# Assesing Domestic Water Demand and Supply adequacy in Medium-sized Towns of Niger State Nigeria: Challenge for Sustainable Development

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***Abstract*- Niger State water facilities scarcely perform effectively. Average of seven persons per household was used at 50 liters per head as bases for assessing the variation that exist between household water demand. Coefficient of Variance (CV) and T-test distribution were used in establishing water deficit for medium-sized towns. Value of water sources distribution is of negative relationship cal-t=11.97 is relatively higher than tab-t = 2.06. Medium-sized towns are grossly in deficit of enough domestic water supply due to distance of most households from sources of water, inability of obtaining enough container for preserving water and lack of maintainers culture. There is the need to create public awareness in respect of obtaining sufficient water for domestic utility. Households should avoid the danger of consuming substandard water by constructing water storage and treatment plants in every medium-sized town, Workable policy of maximum threshold of twenty-five households per borehole or ten households to a well.**

***Keywords- Domestic Water, Medium-sized Towns, Water Facilities, Water Deficit, Maintenance Culture***

## I. INTRODUCTION

Water, is both a commodity of consumption and investment goods which is part of local infrastructure directly or indirectly that generate additional future economic activity by attracting and assisting local commerce and industry. The commodity cannot be replaced by any other substance in the community [1]. Due to this, it is of high demand by man and perfectly in elastic. Water resources development, through which water as a resource is exploited to make it portable and economically accessible source to satisfy human need is mostly treated as social goods consumed mainly by households, industries and institutions in most developing countries. It is the most sought after social good and ranks very high in the developmental preferences in most communities in developing countries [2]. The patterns of domestic water demand in communities are dynamic and changing rapidly with increasing population per capita income and level of improved water supply [3-5]. In Nigeria, the State governments are responsible to provide safe potable water to the residents of their respective jurisdiction while the local government areas serve as the supervisory stakeholder as well as provide and monitor rural water projects like wells and boreholes [6]. Recently the provision of pipe-borne water and boreholes is by both public and private organization. Some supporting organizations like European Union, United Nations International Children Emergency Fund and United Nation Development Programme in form of World Bank projects are engaged in providing boreholes in the rural areas.

Large quantities of water are required for personal hygiene, cooking, food processing, environmental sanitation, and laundry. Water supply are purified or treated to get rid of harmful substances or reduce them. The water is treated to minimum permissible limit to make it safe and fit for human consumption or suitable for the intended general domestic uses. As socio-economic status of the people increases, demand also increases [7, 8]. The availability and use of water through functional infrastructure is a potent social amenity and constitutes developmental catalyst [9]. In the light of these attributes, Water has remained a major concern from the down of civilization. It is imperative to socio-economic development, because it shapes the way of life and pre-occupation of the human society [4, 10]. The United Nations Millennium Declaration confirmed that expanded access to safe drinking water and adequate sanitation contribute majorly to poverty alleviation [11, 12]. Water infrastructure (Physical and Social) is critical to the attainment of the MDGs. This is because several goals specifically water based, issues addresses directly or indirectly importance of water availability and accessibility to poverty alleviation [4, 13]. Therefore, meeting the water needs of medium sized towns of Niger state would be scores of ladder closer to attaining the overall MDGs for Niger state.

The place of medium settlements as captured by [14] noting that socio-economic interdependence between urban dwellers and their rural counterparts can be succinctly captured through a careful analysis of the interactions that exist. It is a positive linkage that is not only important in regional planning but a dual survival strategy for residents of the two divides. Households relying and surviving on both rural and urban-based resources are underlining their important role in local economic development [15]. Therefore aim of this paper is to assess the adequacy of domestic water supply and its implication on demand in medium-sized towns of Niger state. The objectives are to examine household Water Supply and Demand inter play; relate water demand and supply scenario with sources of Water Supply and level of spatial variation.

