

Attributes of Domestic Water Sources in a Rapidly Urbanizing State Capital in a Developing Economy

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Abstract: Problem statement: The efficiency and effectiveness of domestic water sources are often gauged by availability, accessibility and adequacy. This study examined various variables that could be harnessed in measuring these parameters with respect to water supply in Ado-Ekiti, Nigeria. **Approach:** The purpose of this study is to investigate the various attributes of domestic water sources in Ado-Ekiti, Nigeria. Three residential zones were identified in the city. They included the urban core, transitional zone and urban periphery. A sample size of 1,200 amounting to 4.0% of the total number of households in Ado-Ekiti, was chosen. Specific areas referred to as Data Delineation Areas (DDAs) were identified in each zone. Based on the estimated population of each DDA, the number of households to be interviewed was estimated. In consonance with some assumptions, 600 (50.0%) questionnaires were administered in the city core while 420 (35.0%) and 180 (15.0%) questionnaires were administered in the transitional zone and urban periphery, respectively. Subsequently, systematic sampling procedure was adopted in the choice of households to be interviewed. Some of the attributes investigated included the main source of domestic water used by household, access to improved source of water, distance from improved source to residence, average time spent to fetch from main source, average number of trips per person per day, quantity of water used per person per day and attack by water-borne diseases. **Results:** Households in Ado-Ekiti had access to diverse sources of domestic water including wells, boreholes, streams/rivers/springs, tanker-drawn water and rainwater. However, most households (59.8%) depended on wells. Nevertheless, 84.3% had access to improved sources. Only 10.0% of these households obtained supplies from piped water while piped network is largely restricted to the city core. The research showed that distance, time, number of trips and adequacy of supplies placed limitations on access to improved source. Only 63.2% of the households in the city obtained water supplies within 1 km from their dwelling places. About 67.0% spent less than 30 min round trip to obtain water from improved sources while 61.6% made more than three (3) trips to water sources per day. Only 22.7% of the households had access to at least 40 L per person per day while 36.9% were annually afflicted with water-borne diseases such as typhoid, diarrhea and stomach ache. **Conclusion:** Domestic water supply system in Ado-Ekiti, Nigeria is characterized by low level of access, inadequate supplies from improved sources while these sources are usually distant away from the households.

Key words: Accessibility, adequacy, atomization of sources, availability of water resources, domestic water source and piped water

INTRODUCTION

Problem statement: Water constitutes an essential element of life (Topfer, 1998). The entire history of mankind could be written in terms of man's need for water. Early civilization flourished along river valleys where there was abundant water to support life. In our contemporary world, most notable cities are located on great river courses, harbors, estuaries, lagoons and sea fronts (Sonuga, 1984). On the average, each person requires almost 50 liters per day for drinking, bathing, cooking and other basic needs (UNEP, 2002).

Unfortunately, areas of water scarcity and stress are increasing. African nations are more affected as the continent presently has the lowest access to water supply, lowest level of development and utilization of water resources relative to its needs and the lowest capacity to address these challenges. Indeed some authors argue that per capita water supplies in Africa have actually declined by as much as 50% since 1950 (Bryant, 1994).

WHO and UNICEF (2004) identify drinking water sources to include: household connection, public standpipe, borehole, protected dug well, protected

spring, rainwater, unprotected well, unprotected spring, rivers or ponds, vendor-provided water, bottled water and tanker truck water. However, only household connection, public standpipe, borehole, protected dug well, protected spring and rainwater sources were deemed as improved. Bottled water and vendor-provided borehole water sources were not considered improved due to limitations in the potential quantity and not the quality of the water. In this categorization, WHO and UNICEF (2004) regarded improved drinking water as "safe drinking water". Access to safe drinking water is considered as a precondition for health and for success in the fight against poverty, hunger, child deaths and gender inequality (WHO and UNICEF, 2004). Irrespective of its importance, a global paucity of safe drinking water had been established (UN, 2002; UNEP, 2002; WHO and UNICEF, 2004). Specifically, 1.1 billion people representing 18% of the world's population lack access to safe drinking water (UN, 2002). The consequence of the failure to provide safe water is that a large proportion of human beings have resorted into the use of potentially harmful sources of water. In some cases, where households adopt safe sources, they are usually distant away from house thereby requiring a considerable length of time to access. The quantity of water collected from such distant source is likely to be too small for effective hygiene. The implications of failure to provide safe water are dimmed prospects for the billions of people locked in a cycle of poverty and disease (UNEP, 2002).

