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Water Supply and Distribution Problems in Developing Countries: A Case Study of Jimeta-Yola, Nigeria

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Abstract

Provision of clean water has been a major challenge facing most of the urban centers in developing countries, especially through pipe connection. This study focuses on assessment of water supply and distribution system in Jimeta Yola Nigeria, with the aim of providing strategies for improvement. The study examined the supply as well as the distribution coverage in the area. Four different datasets were used in the study area namely; street, existing pipeline network, population and land use data. The area covered by the network was delineated by digitizing the existing pipeline network on the street map using ArcGIS 10.1. Proximity analysis was used to determine the network coverage within the inhabited areas; problems associated with water supply and distribution in the study and the consumers' perception of the services provided were examined using questionnaires. Recommendations were made to ensure effective operation and maintenance of water supply and distribution system in other to ensure total coverage.

Key Words: Water Supply, Water Distribution, GIS, House connection.

1.0 Introduction

Successful management of any resources requires accurate knowledge of the resource available, the uses to which it may be put, the competing demands for the resource, measures and processes to evaluate the significance and worth of competing demands and mechanisms to translate policy decisions into actions on the ground. Lack of adequate information on water resources couple with lack of the technology and its applications hinder the process of water supply and distribution in most developing countries of the world. A study has pointed out that "poor management" as one of the major reasons for poor performance and/or efficiencies of water utilities and the management remuneration rates are determined by the government salaries in most urban areas because the utilities are in public sector and thus follow public service rules [1]. In the past, most government in developing countries responded to water stress by seeking to augment supply. It was reported that large scale river diversion programs in China and India underline the continuing appeal of this approach [2].

Also, population growth without corresponding expansion of water supply facilities causes shortfall in terms of supply. Providing adequate water supply to the rapidly growing urban population is a challenging task for governments throughout the world [3]. The urban poor, who lives in poor condition and often constitute the labour source that generates the wealth of the cities, have limited access to adequate water and face increased health problems as the awareness of what happens as a result of this phenomenon is too apparent [4].

"More recently, in South Asian countries, above 90% of the population with piped water supply still receive water less than 24 hours" [5]. Conditions are similar in most african countries for example only 11% of water consumers in Zaria, Nigeria receive water for 12 hours a day through piped connection and the mean service hours are 2.9 per day in Mombassa, Kenya [6]. Access to piped water into the households averages about 85% for the wealthiest 20% of the population, compared with 25% for the poorest 20%. Consumers residing faraway from

supply point or at higher altitude are at disadvantaged position because intermittency generates inequitable water distribution due to pressure dependant flow condition [7]. Human security concept encompasses water security which ensures that every person has reliable access to enough safe water at an affordable price that promote a healthy and productive life, while maintaining the ecological system that provide water and depend on water [2].

There is a growing concern over the problem of water scarcity in developing countries [3]. Giving example as reported, "It was estimated that by the year 2050, half of India's population will be living in urban areas and will face acute water problems" [8]. Factors such as poor distribution through pipe networks and inequalities in service provision between the rich and the poor contributed to the water stress condition in these countries in addition to source limitation [9].

Water scarcity is a challenge in most developing countries because developing new sources which are cost effective for major urban areas of these countries are usually not available [1]. Human development is being driven by clean water, dignity is enhanced, opportunities extended health improved and wealth rose with clean water, [2]. The crisis in water and sanitation is a crisis for the poor, justifying the claim; it was reported that "Almost two in three people lacking access to clean water, survive on less than $2 a day, with one in three living on less than $1 a day" [2]. Fitness of drinking water to be distributed is paramount; it should therefore be taken into consideration in water supply and distribution system.

Health hazards are prominent with intermittent supply which entails a high risk of contamination through broken pipes or joints, and low pressure or even a vacuum condition in pipelines that last for a significant period of time is usually created by interruption of supply [7]. Efficient urban water supply and management can be achieved with consideration of water quality and health, and drinking water supplied from water authorities is usually associated with health risks in most urban centers of developing countries [1].

The aim of this study is to assess the water supply and distribution system in Jimeta with a view to providing strategies for improvements. This aim can be achieved by first, identifying the problems facing water supply and distribution in the study area, secondly examine the adequacy of the facilities and services provided by the authorities, determine the consumers' perception in terms of quality and quantity of water being supplied and finally make recommendations for improvement.

2.0 Study Area and Methodology

2.1 Study Area

Jimeta is the administrative headquarters of Adamawa State in North Eastern Nigeria. Adamawa State lies between latitudes 7^{o} $00^{'}$N – 11^{o} $00^{'}$N and longitude $11^{o'}$ $00^{'}$E – 14^{o} $00^{'}$ E, while the study area approximately lies between latitude 09^{o} $13^{'}$N and 9^{o} $20^{'}$ N and longitude 12^{o} $20^{'}$ E and 12^{o} $30^{'}$ E. The state is situated in the North Eastern part of Nigeria and it is bounded by one of the largest Rivers in the Country, River Benue serving as a boundary between Nigeria and Cameroon Republic. Like any other Nigerian city, Jimeta comprises of so many land use types ranging from institutional, commercial, and residential.

