.4% supply to the inhabitants while the lowest supply was at Mayne Avenue with 4.99%. This might be as a result of supply from the basic sources such as private boreholes, taps and streams. The spatial and temporal variations justify where and when water is needed.

This research showed that the inhabitants of 8 miles needed water most. The supply variation over time, except distribution of population was attributed to financial incapability of households, and distances from the sources, and topographical constraints. Population growth seems to be the most influencing factor that determines water supply and consumption in Calabar Municipality, because increased in population accelerates demand for water supply to meet the needs of the uprising population. Absence of physical infrastructure, ignorance by government agencies, faulty pumping equipments were the major cause shortage of water.

Table 5. *Consumption of water per household*

Utility of water	**Consumption of water per household**	**Percentage consumption**
Bathing	62	26.9
Cooking	70	30.5
Drinking	45	19.6
Cloth washing	33	14.4
House cleaning/gardening	20	8.6
	230	**100**

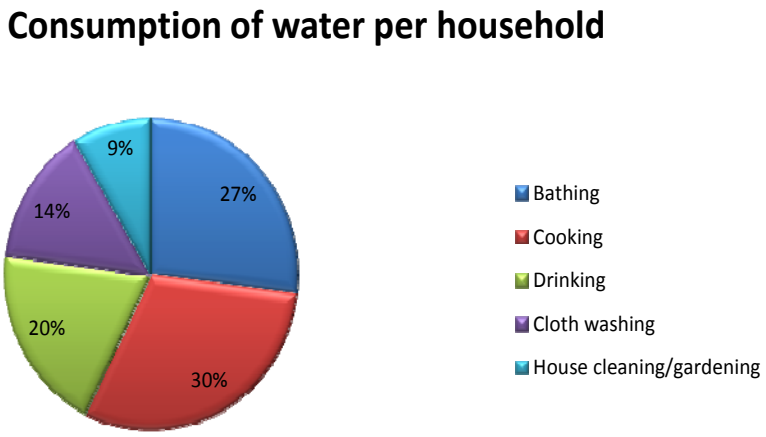

Fig. 5. *Consumption of water per household (percentage)*

The study shows that household used water mainly for cooking with 30.5% and sparingly for house cleaning gardening with a value of 8.6% (see table 5).It was deduced that household use water on priority basis and immediate needs. This confirms that household size is proportionate to demand of water while per capita consumption is inversely related to household size.

5. CONCLUSION

The water resources availability and demand in Calabar metropolis show substantial spatial and variations. Water demand and supply within Calabar metropolis indicated that some areas suffer water scarcity due to inadequate availability of water while other areas are water scar only at dry season. This varies from one part of the study area to another. The spatial variation of population growth is a major factor in future water demand estimations for the state. The sustainability of ground water use in some locations is an important issue for future demand estimations.

The importance of water to living things cannot be over emphasized because water constitutes about 70% of the human body. Of all the principal utility systems required by Calabar, water is the most important because of its utilization for domestic needs. A plan for adequate purism of domestic water supply in Calabar should be designed to stabilize the adjourning rural populations that constitute a potential source of stress on the facility in ground.

REFERENCES

Ajayi, JO, Sonuga FA, Aliboh OP. Oloko DA (2003). Sustainable potable water supply to Nigerians through conjunctive development of surface and groundwater resources. In: A. A Elueze (ed.) Contributions o! Geosciences and Mining to National Development (NMGS), pp. 9-17.

Amarasinghe, Upali A., R. Sakthivadivel, L. Mutuwatta (1998). Water Scarcity Variations within a country: A case Study of Sri Lanka IWMI Research Report 32. Colombo: International Water Management Institute.

Babalola, J.O (1990). Coping with water supply demands and growth in the 1990s. Water Resource. J. Nig. Assoc. Hydrogeol. (NAH), 2(1): 26 -30.

Callow RC, Robins NS, MacDonald AM. MacDonald DMJ. Gibbs BR, Orpen WRG, Mtembozeka P. Andrews AJ, Appiah SO (1997). Groundwater management in drought-prone areas of Africa. Int. J. Water Resource. Dev., 13: 241-261.

Central Water Commission (CWC) (1998). Water Statistics of India, Delhi, India: Central Water Commission. Falkenmark, Lundqvist and Widstrand (1989). Macro-scale water scarcity requires micro-scale approaches: Aspects of vulnerability in semi-arid development. Natural Resources Forum 13 (4): 258-267.