In the Third World, the development of water is mostly government-driven. Failure to develop efficient water supply systems in these countries is a product of the interplay of several factors. Among them, securing finances to build, maintain and expand the systems is perhaps the most important. The availability of finance especially for day-to-day operations and maintenance is significant in view of the low level of public finances for urban development, including water supply (World Bank, 1995; Urban Age, 1993). Water supply in Nigeria most vividly reflects this situation. Irrespective of the fact that several public water works exist and have been in operation for several years in Nigeria, hardly any is performing efficiently. Most urban areas presently lack effective public water systems that could ensure regular supplies to the population. The output from these systems meets only a small percentage of the water need in the cities (Ayoade, 1981; Lee and Anas, 1992). In addition, extensive areas in many cities do not have any network connections. Also, lack of proper water-works management, lack of appropriate technology and ineffective commercial operations were identified as problems militating against water supply in the country (Williams, 1996; Oyeboade, 1996).

The purpose of this study is to investigate the various attributes of domestic water sources in Ado-Ekiti, Nigeria. The inquiry shall focus on availability of water resources for domestic water use; accessibility and adequacy of the various domestic water sources. An understanding of these attributes will definitely enhance the formulation of policies aimed at ensuring the development of improved and sustainable water system in Ado-Ekiti and other cities in Nigeria.

MATERIALS AND METHODS

Research site: The study area is Ado-Ekiti. It is located in the south west of Nigeria. Following the creation of Ekiti state on October 1, 1996, Ado-Ekiti became a capital city. The city lies entirely within the pre-Cambrian Basement complex rock group which underlies most south western part of Nigeria. Due to its peculiar gneisses formation with small aquifers and relatively shallow overburden, Ado-Ekiti is poor in groundwater potentials (Fadipe and Adeduro, 1993). These peculiarities result into low yield situation of boreholes in this city while most wells often dry up during dry season. Ado-Ekiti experiences a tropical climate with distinct wet and dry seasons. These seasons are associated with the prevalence of maritime south westerly monsoon winds from the Atlantic Ocean and the dry continental north easterly harmattan winds from the Sahara Desert. The city therefore enjoys water surplus between May and October with substantial water deficit between November and April when all stream channels are completely dry while the main rivers are reduced to a chain of pools (Ebisemiju, 1993). The significance of these factors to the per capita volume of surface water that can be drawn by Ado-Ekiti is tremendous. In general, it could be safely concluded that in terms of per capita volume of surface water resources that can be drawn upon by a given community, Ado-Ekiti has abundant stock that if will harnessed could meet the domestic water need of the city.

The responsibility for the supply of potable water to the city is assigned by government to Ekiti State Water Corporation. This mandate is to be met through a supply from Ureje Dam, Ado-Ekiti, a dam that was commissioned in 1962. With a design capacity of $4,950 \text{ m}^3 \text{ day}^{-1}$ on commissioning, the current capacity utilization of the dam still remains at 95%. Water pipe network is restricted to the city core. With an estimated population of 209,866, the city needs about $16,000 \text{ m}^3$ of water supply every day, but the town receives only $4,950 \text{ m}^3$ daily. There is therefore an obvious gap between the water supply from the designated water

supply agency and water need in this growing city. Most people therefore rely on other sources of supply, such as wells, streams and rivers and supplies from vendors among others that are often highly contaminated or in most cases inadequate to meet the hygiene requirements.

The database: As an addition to the main thrust of this research, the study was interested in the analysis of the spatial variation in water supply and demand systems in Ado-Ekiti. To achieve this, three residential zones were identified in the city. They include the urban core, transitional zone and urban periphery. Basic assumption made with respect to the populations of these zones was that (50%) of the total population live in the city core while (35%) and (15%) live in the peripheral neighborhood to the core and the suburb respectively (Onokerhoraye, 1978).