The city is clearly stratified in terms of population densities. These are low, medium and high density areas. The low density areas are well planned units where government officials reside while medium and high density areas are made up of common people with little or unplanned buildings. Land uses in Jimeta can be classified into six as study has shown, the results from aerial photograph indicated that six land use/cover were identified thus; built-up land, bare surface, natural vegetation or forest, marshy land, croplands and water bodies [10].

2.2 Methodology

For the purpose of this study, four different datasets were used in the study area namely; street, existing pipeline network, population and land use data. Questionnaires were also administered. Street and land use data were generated from Yola geodatabase using ArcGIS 10.1, existing pipeline network was obtained from Adamawa state water board, and

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population and household data was obtained from the National Population Commission (NPC). In questionnaire administration, stratified random sampling was used because of large population. 50 respondents were selected at random from each of the 11 wards of Jimeta, making a total of 550 questionnaires. Out of this number, 510 questionnaires were returned.

Fig. 1: Map of Nigeria Showing Adamawa State

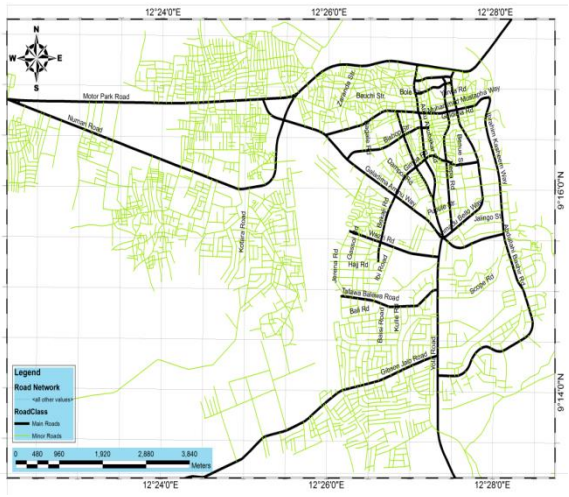

Fig. 2: Jimeta street map
(Source: Generated using ArcGIS 10.1)

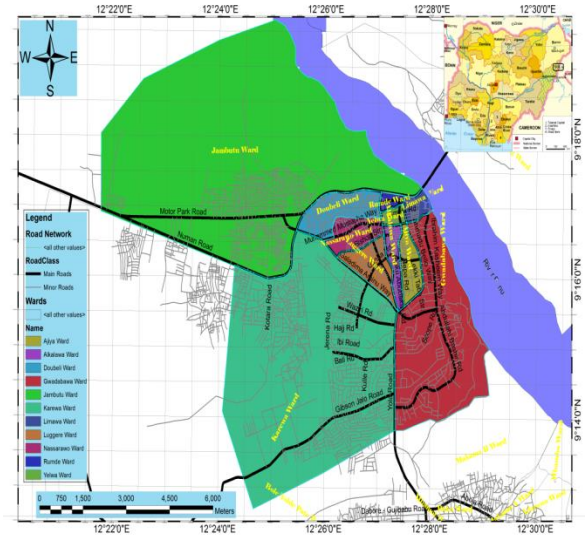

Fig. 3: Map of Jimeta Showing 11 Wards
(Source: Generated using ArcGIS 10.1)

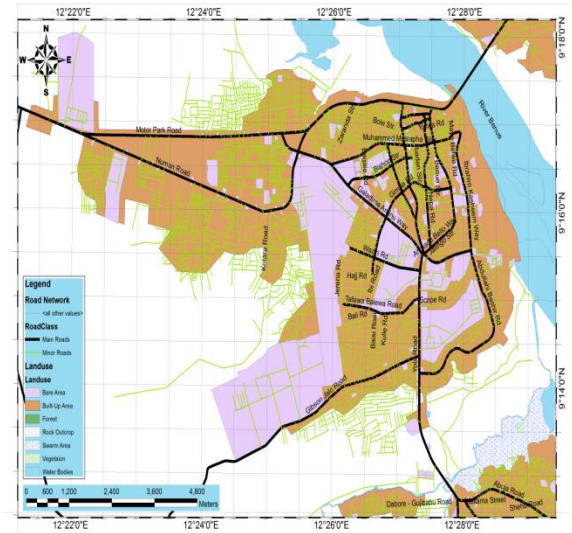

Fig. 4: Jimeta Land use map
(Source: Generated using ArcGIS 10.1)

Table 1: Population and Household Data for Jimeta-Yola.

S/No	Name of Ward	Base Population NPC (2006)	Projected Population (2015)	Number of Household (2015)
1	Ajiya Ward	14,359	17,949	3,590
2	Alkalawa Ward	23,043	28,804	5,761
3	Doubeli Ward	31,077	38,846	7,769
4	Gwadabawa Ward	21,209	26,511	5,302
5	Jambutu Ward	17,981	22,476	4,495
6	Karewa Ward	22,227	27,784	5,557
7	Limawa Ward	14,426	18,116	3,623
8	Luggere Ward	15,854	19,817	3,963
9	Nassarawo Ward	15,891	19,864	3,973
10	Rumde Ward	11,493	14,366	2,873
11	Yelwa Ward	10,687	13,359	2,672
	Total	**198,314**	**247,892**	**49,579**

Source: National Population Commission (NPC), Nigeria.