Chakraborly, S. Paul, P.K.. & Sikdar, P.K. (2007). "Assessing aquifer vulnerability to arsenic pollution using DRASTIC and CIS of North Bengal Plain. A case study of English Bazar Block. Malda District West Bengal, India. "Journal of Spatial Hydrology 7(1): 10 - 121.

DWAF (1997) White paper on a National Water Policy for South Africa. Department of Water Affairs and Forestry.

Dyson, M. Bergkamp, G. Scanlon, J. (eds) (2003) Flow - the essentials of environmental flows. 1UCN. Gland, Switzerland and Cambridge, UK . xiv+118 pp.

Edmunds, W.M.E. (2009). Palaeoclimate and groundwater evolution implications in Africa adaptation and management. *Hydro!. Sci. J.* 54: 781 - 792 (this issue).

Eni D.I., Obiefuna, J.N. Oko, C. & Ekwole, J. (2011). Impact of urbanization on subsurface water quality in Calabar municipality, Nigeria International Journal of Humanities and Social Science, 1(10): 167- 173.

Eni, D, Imoke, Ndifon, H.M. & Bisong, J.N. (2006). Assessment of the portability of water from

Eni, D. Imoke & Effiong J. (2011). Seasonal variations in hydrochemical parameters of ground water in Calabar South Cross River State, Nigeria. *British Journal of Arts and Social Sciences,* 3(1):85 - 97.

Eni, D. Imoke, & Digha, 0. Nicholas (2014). Estimation of ground water recharge using the chaturvedi method in Akpabuyo Local Government Area, Nigeria. *International Journal of Scientific Research and Education,* 2(2): 589 - 600.

Eni, D. Imoke, Effiong, J. & Upla, J. Ibu (2013). The influence of aquifer depth on microbial parameters of borehole water in Calabar Metropolis, Nigeria. *International Journal of Science, Environment,* 2(2): 286 - 299.

Eni, D.I., Atu, J.E., Oko, C. & Ekwok, I. (2011). Flood and it impact on farmlands in Itigidi, Abi Local Government Area, Cross River State, Nigeria International Journal of Humanities and Social Science, Vol. 1, No. 9, 98 - 104.

Ezeigbo HI (2003). Towards sustainable potable water supply to Nigerians in the New Millennium. In: A.A Elueze (ed.) Contributions of Geosciences and Mining to National Development (NMGS). pp. 19-21.

FAO (Food and Agriculture Organization) (2002a). AQUASTAT Statistical Database www.fao.org Rome: FAO

Foster, S. Tuinbof, A. & Garduno, H. (2006). Groundwater development in sub-sahara Africa strategic overview of key issues and major needs sustainable groundwater management lesson from practice. Case profile collection number 15, World Bank. Washington DC, USA.

Glieck, Peter H. (2000). The world's water 2000-2001. The Biennial Report on Freshwater Resources. Oxford, England: Oxford University Press.

GOI (Government of India) (1999). Report of the National Planning Commission Integrated Water Resources Development, India: Government of India

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

Hanidu JA (2003). Provision of potable water supplies to rural communities in Nigeria. In: A.A Elueze (ed.) Contributions of Geosciences and Mining to National Development (NMGS), pp. 23-25.

ICID (International Commission of Irrigation and Drainage) (2000). Country Policy Support Study - India, In Country Policy Support Studies, Delhi: International Commission of Irrigation and Drainage WM1

Igboekwe, M.U. & Adindu, R. (2011). Groundwater recharge through infiltration process. A case study of Umudike, Southeastern Nigeria, vol. 3(5).

IWMI (International Water management Institute) (2000). World Water Supply and Demand 1995 to 2025, Draft Report prepared for World water Vision. Colombo, Sri Lanka: International Water Management Institute.

IWP (India Water Partnership) (2000). India Water Vision 2025, New Delhi, India: Institute for Human Development.

kabera, T. & Zhaohui, I. (2008). "A CIS DRASTIC model for assessing groundwater in shallow aquifer In Yunchenge Basin. Shanix. China. *Journal of Applied Science Medwell Journals*, 3(3): 195 - 205.

Long, D.T. & Salem, Z.A. (2006). Hydrochemistry of carbonate groundwater of an urban area. Water resources research, pp. 1229-1238.