The projected population figure for Ado-Ekiti in 2006 was put at 209,866. Average family size in Nigeria has been estimated at 7 (Fasakin, 2000). This implies that there were about 29,981 households in Ado-Ekiti. For this research, a sample size of 1,200 amounting to 4.0% of the total number of households in Ado-Ekiti was chosen. This appears plausible since there are traits of homogeneity in habitability in this study area.

Having stratified the city into three zones, specific areas that are convenient for data collection otherwise referred to in this study as Data Delineation Areas (DDAs) were identified in each zone. Based on the estimated population of each DDA, the number of households to be interviewed was estimated. In consonance with our earlier assumptions, 600 (50%) questionnaires were administered in the city core while 420 (35%) and 180 (15%) questionnaires were administered in the transitional zone and urban periphery respectively. Subsequently, systematic sampling procedure was adopted in the choice of households to be interviewed in each DDA. Fieldwork commenced in September 2006 and ended in March 2007. The survey utilized 26 variables for this study. For the purpose of data analysis, descriptive statistics including tables, frequencies and means were utilized.

RESULTS AND DISCUSSION

The richness of water resources that could be harnessed for domestic use in Ado-Ekiti is reflected in the series of domestic water sources available to the households. These include piped water, well, borehole, rain water, purchase from private boreholes, free water supply scheme, sachet water, purchase from overhead tank, purchase from water tankers and

stream/river/spring (Table 1). The free water supply scheme was a political campaign strategy of a gubernatorial candidate in the state that later became a palliative strategy by the government to alleviate the incessant domestic water shortage in the city having won the election. Record has it that the only weapon that gave him electoral victory at the poll was this strategy. This is indeed a manifestation of water scarcity in the city. The scheme is essentially a tanker-drawn system that supplies water to an overhead tank from which household subsequently fetch. Emphasizing further the inadequate supply of domestic water in Nigeria, is the advent of sachet water. It was supposed to be a substitute for bottled water that is out of reach for the poor people. Nylon coffer of about 50cl is adopted as container for this water. Each sachet sells for about USD0.04. The inadequacy of domestic water continuously provides business opportunities for some individuals in Nigeria. For examples, some wealthy Nigerians often develop commercial boreholes from which water are sold to households. Some also adopt water tankers from where water is marketed. Again, overhead tanks are now common features in Nigerian cityscape especially in the low income residential areas. They are important water points from which water are put for sale. However, from our earlier definition, none of these sources could be described as ‘safe’.

It is pertinent to state that the pilot survey revealed that all the wells sighted in Ado Ekiti were covered and even relatively raised above the ground level to ensure that surface water does not run directly into them. Our investigation revealed that this situation was made possible through the massive awareness campaign embarked upon by the State Ministry of Health in the past. Therefore, all wells were considered as ‘improved’ in Ado-Ekiti. However, no spring was sighted as protected during the pilot survey. Therefore, all springs were considered as “unimproved”.

Table 1: Main source of domestic water used by households

Main source/ No. of respondents	Total 1,200 (%)	Urban core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Stream/river/spring	6.7	5.3	7.6	8.4
Well	59.8	57.5	63.1	59.4
Borehole	5.2	5.2	3.8	8.3
Rain water	0.7	0.7	0.7	0.6
Piped water	18.5	20.2	19.8	10.0
Purchase from private borehole	1.1	0.5	1.4	1.6
Sachet water	0.2	0.2	0.5	2.6
Purchase from Water tankers	2.0	2.2	1.0	3.9
Purchase from overhead tanks	2.1	3.3	1.2	3.0
Free water scheme (overhead tank)	3.9	5.0	1.0	2.2
Total	100.0	100.0	100.0	100.0

In addition, both the household piped water connection and public standpipes were categorized as piped water in this research.