3.0 Data Analysis and Findings

In analyzing the data collected, the existing water distribution network was digitized on the street map using ArcGIS 10.1 to delineate the areas covered by the network, since the network pipeline was laid along the roads. This will show the areas being served by the network and the areas outside the network. Proximity analysis was also carried out by overlaying the land use map on the digitized existing distribution network, so as to determine the area of coverage within the built up or inhibited areas in the study area.

Figure 4 below, shows the existing water distribution network of Jimeta being digitized on the street map and overlaid on the land use map to show the areas covered by the network within the built up areas. From figure 4 below, it can be observed that a larger portion of Jimeta circled in red which is within the built up area was not covered by the distribution network. From the findings of this research, it was discovered that that the water supply in the study area is far below the daily water demand which is about 30% of the required supply.

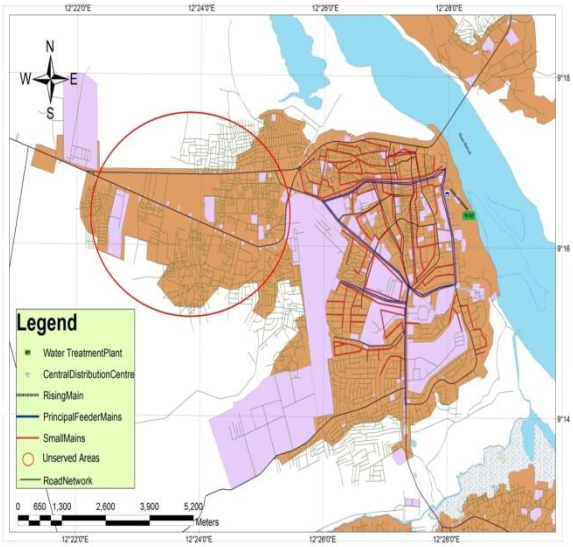

Figure 5: Jimeta existing water distribution network
(Source: Generated using ArcGIS 10.1)

Table 2 below shows the daily water demand for the study area on ward basis, as an urban area the per capita consumption is taken as 120 liters per capita per day. This is based on the reviewed National Water and Sanitation Policy of the Federal Republic of Nigeria, 2004.

Table 2: Water Consumption Requirement for Yola

S/No	Name of Ward	Base Population NPC (2006)	Projected Population (2015)	Water Demand (Liter)
1	Ajiya Ward	14,359	17,949	2,153,880
2	Alkalawa Ward	23,043	28,804	3,456,480
3	Doubeli Ward	31,077	38,846	4,661,520
4	Gwadabawa Ward	21,209	26,511	3,181,320
5	Jambutu Ward	17,981	22,476	2,697,120
6	Karewa Ward	22,227	27,784	3,334,080
7	Limawa Ward	14,426	18,116	2,173,920
8	Luggere Ward	15,854	19,817	2,378,040
9	Nassarawo Ward	15,891	19,864	2,383,680
10	Rumde Ward	11,493	14,366	1,723,920
11	Yelwa Ward	10,687	13,359	1,603,080
	Total	**198,314**	**247,892**	**29,747,040**

Source: National Population Commission (NPC), Nigeria.

From table 2 above, it can be observed that the daily water demand for the study area is about 30ML/D based on the projected population of 2015. This shows gross inadequacy in terms of supply as the present supply is just about 10ML/D which is about 30% of the required supply as earlier mentioned. A total of 550 questionnaires were administered across the 11 wards of the study area, out of this number, 510 questionnaires were returned. The opinion of the respondents was closely examined and data collected were analyzed using statistical charts.

3.1 Results

3.1.1 Personal Data of Respondents

Figure 6 below represents distribution of respondents by marital status. It shows that majority of the respondents were married with 63%, while the remaining 37% were singles.

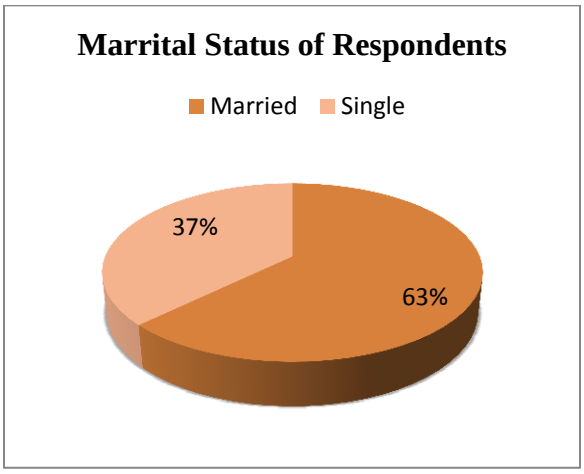

Figure 6: Distribution of Respondents by Marital Status.
Source: Field Work, 2015

Figure 7 below represents distribution of respondents by sex; it shows that males are the majority of the respondents with 70%, while the females were just 30%.

