

Determination of Water Consumption Rate for A Growing Urban City in Osun State, Nigeria

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Abstract— Water is the simplest important element of life that is basic to man's existence. Most researchers are discouraged from working on determination of water consumption rate in Ikirun due to improper and inadequate water demand data estimate in Ikirun the headquarters of Ifelodun local government in Osun State. Hence, this study determines the rate of water consumption in Ikirun. 1213 questionnaires related to water uses and demand rate were randomly distributed to residential, and 250 were administered on institutional, commercial and industrial consumers from high density area (Eweta), medium density area (Oja-Oba, Thursday market, Oke-Afo area) and low density area (Laade/testing ground area) using End Use Analysis Technique. The results obtained show that most residential and commercial consumers source water from deep well, industrial consumers source their water from boreholes while institutional consumers mostly depend on tap water for their basic needs. The total volume of water used daily per house for residential consumers at low density area varied from 95-1255liters, the values at medium density area varied from 3465-11,570liters, while that of high density area varied from 3485-22,805liters. The daily values for total volume of water consumed for commercial, industrial and institutional facilities were 4,824, 3299 and 3812 liters respectively. The average water demand for low, medium and high density areas were 25.31 l/c/day, 16.42 l/c/day, and 27.61 l/c/day which is not within the range specified by WHO standard. It is recommended that the water pipe network should be extended to all nook and cranes of Ikirun township to allow consumers access to portable water. **Index Terms**— Water Consumption Rate, Water Demand, Water Consumers.

I. INTRODUCTION

Every human activity revolves round water availability. It is used for industrial, commercial, institutional, and domestic purposes. It is a basic need for human life and the focus on water as a necessity for life obscures the fact that in present societies only a very small fraction of water consumption is used for drinking and for sustaining human life. Inocencio, Padilla, and Javier (1999) and Clarke (1993), stated in their studies that an average person would need to drink about a liter of water a day to stay alive. The demand for water is increasingly recognized universally as a fundamental

right for human being, however access to it has become a day to day struggle for many citizens in developing countries. Water consumption varies from one area to another depending on socio-economic standard of the people, the level of education and development, nature of prevailing climate, the hygienic characteristics of the people, level of provision of sanitation facilities and general sanitary habit of the people. Schleich and Hillenbrand (2007) studied the impact of economic, environmental and social determinant for average per capita demand for water and sewage in about 600 water supply areas in Germany using econometric analyses. Uhlendahl, Zienigmayer, Wiennecke, Mawisa, and Piet du pisani (2010) established that the factors influencing the rate of water supply and water consumption depend on area of residence, different water access systems, and differences in sizes, quality, number and age of pipes.

It is generally agreed that a minimum of 50l/c/d is needed by an individual to satisfy his basic need irrespective of socio-cultural background (Ayanshola, Salami, and Sule 2012). Cook et al. (2001) and Ifabiyi et al. (2012) studied the relevance of determination of water consumption and noted that such approach ensures better water management among inhabitants of such area. Also, the determination of rate of water usage ensures fair sharing and distribution of water, thereby preventing crisis associated with water accessibility. The determination of water use assist in overcoming the challenges of urban and suburban growth and also assists systems optimization which leads to lower cost. The determination of water consumption allows an understanding of the underlining factors that will affect water demand, and the forecasts provide information about past and future water uses.

Ikirun is one of the major towns in Osun State, Nigeria with inadequate data on volume of water consumed that could be used for the design and improvement of the water supply system. It was also established by David (1997) that weakness in water demand estimation and projections is partly due to availability of limited data and paucity of empirical studies and econometric estimation of water demand function typical in developing countries. The rapid growth of population, not only by natural growth, but also through migration from neighboring town of the study area adds to increasing water demand. Therefore, there is need for determination of water consumption rate for the purpose of upgrading the water supply scheme, water treatment plant, pumping stations, as well as storage and distribution system for Ikirun metropolis. This study evaluates water use pattern in Ikirun in order to establish water consumption rates for the residential, institutional, commercial and industrial consumers.

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II. MATERIAL AND METHODS

The Study Area

The study was carried out in Ikirun, which is situated in the north-eastern part of Osun State, Nigeria (fig 1a). Ikirun is located within latitude 7°55'North and longitude 04°41'East of the Greenwich Meridian. The population of Ikirun according to 2006 population census is 96746. The town is located in a valley surrounded by three hills; Obagun/Gbogbi hill to the North and Aafo hill to the South and Alaroka and Idi-Olo Mountain to the East. Ikirun is bounded on the north by Inisa town in Odo-Otin local government area, on the South by Osogbo (State capital), to the East by Iragbiji town in Boripe local government, and on the West by Eko-Ende town also in Ifelodun local government council (fig 1b).

both primary and secondary sources. The primary data which involves map of the study area was downloaded from the internet. The estimated population and the number of household as at 2006 were collected from National Population Commission (NPC) in Osun State, Nigeria.