The main sources of domestic water among households in Ado-Ekiti are well (59.8%) and piped water (18.5%) (Table 1). Breakdown by zones reveals that more than half of the households (57.5%) in city core depend solely on well while 20.2% depend on piped water. In the transitional zone a greater proportion of the households (63.1%) obtained their domestic water mainly from well and at a lower level from piped water (19.8%). The urban periphery also exhibits similar pattern with majority of the households depending on well (59.4%). However, only 10% of the households obtained their supplies from piped water. A major observation in this analysis is that access to piped water decreases away from the city core. This situation is explained by the fact that water trunk network is largely restricted to the core area of the city. Specifically, there had not been any significant network extension since 1961 when Ureje dam was commissioned.

Purchase from water tankers and overhead tanks are popular in the city core and urban periphery (Table 1). This goes further to confirm the inadequacy of domestic water in these zones. The low patronage of these sources in the transitional zone could be attributable to the fact that most households (63.1%) in the transitional zone have access to well (Table 1) that are largely self-owned. The awareness that purchase from private borehole is safe might have been responsible for its progressive patronage from the city core (1.1%) to the urban periphery (1.6%). Although, our data reveal that a substantial proportion of the households fetch from stream/river/spring, further investigation revealed that these sources are hardly used for drinking but rather for other chores such as bathing, washing clothes/plates/dishes/cooking utensils, flushing toilets, bathing, wetting flowers among others.

In this study, improved sources of domestic water include piped water, well, borehole and rain water. 84.3% of the households in Ado-Ekiti have access to these sources while 15.7% obtained their main supplies from unimproved sources, namely stream/river/spring, purchase from private boreholes, purchase from water tankers, purchase from overhead tank, sachet water and free water scheme (Table 2). In general, only slight variation was observed in access pattern among the different zones in the city. However, it is significant to observe that the transitional zone recorded the highest access (87.4%) to improved source. This is largely explained by the preeminence of this zone following the

creation of Ekiti state in 1996. Most civil servants not only found places of abode in the zone but also built their own houses. Most of these buildings were therefore ab initio furnished with wells.

However, if safe water is defined as the percentage of the households having access to piped water (Sullivan *et al.*, 2003), only 18.5% of the city's population has access to safe water (Table 2). In terms of variation among zones, the city core records the highest rate of access. Specifically, 20.2% of the households in this zone have access to safe water. This situation is explained by the fact that piped water supply trunk network is largely restricted to this zone. Again, only slight variation was observed in terms of access between the city core and the transitional zone that records 19.8% access. However, it is obvious that unlike the city core, a significant proportion of this zone is not furnished with water supply trunk. In an attempt to justify this observation, further investigation reveals that the level of awareness of the households who are largely civil servants made it imperative for them to still obtain their water from this source irrespective of distance and time cost. A worse scenario was obtained in the urban periphery where only 10.0% of the households have access to safe water. These households also obtain water from this source at a very high cost in terms of distance and time. The low rate of access to safe water is explained by the fact that since the commissioning of the Ureje dam in 1961, no effort had been made by the State Water Corporation for any system expansion.

However, the concept of safe water has to be taken with caution. This is because our survey revealed that the piped water system in the city is bedeviled with incessant pipe leakages that are often left unattended to by the State Water Corporation for a relatively long time thereby leading to contamination of the system. Again, one cannot rule out the possibility of corrosion from water pipes and subsequent contamination of the water system since pipes have been largely left unreplaced since commissioning in 1961.

Table 2: Access to improved source of domestic water

Source	Total 1,200 (%)	Urban core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Well	59.8	57.7	62.9	58.9
Piped water	18.5	20.2	19.8	10.0
Borehole	5.3	5.0	4.0	8.9
Rain water	0.7	0.7	0.7	0.6
*Total (%)	84.3	83.6	87.4	78.4

*: Unimproved sources account for 15.7% city-wide and 16.4, 12.6 and 21.6% in the city core, transitional zone and urban periphery respectively