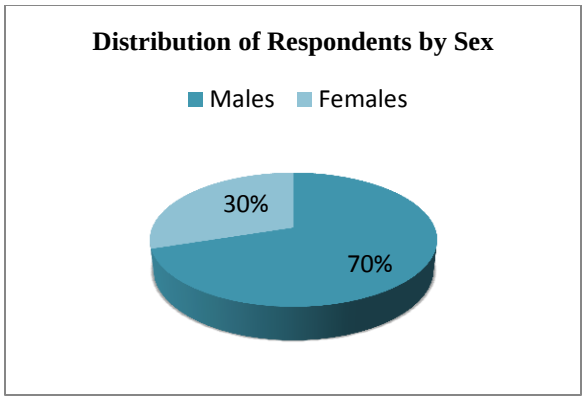

Figure 7: Distribution of Respondents by Sex.
Source: Field Work, 2015.

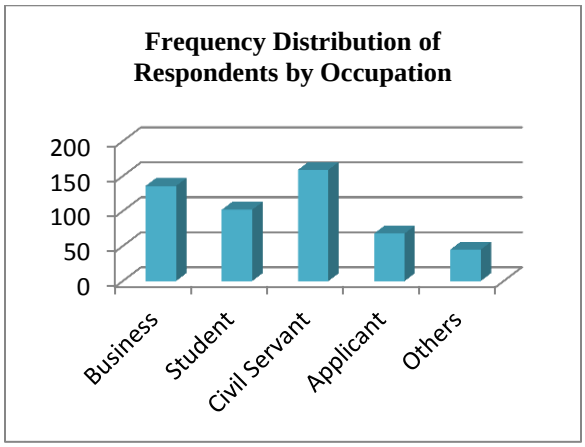

Figure 8: Frequency Distribution of Respondents by Occupation. Source: Field Work, 2015.

Figure 8 above shows that civil servants forms the highest portion of the respondents with over 150 which is about 1/3 of the total respondents, followed by business Men, students, applicants and others being the lowest with less than 50.

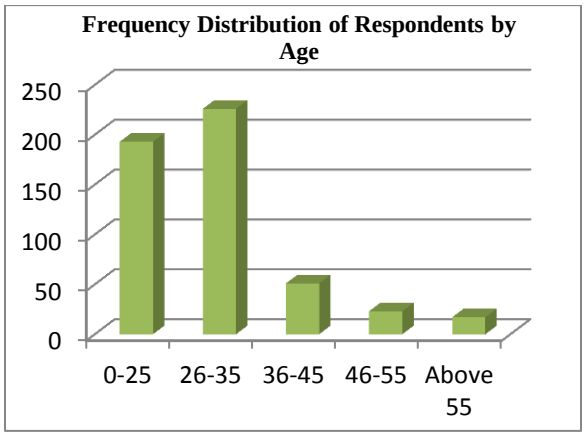

Figure 9: Frequency Distribution of Respondents by age. Source: Field Work, 2015.

Majority of the respondents were less than 35 years as shown in figure 9 above. Those above the age of 55 forms the least with frequency of less than 20 and those between the ages of 36-55 were just about 15% of the respondents.

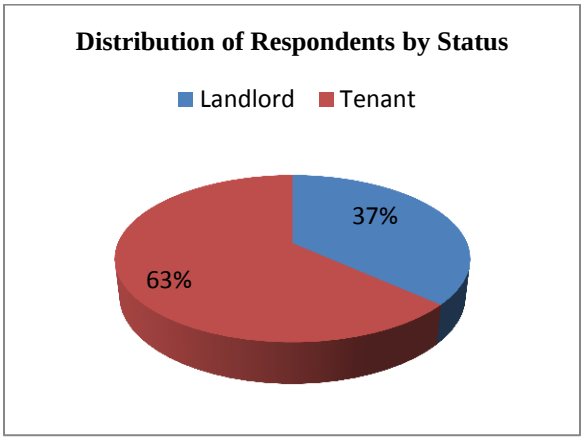

Figure 10: Frequency Distribution of Respondents by Status. Source: Field Work, 2015.

The Majority of the respondents are tenants with 63%, while those who owned their houses or landlords were 37% of the respondents

3.1.2 Water Supply and Distribution Problems

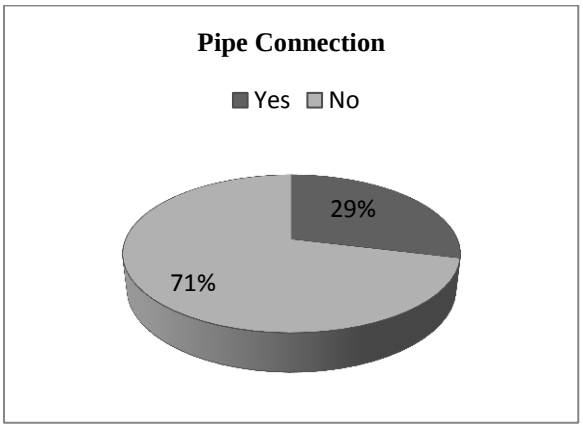

Figure 11: Observing the Respondents having Pipe Connection. Source: Field Work, 2015.