The study area was disaggregated into three major sections: low, medium, and high density areas. The low density is Laade/Testing Ground zone, medium density is Oja-Oba – Thursday Market – Oke – Afo zone while the high density zone is Eweta area. Two types of well-structured questionnaires were developed and administered at the study area. The first set of questionnaires was administered randomly on the residential consumers using End Use Analysis techniques and this is in line with the work of White and Milne (2004). There were 2342 houses in the study area and sample size of 51.8% (1213 houses) was surveyed. The number of houses in the high density zone was 1463 and a sample size of 750 (51%) was taken while 846 houses were in the medium zone and a sample size of 50% (430 houses) was surveyed. The survey covered the entire population size of the low density area of 33 houses.

The second set of questionnaires was administered on the commercial, institutional and industrial establishments within the study area. A total of 1622 of such establishments exist in the area and a sample size of 15% of the population (250) was used for the research work.

IV. RESULTS AND DISCUSSION

The distribution of residents in households, type of building in the residential area, and sources of water supply available to the people in the residential area and the quantity of water used by the households in the three zones are presented in Tables 1- 4.

Table 1 shows the number of household in each area varies with their population. Low, medium, and high density areas have a total values of 28, 417 and 629 houses respectively, with a varied population values from 1-5 and 20 above. The result showed that the number of household as important in domestic water demand. The higher the number of household the higher is the water demand. This finding is in agreement with the works of Keshavarzi et. al (2006) and Ayanshola et. al. (2010) where household size was observed to be one of the determinant of domestic water demand. Table 2 shows the type of house in each low, medium and high density areas with their numbers. The bungalow buildings of 65% are dominant in the residential areas surveyed with higher density area having 457 houses. Table 3 also shows the source of water supply for the residential areas. Majority of the resident in the areas relied on other sources of water supply apart from tap water. Only 23% relied on tap water as the main source while tap and well accounted for 15%. The fact still remains that the old water pipe network from Water Works at Eko-Ende has not been extended to other areas and supply of water to Ikirun township has not been regular which forced the residents to look for other alternative means.

Table 4: shows the total quantity of water used per household according to the number of people in household, in low, medium and high density areas. The total volume of water used by all the households divided by the total population



(a) Map of Nigeria showing Osun State.



(b) Map of Osun State Showing Ifelodun.
Fig. 1: Map showing the Study Area

III. METHOD OF DATA ANALYSES

The data used for this research was sourced from

gives per capita water use. The result from the distributed questionnaires indicated that the average quantity of water used at low, medium, and high density areas were 25.31l/c/day, 16.42l/c/day, and 27.61l/c/day respectively. This is not within the range specified by the World Health Organization (WHO) range for developing countries from 35 to 90l/c/day Argawal (1981). The decrease in household size at low density area results to increase in per capita water used at low density area compared to medium density area. This is in line with Ayansola et. al., (2012) work, where the average value for density of water used at low density area was 92.74l/c/day which is higher than the value of medium density area which was 55.02l/c/day. The quantity of water used at low density area varied from 88.33-111.67litres, the medium density area values varied from 78.50-103.04litres while that of high density area varied from 79.28-107.65litres.

V. COMMERCIAL, INSTITUTIONAL AND INDUSTRIAL WATER CONSUMERS

The results of the data gathered from commercial, institutional and industrial water consumers are presented in Tables 5 – 8. Out of 160 questionnaires administered on commercial consumers, 142 (88.75%) were returned. 35 (72%) questionnaires were returned out of 50 administered for institutional while 23 (57.5%) respondents returned the questionnaires out of 40 administered. The total volume of water used by for commercial, institutional and industrial consumers sample within the surveyed areas are 4,824, 3,299, and 3,812 liters respectively.

Most of the residents in the surveyed areas engaged in petty commercial trades as shown in Table 5 with 25% having retail shops, 14% having canteens and 14% having hair saloons. Most of these residents were women who source their water from deep well (68%) with only 14% relying on both tap and well as the major source of water (Table 8). The water demand of these groups is very high and since the quality of the water from deep wells cannot be guaranteed, they are vulnerable to water borne diseases. This observation of female gender to high water demand is similar to that of Xinming et. al (1990). Table 6 shows the total number of institutional consumers surveyed. Out of 36 sampled within the surveyed area, religion, institutions and schools have the highest numbers with 16 and 11 with 44.44% and 30.55% respectively. Banks and Ministries have the least number with 4 combined together. Table 7 shows the industrial consumers surveyed in the study area. 23 Industrial consumers surveyed consist mostly of block industries and pure water factories, with only 2 bakeries from result got in the questionnaire administration survey. Table 8 shows the sources of water for the various commercial, industrial and institutional consumers surveyed in the study area. Deep well is mostly used as the main source of water for the commercial consumers, while institutional consumers depend solely on tap water for their basic needs. Boreholes are most common among the industrial consumers.