As stated earlier, for a source to be considered as improved or safe several variables need to be considered. These include among others: distance, time, number of trips and adequacy of supplies among others. WHO and UNICEF (2004) concludes that for a water source to be considered as improved, it must be within 1 km from home. Again, fetching from a source that would require more than 30 min of walking is also considered unhealthy (UNICEF and WHO, 2004). Several trips to a water source imply time wastage. Any household that makes more than 3 trips to a water source in this study was considered as hauling less water that is essential to meeting hygienic needs. When distance from improved source is factored in, only 63.2% of the households in the city obtain their water supplies within 1 km from their dwelling places (Table 3). In terms of disparity among zones, one finds it extremely curious to observe that irrespective of its compact nature, the least access in terms of distance was recorded in the city core (59.2%). The implication of this is that even though the provision of water trunk network is limited to this zone, households still obtain improved water at a relatively longer distance. This paradox could be explained by the fact that the few functioning public standpipes are sparsely distributed in the city core thereby increasing distance covered by most households to fetch water. Again, the State Water Corporation confirmed that water is only released to the city once or twice in a week on a diversionary basis. Subsequently, households have to divert their water search to this area of water release. This leads to increased distance covered to fetch water. It was also observed that a significant proportion of the households have to trek to the waterworks directly, a relatively long distance to most households, to meet their water need since they confirmed that it is the only assured water point. On the other hand, the relatively high access in terms of distance recorded in the transitional zone (70.0%) and urban periphery (61.1%) could be explained by the relatively high income of the households which supports their ability to construct their own wells.

A further attempt was made to disaggregate these data according to various sources (Table 4). Important conclusion that could be drawn from this analysis is that 35.6 and 2.3% of the households in Ado-Ekiti have wells and boreholes located within their houses respectively while 5.8% have access to household piped water connection. From these data, one becomes more apprehensive when one observes that only 12.3% of the households in the city have access to piped water within 1 km from their dwelling places. If by definition clean water implies safe water, one could conclude that only an insignificant proportion of the city population have access to safe water.

Table 3: Distance from improved source to house

Distance	Total 1,200 (%)	Urban core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Within household	44.3	35.5	53.3	52.8
Less than 1 km	18.9	23.7	16.7	8.3
More than 1 km	20.8	24.3	10.7	13.3
No response	0.3	0.1	6.7	4.0
Total	84.3	83.6	87.4	78.4

*: Unimproved sources account for 15.7% city-wide and 16.4, 12.6 and 21.6% in the city core, transitional zone and urban periphery respectively

Table 4: Distance from improved source to house-disaggregated according to sources

Distance	Total 1,200 (%)	Well 717 (%)	Borehole 62 (%)	Piped water 222 (%)	Rain water 8 (%)
Within household	44.3	35.6	2.8	5.8	0.7
Less than 1 km	18.9	12.1	0.3	6.5	0.0
More than 1 km	20.8	12.1	1.9	6.2	0.0
No response	0.3	0.0	0.3	0.0	0.0
*Total	84.3	59.8	5.3	18.5	0.7

*: Unimproved sources account for the rest 15.7% city-wide (total)

Table 5: Average time spent to fetch from improved source

Average time spent	Total 1,200 (%)	Well 717 (%)	Borehole 62 (%)	Piped water 222 (%)	Rain water 8 (%)
Less than 10 min	39.2	27.9	2.3	8.3	0.7
10-20 min	18.5	16.2	0.5	1.8	0.0
21-30 min	9.7	5.8	2.1	1.8	0.0
31-1 h	12.8	6.8	0.1	5.9	0.0
1 h 1 min-2 h	0.7	0.7	0.0	0.0	0.0
More than 2 h	3.1	2.3	0.1	0.7	0.0
No response	0.3	0.1	0.2	0.0	0.0
Total	84.3	59.8	5.3	18.5	0.7

*: Unimproved sources account for the rest 15.7% city-wide (total)

Only 67.4% of the households in the city spend less than 30 min round trip to obtain water from improved source (Table 5). However, when variable safe water was considered with respect to time spent, only 11.9% of the city's population could be considered as having access to safe water. The slight differences in percentage change observed between distance from source and average time spent to fetch water is also indicative of access to conjunctive sources of water supplies which makes the households to exhibit tendency to fetch close to their dwellings at relatively short distance (Table 4 and 5).