Majority of the respondents were not connected to the water supply pipeline as shown in figure 11 above, that 71% of the respondents do not have pipe connection in their houses. This reflects what was earlier stated that the current supply cater for just about 30% of the daily water demand of the study area.

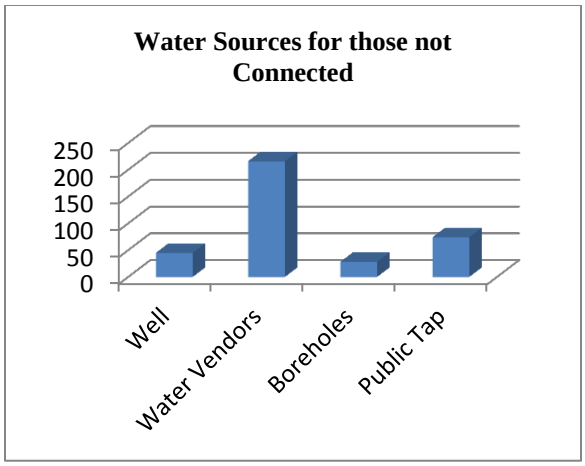

Figure 12: Observing Water Sources for Respondents.
Source: Field Work, 2015.

Figure 12 above indicated that more than 50% of those that were not connected to the pipeline rely on water vendors as their source, while very few have access to boreholes as their source.

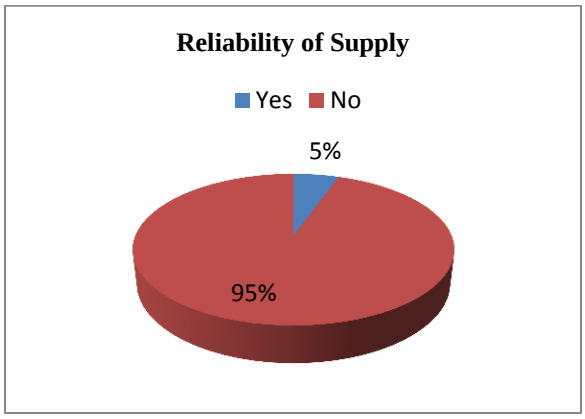

Figure 13: Observing Reliability of Supply to Respondents.
Source: Field Work, 2015.

Reliability of the supply to those connected is insignificant as shown in figure 13 above that only 5% of the respondents have reliable water supply, while 95% says the supply is not reliable.

Figure 14 below shows that those who never get water through the pipe in their houses forms the majority among the respondents, followed by those getting supply weekly, thrice a month, daily, twice a week and monthly, while the least segment among the respondents are those getting the supply fortnightly.

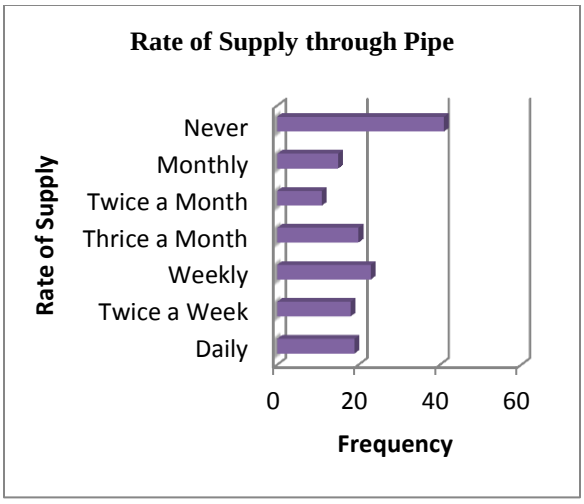

Figure 14: Observing Rate of Supply through Pipes.
Source: Field Work, 2015.

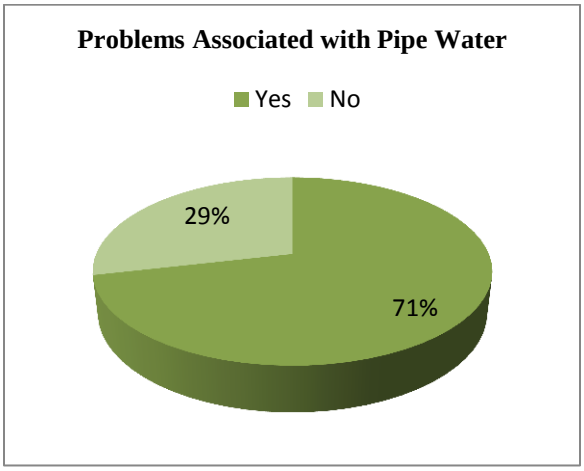

Figure 15: Observing Problems Associated with Pipes Water.
Source: Field Work, 2015.