*The Study Area：*

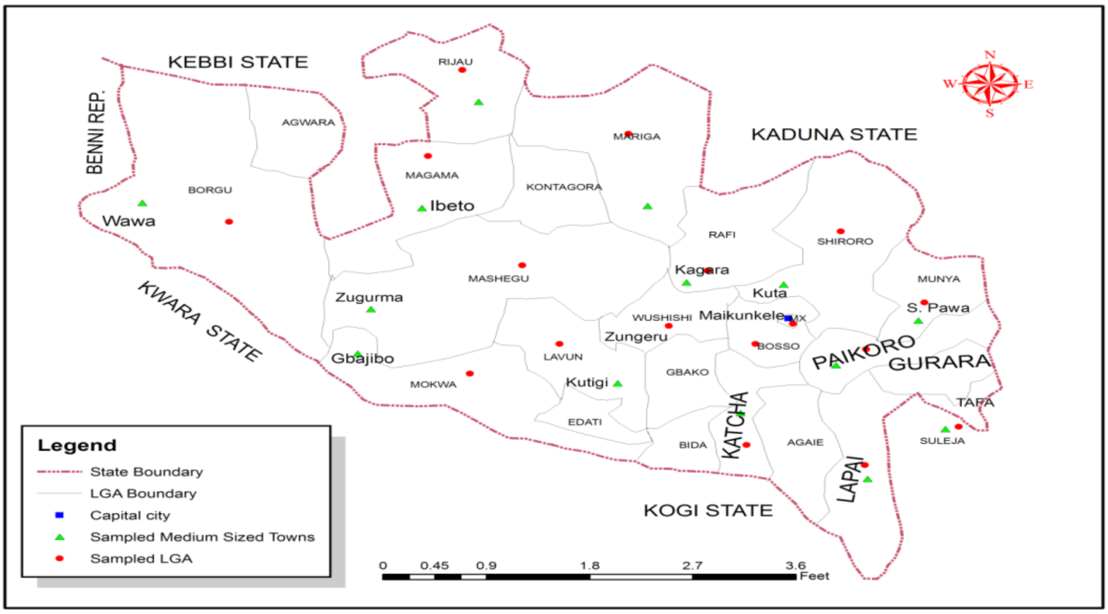


Fig. 1 Sampled L. G. A and Medium-sized Towns

Source: Niger State Ministry of Land and surveys, Minna (2001)

In Fig. 1, Niger State lies between Latitudes $8^0$ 20'N; $11^0$30'N and Longitudes $3^0$ 30'E; $7^0$ 20'E, sharing boundaries with Zamfara State in the North, Kebbi State and Republic of Benin in the Northwest, Kwara State in the Southwest, Kogi State in the South, and Federal Capital Territory (FCT) and Kaduna State in the Southeast and Northeast, respectively [12, 16].

## II. METHODOLOGY AND MATERIALS

Systematic Stratified sampling techniques was used on the 2010 projected estimated population of 6,122,372 people from 2006 census result [12, 17] based on annual population growth rate of 3.4% and the family size average of seven members per household [17]. A total of 2911 questionnaire were distributed to the sampled household heads in 30,329 sampled compounds, only 2523 (87%) questionnaire were successfully returned while the remaining 300 (10%) were nullified due to mistakes, 88 (3%) were not returned. The questionnaire elicited for information on settlement, family size, sources of water, distance of households from the water sources and available household water storage facilities. In order to achieve the objectives of this study, t-test distribution statistical method was employed to compare the variation between water samples of different sources. Coefficience of Variance scattered graph was employed by computing the distribution variation of the data collected from sources of water available. This was employed inorder to depict the gap that exist between water demand and water use within medium sized towns.

## III. RESULTS AND DISCUSSIONS

The data collected from the sources of water segments established within the medium-sized towns (well, borehole, river and rain water) were subjected to one-way analysis of variance (ANOVA). Most of the households use untreated water supplied from these sources. This do led to taking water from poor sources for a long time, thereby ignorantly accumulating sediment and bacterial for long times which become serious problem to the health of the people. This relates to [18, 19] report that the bacterium is of public health concern given its high virulence with a mortality rate as high as 65-80% infection symptoms. Some households have their source of water in the compound while some is outside the compound. It was only observed that many hand lift boreholes have been abandoned because they were damaged and some wells were abandoned for lack of water. Due to this reason a threshold of more than fifty households depend on a borehole. Some rivers which are perceived as good source of water supply are few meters away from the household. However, households that do not have any other alternative, have to use the source of water close to them. In determining the level of Water Supply within the Medium-sized towns, data that was generated from the sources of water were correlated with the Purpose of water demand. Hence the purpose of water demand is considered as the dependable variables in this study and the different household water sources are the independent variables. The average household purpose of water demand per day in each medium-sized town is compared to the sources of water supplied and run in GraphPad Instat statistical program to calculate the Correlation Coefficient by using ANOVA. It was revealed that there is no significant relationship between the demand for water and the sources of water in the study area. It implies that sources of water supply do not satisfy the demand for water since P> 0.05 the significant level. While T-test distribution of Table 1, reveals in all water samples that the cal-t is greater than tab-t except in river samples 11, 28 and 30 that has their cal-t to be less than tab-t. This reveals that only in those areas that water is adequately supplied to the domestic needs of the household.