The number of trips made by household to fetch from a water source is significant since only 44.3% of the households have water sources located within their houses (Table 4). It appears that the number of trips made to fetch water from the respective main sources varies depending on the distance covered per trip and time required to fetch. Only 48.8% of the households made 3 or less number of trips to fetch from main

source (Table 6). In terms of zonal variation, the city core has 45.3% of its household making between 1 and 3 trips per day. This decrease from the city's average could be explained by the fact that the zone also parades the least number of people having wells or piped water within their houses. Again, the transitional zone records the highest proportion of access in terms of number of trips made. This zone equally coincides with the city district that has a larger proportion of its inhabitants having wells and piped water within their houses. The situation in the urban periphery does not differ significantly from what we have in the urban core (Table 6).

A relationship also exists between access component and quantity of water fetched per person per day. Such relationship measures the adequacy or otherwise of the supply of domestic water from the main source among households. Based on the WHO standard on per capital per day requirements that has been put at 20 liters, 56.2% of the total households obtain adequate supply from main source while 43.8% has no access to adequate source. In general, the city core has the highest access of 60.8% in terms of adequacy of source. This is followed by the transitional zone which recorded 60.1% while the urban periphery has 59.1% (Table 7). The high access recorded in the city core could be attributed to the fact that this zone has access to various sources of water thereby given the household an open choice to fetch from source that could afford him adequate supply.

Table 6: Average number of trips per person per day to main source

No. of trips	Total 1,200 (%)	Urban core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
One trip	9.7	9.0	10.5	10.0
2 trips	20.8	15.5	29.8	17.2
3 trips	18.3	20.8	15.7	16.1
4 trips	19.0	25.2	9.3	11.1
5 trips	5.8	6.2	4.0	8.3
5 trips +	26.2	16.6	30.2	36.1
No response	0.2	6.7	0.0	0.0
Total	100.0	100.0	100.0	100.0

Table 7: Quantity of water used per person per day (L)

Quantity (L)	Total 1,200 (%)	Urban core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Less than 10	23.3	16.3	14.3	18.8
10-19	20.5	22.9	25.6	22.3
20-39	25.1	19.3	30.8	26.0
40-59	10.3	18.2	9.8	11.7
60-79	6.0	5.0	6.7	7.8
80-99	4.3	4.3	4.3	3.9
100++	9.5	11.8	7.9	8.8
No response	1.0	1.2	0.6	1.7
Total	100.0	100.0	100.0	100.0

However, when improved source was factored in, only 32.1% of the city's population could be considered as having access to improved water in sufficient quantity (Table 8). Specifically, 22.7% of the households have access to adequate supply from wells. This situation is not unconnected with the fact that 35.6% of the households own their wells while others depend on wells outside their houses (Table 4). These users that do not own wells are usually subjected to control from the owners of such wells which affect the quantity of water that is fetched. It is also a common practice for such owners to ration water from these wells. Investigation confirmed that some owners usually specify the time of the day when other neighbors could fetch water. More often than not, this situation usually results to queuing and even fighting. In addition, the time wasted during this process usually sets limitation to the quantity of water that could be fetched by the affected households. Again, barely 6.6% of the households have access to piped water at sufficient quantity. Also, as in the case of household-owned wells, there seems to be a relationship between quantity of water fetched and household piped water connection as only 5.8% of the city's households have piped water within their household (Table 6). This displeasing situation could be traced to the inefficiency of the State Water Corporation that produces only 1,943,753 L of water per day as against the city daily requirement of 4,197,320 L. Apart from the fact that the Corporation could meet 50% of the city water requirement, the supply coverage is restricted to the city core thereby denying several other households outside this zone access to piped water. This problem becomes heightened with the regulated pumping that has been put by the Corporation at one or twice per week. If supply from piped water is regarded as safe water, the above scenario should be a point of concern for the city planner. Again, this analysis revealed that the potentials offer by rain water as an alternative source of domestic water is not yet fully harnessed in Ado-Ekiti as only