Majority of the respondents representing 71% indicated having problems associated with the pipe water being distributed to their houses, while 29% have not.

Considering the nature of problems associated with the pipe water supplied, figure 16 below shows that majority of the respondents complained about dirtiness of the water being distributed, while insignificant portion of the respondents complained of saltiness, odor and other problems associated with the water supplied to them.

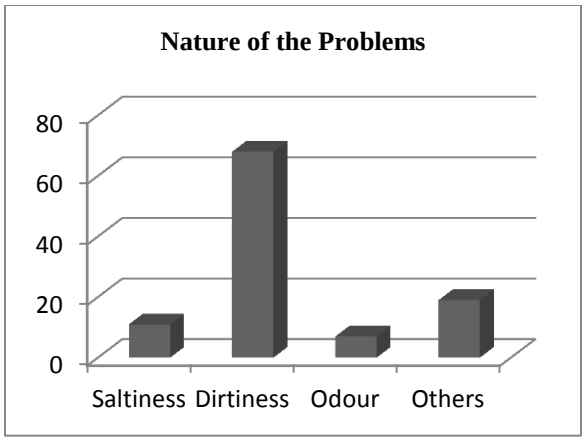

Figure 16: Observing Nature of the Problems.
Source: Field Work, 2015.

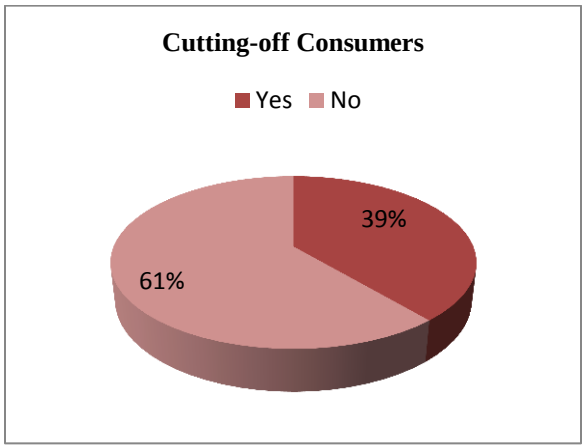

Figure 17: Observing Whether Consumers have ever Been Cut-off.
Source: Field Work, 2015.

Figure 17 above shows that 39% of the respondents indicated that they have been cut-off from the supply at one time or the other, while 61% have not experienced that.

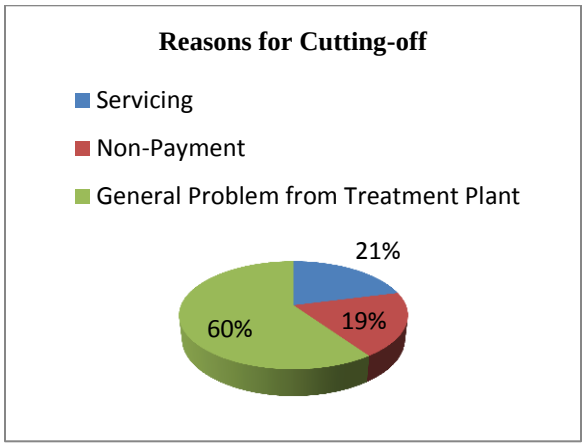

Figure 18: Observing Reasons for the Cut-off.
Source: Field Work, 2015.

Figure 18 above shows the reasons for cutting-off the supply of some respondents. While 60% of the respondents attributed that to general problem from the treatment plant, 21% attributed the problem to servicing of the facilities and 19% admitted that it was due to non-payment from their own side.

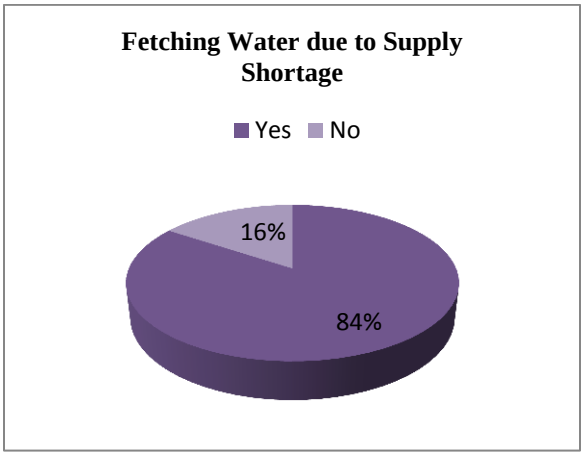

Figure 19: Observing Whether Consumers Fetch Water due to Supply Shortage. Source: Field Work, 2015.

In figure 19 above, 84% of the respondents indicated that they fetch water due to supply shortage, while 16% do not fetch water to supplement the supply.