CONCLUSION

An investigation into the determination of water consumption rate for Ikirun, a growing urban city in Osun

State, Nigeria has been examined. The results from the analysis of the questionnaires showed that most of the consumers relied on deep well as the source of water supply which the quality cannot be ascertained. The tap water was not available for the consumer due to non-extension of water pipe network from Water Works at Eko-Ende to most areas in the town. The average quantity of water used at low, medium, and high density areas are 25.31 l/c/day, 16.42l/c/day, and 27.61l/c/day. There is significant relationship between the population of households in the surveyed area. Since the Water Work at Eko-Ende is functioning, it is hereby suggested that government should embark on extension of water pipe network to all areas in Ikirun Township to allow residents have access to portable water. Periodical water analysis should be carried out on all the deep wells within the town to ascertain the suitability of the water from the wells for consumption. Further research work can still be carried out to develop appropriate model for prediction of future water demand for the town.

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Table 1: Numbers of Residents in Residential Area

Number of people in household/ building	Number of houses in Residential Areas				
	Low Density Area	Medium Density Area	High Density Area	Total	%
1 – 5	3	107	191	301	28
6 – 10	13	137	240	390	36
11 – 15	8	70	80	158	15
16 – 20	1	34	33	68	6
20 above	3	69	85	157	15
TOTAL	28	417	629	1074	100

Table 2: Type of Buildings in the Residential Areas

Type of Houses	Low Density Area	Medium Density Area	High Density Area	Total	%
Bungalow (multi-tenant)	13	120	259	392	36
Bungalow (flat)	15	98	198	311	29
Storey Building (Flat)	0	46	46	92	9
Storey Building (multi-tenant)	0	128	97	225	21
Duplex	0	25	29	54	5
TOTAL	28	417	629	1074	100

Table 3: Sources of Water Supply available to the household in the Residential Areas

Source of Water	Low Density Area	Medium Density Area	High Density Area	Total	Percentage (%)
Deep Well	17	181	276	474	44.13
Tap	1	87	158	246	22.90
Borehole	4	16	43	63	5.87
Tap and Well	1	81	76	158	14.71
Tap and Borehole	0	23	27	50	4.66
Well and Borehole	2	5	24	31	2.88
Tap and Well and Borehole	0	16	17	33	3.00
Stream and River	3	8	8	19	1.77
TOTAL	28	417	629	1074	100

Table 4: Total quantity of water used per house based on households

Population of people in household	No of houses in residential Areas			Quantity of Water Used per house in the areas			Total quantity of Water Used per house in the areas		
	Low Density Area	Medium Density Area	High Density Area	Low Density Area (lit)	Medium Density Area (lit)	High Density Area (lit)	Low Density Area (lit)	Medium Density Area (lit)	High Density Area (lit)
1-5	3	107	191	88.33	78.50	79.28	265	8400	15140
6-10	13	137	240	96.53	84.45	95.02	1255	11570	22805
11-15	8	70	80	93.12	102.36	101.06	745	7165	8085
16-20	1	34	33	95	101.91	105.61	95	3465	3485
Above 20	3	69	85	111.67	103.04	107.65	335	7110	9150
Total	28	417	629	484.65	470.26	488.62	2695	37710	58665

Table 5: Number of Commercial Consumers Surveyed

Type of Establishment	Number	Percentage (%)
Retail Shops	35	24.65
Hotels and Restaurants	5	3.52
Canteens	20	14.08
Slaughter slab	5	3.52
Car wash	5	3.52
Cool spots	8	5.64
Hair Dressing saloon	20	14.08
Tailor	15	10.56
Barbing saloon	10	7.05
Others	19	13.38
TOTAL	142	100

Table 6: Institutional Consumers Surveyed

Type of Establishment	Number	Percentage (%)
Nur/Pry schools	5	13.88
Secondary school	6	16.67
Hospital/clinic	5	13.88
Church	11	30.56
Mosque	5	13.88
Ministries and Government Parastatals	3	8.33
Banks	1	2.78
TOTAL	36	100

Table 7: Industrial Consumers surveyed

Type of Establishment	Number	Percentage (%)
Pure Water	9	39.13
Block Industry	12	52.17
Bakery	2	8.70
TOTAL	23	100

Table 8: Sources of Water Supply for Commercial, Industrial and Institutional consumers surveyed.

Sources of Water	Commercial		Institutional		Industrial	
	nr	%	nr	%	nr	%
Tap	9	6	11	30.6	3	13.0
Deep well	96	68	9	25.0	7	30.4
Borehole	10	7	6	16.7	8	34.8
Tap and Well	20	14.1	5	13.9	1	4.4
Tap and Borehole	1	0.7	3	8.3	4	17.4
Well and Borehole	4	2.8	2	5.5	0	0
Borehole and Well and Tap	0	0	0	0	0	0
Stream/River	2	1.4	0	0	0	0
TOTAL	142	100	36	100	23	100