Table 8: Quantity of water used per person per day for households having access to improved source

Quantity (L)	Total 1,200 (%)	Well 717 (%)	Borehole 62 (%)	Piped water 222 (%)	Rain water 6 (%)
Less than 10	16.2	11.3	0.3	4.4	0.2
10-19	35.5	25.5	2.5	7.5	0.0
20-39	9.4	5.4	1.4	2.6	0.0
40-59	5.8	4.0	0.5	1.3	0.0
60-79	3.2	1.8	0.0	1.1	0.3
80-99	6.4	5.6	0.3	0.3	0.2
100++	7.3	5.9	0.1	1.3	0.0
No response	0.5	0.3	0.2	0.0	0.0
Total	84.3	59.8	5.3	18.5	0.7

*: Unimproved sources account for the rest 15.7% city-wide (total)

Table 9: Water-borne disease situation in ado-ekiti

Whether infected	Total 1,200 (%)	City core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Infected	36.9	48.2	26.7	23.3
Not infected	60.7	49.5	71.7	72.2
No response	2.4	2.3	1.7	4.4
Total	100.0	100.0	100.0	100.0

Table 10: Types of water-borne diseases observed and their distribution

Type	Total respondents 1,200 (%)	City core 600 (%)	Transitional zone 420 (%)	Urban periphery 180 (%)
Stomach ache	7.6	8.7	4.00	8.6
Cholera	5.1	7.2	3.20	1.7
Diarrhea	8.8	13.8	3.30	3.6
Guinea worm	0.0	0.0	0.00	0.0
Typhoid	15.4	18.5	16.20	9.4
*Total	36.9	48.2	26.70	23.3

*: Percentage of households not infected accounts for 60.7% city-wide and 49.5, 71.7 and 72.2% in the city core, transitional zone and urban periphery respectively

0.5% households obtain adequate quantity of water from this source. Like the rain water, borehole is not popular in the city. Only 2.3% of the households obtain adequate quantity of water from this source. This could be due to the prohibitive cost of construction and the nature of the underground rock formation that does not allow high water yield.

Also critical to the issue of access is the measure of quality of water since this generally indicates whether or not it is fit for drinking. Although this research did not carry out scientific analysis of water quality, some information on the subject were inferred from the data on health and perception of households on piped water source. Information from households revealed that about 37.0% of the city's inhabitants were annually afflicted with one or more water-borne diseases. Disaggregating this data further, it was revealed that water-borne diseases were more prevalent in the city core in Ado-Ekiti. The rate of infection however decreases away from the city center. Specifically, 48.2% of the city core that houses most urban poor was afflicted by water-borne diseases while the transitional zone and urban periphery recorded 26.7 and 23.3% respectively (Table 9).

Comparing Table 2 with 9, one observes that in terms of access to improved source, there was no significant variation among zones while wide disparity exists between susceptibility to diseases in the city core and other zones in the city. Other factors such as quantity accessed from improved source and level of education and other population characters such as profession/occupation with their consequential effects

on improved hygiene practices might be responsible for this pattern. It should be reminded that the city core is mostly inhabited by traditional people having relatively low education.

It is also imperative to observe that typhoid is the most common water ailment having afflicted about 15.4% of the city's inhabitants at one time or the other. This is followed by diarrhea and stomach ache with 8.8 and 7.6% affliction rates respectively. About 5.1% of the population has also suffered from cholera at one time or the other (Table 10). Again, the affliction rates are higher in the city core than the other zones. For example, 13.8% of the inhabitants of the city core had suffered from diarrhea while only 3.3 and 3.6% of the residents in the transitional zone and urban periphery ever suffered from this ailment. In general, all the rates recorded for the city core are all above the city rate for each ailment. It was observed during field investigation that pit latrines were more prevalent in the city core. Specifically, faecal waste through septic tank decreases away from urban periphery to the city core. Pit latrines, in general, contribute greatly to underground water pollution. Since a large proportion (57.5%) of the households in the city core depend on well for their domestic water need coupled with their relatively low level of education which usually affects awareness on basic hygiene especially on water safety through treatment, little wonder, they are mostly affected by water-borne diseases. It is pertinent to report that no household was afflicted by guinea worm infection in the city. This is largely explained by the efforts of UNICEF and other international donors that have worked ceaseless to eradicate this devastating disease.