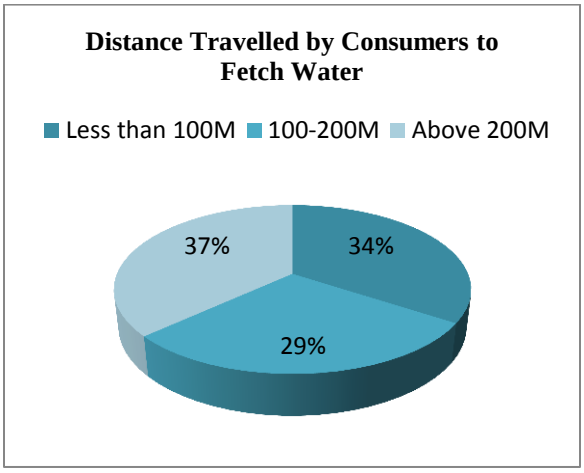

Figure 20: Observing the Distance Travel to Fetch Water.
Source: Field Work, 2015.

Figure 20 above shows that 34% of the respondents travel less than 100M to fetch water, while 29% travels between 100-200M and 37% travels more than 200M in order to fetch water.

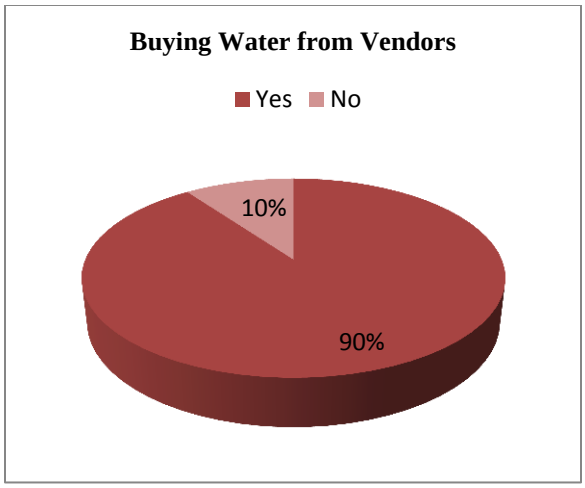

Figure 21: Observing Whether Consumers Buy Water from Vendors. Source: Field Work, 2015.

From figure 21 above, 90% of the respondents buy water from vendors while the remaining 10% indicated that they do not buy water from vendors.

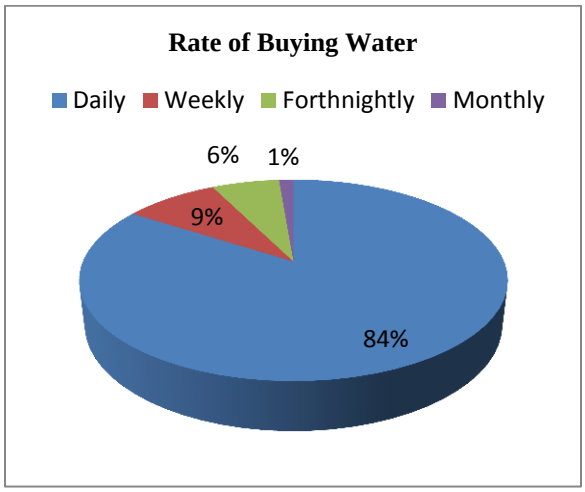

Figure 22: Observing the Rate at Which Consumers Buy Water Source: Field Work, 2015.

As in the figure 22 above, 84% of the respondents buy water daily, 9% buys weekly, 6% fortnightly and only 1% buys monthly.

Observing how much consumers spend on water daily, figure 23 below indicated that majority of the respondents do not spend above $1.5, while very few spend more than $2.0.

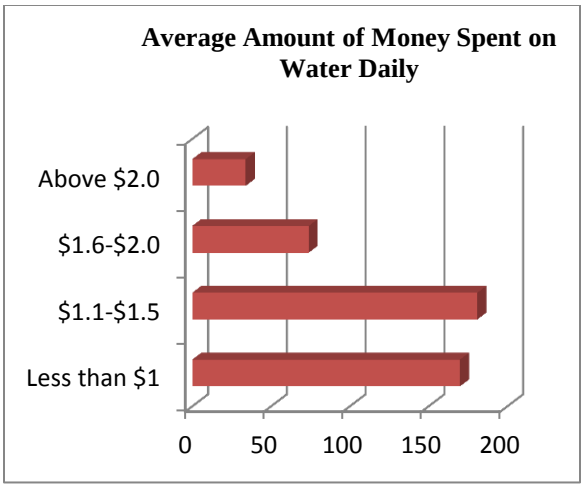

Figure 23: Observing Average Amount of Money Spent on Water Daily Source: Field Work, 2015.

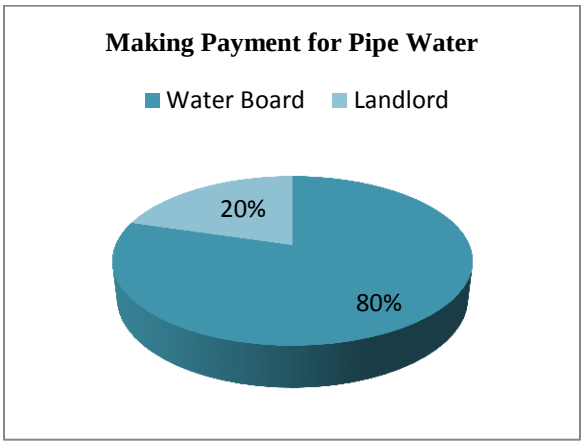

Figure 24: Observing Where Consumers Pay for Pipe Water Source: Field Work, 2015.