MacDonald, AM, Davies J, Calow RC, Chilton PJ (2006). Developing Groundwater: A guide for rural water supply. ITDG Publishing, Rugby, UK.

MICS (1999). Multiple Indicator Cluster Survey, WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Moriarty P, Butterworth J (2003). The productive use of domestic water supplies: How water supplies can play a wider role in livelihood improvement and poverty reduction. Thematic Overview Paper, IRC International Water and Sanitation Centre. Available at http://www.irc.nl.

Molden, David (1997). Accounting for water use and productivity. SWIM paper 1. Colombo, Sri Lanka: International

Nicol AL (2000), Adopting a sustainable livelihoods approach to water projects: Implications for policy and practice. Working Paper 133, Overseas Development Institute, London. Available at http://www.odi.org.uk/publications.

Nwankwoala HO (2009). Sustainable groundwater development and management in Nigeria: Mission achievable or mission impossible Water Resource. J. 19: 63-68.

Nwankwoala HO, Mmom PC (2008). Groundwater utilization versus millennium development goals: Implications for sustainable development. J. Nig. Environ. Soc. (JNES), 4(3): 34-42.

Offodile ME (2003). The development and management of groundwater in Nigeria. In: A.A Elueze (ed.) Contributions of Geosciences and Mining to National Development, (NMGS), pp. 1-7.

Offodile ME (2006). Overview on sustainable development and management of water resources in Nigeria. J. Min. Geol. 42(1): 57.

Onugba A. Yaya OO (2008) Sustainable groundwater development in Nigeria. In. Adelena SMA. MacDonald AM (ed) applied groundwater studies in Africa, IAH Selected Papers in Hydrogeology. CMC Press/Balkoma. Leiden, Netherlands.

Otezo GE (2006). Management approaches for Nigeria's water resources. J. Min. Geol. 42(1):15-20.

Oyebando L(2006).Appropriate administrative structures in harnessing water resources for sustainable growth in Nigeria J Mm. Geoi 42(1): 21-30.

Pretoria, South Africa.

Rijisberman, Frank R. (2000). World water Scenarios. Analysis, London: UK: Earthscan Publications Ltd.

Rosegrant, M. W.; Cai, X.; Cline, S. A. (2002). World water and food to 2025: Dealing with scarcity. Washington, DC, USA: International Food Policy Research Institute.

Schoeneich K (2003). Water Resources Administration in Nigeria Paper Presented at the 39th Annual International Conference of the Nigeria Mining and Geosciences Society, "Itakpe 2003" Kogi Stale 2nd-8th Annual. March.

Seckler D, Upali A. Amarasinghe, David Molden, Radhika de Silva and Randoloph Barker (1998). World Water Supply V and Demand, 1995-2025: IWMI Research Report 19, Colombo, Sri Lanka: International Water management Institute

Shah, T. (2001). Wells and Welfare in the Ganga Basin: Public Policy and Private Initiative in Eastern Uttar Pradesh, India. IWMI Research Report 54. Colombo, Sri Lanka: International. Water Management Institute.

Shiklomonove, I. A. (1997). Assessment of Water Resources and Water Availability of the World. World Meteorological Organization. (Duplicated)

UNDP-World Bank (1995). Water and Sanitation Programme. Annual Report, July 1994 -June 1995. Publication of International Bank for Reconstruction and Development/World Bank, 1818 Street NW Washington D.C 20433, USA.

Water Aid (2004). Water and Sanitation. The education dram Education Media Report 3, written by Gideon Burrows, Jules Action and Tamsin Maunder. Available at http:www.wateraid.org

Water Aid (2001). Looking back: The long term impacts of water and sanitation projects. A condensed version of the WaterAid research report. Looking back: Participatory impact assessment of oldest projects'. WaterAid, I London, June 2001 Available at http://www.waleraid.org

WCD (World Commission of Dams) (2000). Dams and Development, A New Framework for Decision Making. The report of the World Commission of Dams. London: Earthscan Publication Ltd.

World Bank (1991). Water supply and sanitation in Africa: Laying me foundation (or the 1990s. Proceedings, All Africa Rural Water Supply and Sanitation Workshop and Water Supply and Sanitation Conference. Vols. 1 & 2, World Bank. Washington DC.

WRI (World Resources Institute) (1999). World Resources 1998-1999. New-York: Oxford University Press.