CONCLUSION

This research has examined the various attributes of domestic water sources in Ado-Ekiti, Nigeria. Investigation revealed that the domestic water supply system in the city is characterized by low level of access to improved source of domestic water irrespective of the abundant stock of water resources in the city. Supplies from improved sources are largely inadequate while these sources are usually distant away from the households. Although no effort was made to carry out quality test on water, the large proportion of the populace that suffers from one water-borne disease or the other speaks volumes on the potability of the various sources of water in the city.

The need for access to improved water had been expressed rigorously in literature (Topfer, 1998; UNEP, 2002; UN, 2002). However, Ado-Ekiti cannot rely on underground water resources to meet this requirement

(Fadipe and Adeduro, 1993; Ebisemiju, 1993). The only meaningful source is therefore the surface water. Unfortunately, the city possesses a dam whose current design capacity cannot meet the city's water need even at full capacity utilization. Ideally, it is rational to consider the construction of additional dam for Ado-Ekiti as a viable option but the cost could be prohibitive. It is therefore suggested that the capacity of the existing dam be upgraded. In addition, it is canvassed that the city's water supply system be linked with other existing dams in the state.

There is no doubt that the conventional centralized water supply and distribution systems can no longer be effective in a rapidly growing city like Ado-Ekiti. Any effort to meet the water need of the city dwellers must therefore consider the atomization of sources through linking the city with other dams and construction of large-scale water distribution centers as a priority. The objective of this strategy is to create sectional water-works that would have defined sphere of influence and coverage to be known as Water Supply Area (WSA). However, this recommendation does not totally rule out the possibility of construction of additional dams especially from the private sector initiative. It is suggested that the development of such new dams for the city must be preceded by the Surface Water Resources Inventory Survey (SWRIS) that would clearly indicate total annual discharges of existing rivers, lakes, springs, streams and rivulets in Ado-Ekiti in an attempt to determine their optimum design capacity.

Rainwater harvesting has traditionally been viewed as a potential water supply source in rural settlements in Ekiti state. The potentials offered by this source are largely derived from the location of the state in a humid tropic region with its high annual rainfall. Due to its economic and ecological advantages, efforts should be made to encourage rainwater harvesting in Ado-Ekiti. An aggressive enlightenment campaign especially on the use of water reservoir (surface or underground), rainwater treatment, for example, the use of water guards among others should be embarked upon by government to facilitate the successful adoption of this source.

Although, this research does not concentrate on measuring water quality, however, it is universally agreed that piped water constitutes safe water. Therefore, it is recommended that efforts should be geared towards ensuring that every household in Ado-Ekiti has access to piped water. The influence of distance and time on both quantity and quality of water has been well emphasized in literature. Efforts should therefore be made to bring piped water close to the homes. To ensure that most households are accessed to safe water, it is urgent for the Corporation to expand

piped water network beyond its current coverage that is largely restricted to the city core. The long term desire of water supply system in the city should be to ensure that every household is connected to the piped water system. However, at the interim, we proposed that no household should travel more than 200 meters before obtaining piped water. Therefore, at this stage of development in Ado-Ekiti, fauceting of water cannot yet be discouraged rather the existing ones need to be coordinated and improved upon. To ensure adequate number of faucets, we suggest that government should take a census of each neighborhood in the city with the aim of determining the required number of faucet per neighborhood. In addition to the absolute population figure, the number of faucets to be established should take into consideration the characters of the population. The adoption of multi-pronged faucets in a bid to eliminate time wastage arising from queuing is further canvassed. The success of this proposed programme would be largely determined by the efficiency of the agency responsible for water supply. Such agency should therefore ensure ceaseless flow of water from pipes, regular maintenance of the system and quick response to leakages. However, in view of the limitations posed by water fauceting, we wish to propose that government should wipe away faucets and legislate on the need for household connection in 2015.

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