From the figure 24 above, majority of the respondents representing 80% pay for pipe water at the water board, while 20% pay to the landlord.

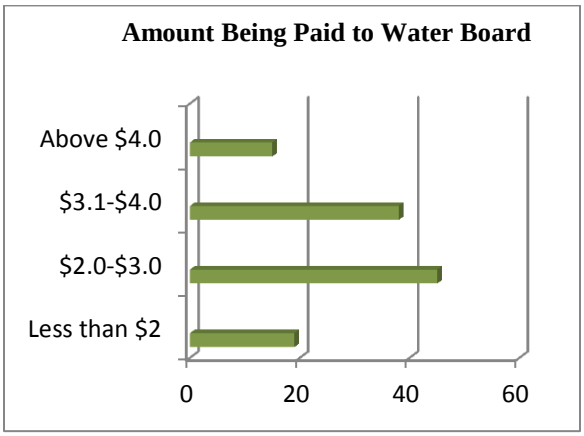

Figure 25: Observing Amount Being Paid to Water Board. Source: Field Work, 2015.

Majority of the respondents pays between $2.0 and $4.0 to the water board, as shown in figure 25 above, while an insignificant segment of the respondents pays more than $4.0.

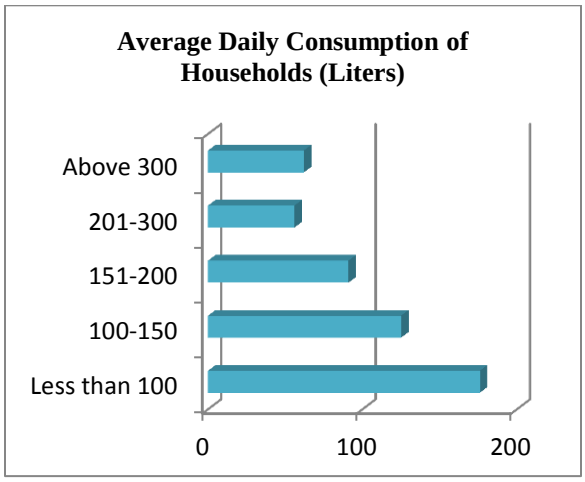

Figure 26: Observing Average Daily Consumption of Households. Source: Field Work, 2015.

Figure 26 above shows that most of the households consume not more than 150 liters daily, while a smaller portion of the respondents consume more than 300 liters.

3.2 Discussion of Results

Findings of this study includes; marital status, sex, occupation age and tenancy status of respondents. Majority of the respondents were not connected to the water distribution pipeline, only about 29% of the respondents have pipe connection in their houses and that justifies the 30% pumping capacity of the water facilities in the study area. And for that reason, those that were not connected resorted to other sources where over 50% rely on water vendors for their daily water need.

Also, 95% of those connected indicated that the supply is not reliable as about 1/3 never get water through tap in their houses. It was also deduced that 71% of the respondents indicated having problems associated with the pipe water being distributed to their houses, and about 70% complained of dirtiness of the water. 39% of the respondents connected to the pipeline have specified that they have been cut off from the supply at one time or the other and 60% of them attributed that to general problem from the treatment plant, while others attributed that to servicing the water facilities and non-payment. The result also showed that consumers fetch water outside their homes due to shortage of supply, where 84% indicate that they do, out of which 34% travel less than 100M to fetch water, while 29% travels between 100-200M and 37% travels more than 200M in order to fetch water. As a result of the shortage of supply, 90% of the respondents buy water from vendors, and while 84% of them buy on daily basis, majority spends no more than $1.5 on water daily.

The study also reveals that 80% of those connected to pipeline pay their water bills at the water board with majority paying $2.0-$3.0 monthly. It was also discovered that about 60% of the households consumes no more than 150 liters of water per day.

4.0 Conclusion

Most of the towns and cities in developing countries experience rapid urbanization without corresponding expansion of facilities to cater for the increasing population. Jimeta being the administrative capital of Adamawa state witnessed a tremendous influx of people from all angles, and the water facilities were installed about 40 years ago when Adamawa state was created. Thus, the facilities have been over stretched and that led to acute shortage in supply, low quality of water being distributed due to obsolete equipment at the treatment plant, as well as rusted and broken pipes due to intermittent supply, as revealed by this study. Therefore consumers tend to spend much in buying water from vendors or travel some distances to fetch water.

5.0 Recommendation

Based on the findings of this study, the following recommendations were made; the government should set a sound policy as regards to water supply, and make provision of safe water a priority. Making funds available for maintenance of water facilities and equipment can do this. There is also the need for the government to improve and establish an effective revenue collection process. Pipeline should be connected to every single house and adequate record of distribution network and house connection maps should be kept. The use of meters should be

introduced; installing meters in housed will solve most problems of wastage and promote savings on the side of consumers.

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