TABLE 1 WATER QUALITY SIGNIFICANT LEVEL

| Description | Samples | t-cal | t-tab | Decision |
|---|---|---|---|---|
| Well | 1 | 8.47 | 2.06 | $H_o$ Rejected |
| Borehole | 2 | 12.144 | 2.06 | $H_o$ Rejected |
| Well | 3 | 11.674 | 2.06 | $H_o$ Rejected |
| Well | 4 | 12.978 | 2.06 | $H_o$ Rejected |
| Borehole | 5 | 11.714 | 2.06 | $H_o$ Rejected |
| Borehole | 6 | 5.779 | 2.06 | $H_o$ Rejected |
| Well | 7 | 10.662 | 2.06 | $H_o$ Rejected |
| Borehole | 8 | 9.841 | 2.06 | $H_o$ Rejected |
| Borehole | 9 | 7.669 | 2.06 | $H_o$ Rejected |
| River | 10 | 9.015 | 2.06 | $H_o$ Rejected |
| River | 11 | 0.945 | 2.06 | $H_o$ Accepted |
| Well | 12 | 10.636 | 2.06 | $H_o$ Rejected |
| Borehole | 13 | 9.558 | 2.06 | $H_o$ Rejected |
| Borehole | 14 | 2.425 | 2.06 | $H_o$ Rejected |
| Borehole | 15 | 3.483 | 2.06 | $H_o$ Rejected |
| River | 16 | 2.536 | 2.06 | $H_o$ Rejected |
| Well | 17 | 11.40 | 2.06 | $H_o$ Rejected |
| Borehole | 18 | 10.467 | 2.06 | $H_o$ Rejected |
| River | 19 | 5.501 | 2.06 | $H_o$ Rejected |
| Well | 20 | 8.927 | 2.06 | $H_o$ Rejected |
| Well | 21 | 10.292 | 2.06 | $H_o$ Rejected |
| Borehole | 22 | 8.831 | 2.06 | $H_o$ Rejected |
| River | 23 | 4.325 | 2.06 | $H_o$ Rejected |
| Borehole | 24 | 10.846 | 2.06 | $H_o$ Rejected |
| Well | 25 | 11.984 | 2.06 | $H_o$ Rejected |
| River | 26 | 2.200 | 2.06 | $H_o$ Rejected |
| Borehole | 27 | 7.103 | 2.06 | $H_o$ Rejected |
| Borehole | 28 | 0.3065 | 2.06 | $H_o$Accepted |
| Well | 29 | 5.190 | 2.06 | $H_o$ Rejected |
| River | 30 | 0.3237 | 2.06 | $H_o$Accepted |
| Borehole | 31 | 10.931 | 2.06 | $H_o$ Rejected |
| Well | 32 | 10.618 | 2.06 | $H_o$ Rejected |
| River | 33 | 2.336 | 2.06 | $H_o$ Rejected |
| Borehole | 34 | 9.886 | 2.06 | $H_o$ Rejected |
| Well | 35 | 10.757 | 2.06 | $H_o$ Rejected |
| River | 36 | 4.199 | 2.06 | $H_o$ Rejected |

Source: Author's Fieldwork Results, 2010

Both Table 1 and Table 2 reveal that water demand in most medium-sized towns is beyond the capacity of water supplied from most sources; Water demand level has correlation coefficient of $r = 0.39$ and water supply level at $r = - 0.07$ and $\delta = 14.7$ and 19.6 respectively. There is therefore negative significant relationship between water demand and supply in medium-sized towns of Niger State. Since cal $t = 11.94$ is higher than tab $t = 2.06$ from the study area. This portray the reason why most of the medium-sized towns household experience deficit of water demand.

In determining Water Demand within the study area, data on the average distance of household sources of water were considered as the dependable variable, which is correlated against the data generated from the average household size, average quantity of water demand, and average quantity of water obtained in demanding for water as independent variables as indicated in the regression line. In dry seasons most sources especially the boreholes and wells are often stressed beyond the expected level. Many households usually prefer obtaining water from a specific source and will not mind to stay on queues for long hours. The inability of households obtaining enough water for use becomes paramount during the wet season when water table levels recharge the wells and the boreholes including the surface water.

TABLE 2 WATER USED PER LITER ACCORDING TO LOCALITY

| S/N | MEDIUM–SIZED TOWNS | Dependent variable | Independent variable | | |
|---|---|---|---|---|---|
| | | Quantity | Educational Attainment | Purpose of Demand | Expense Per month |
| | | In '000 ltr | In '000 ltr | In '000 ltr | In '000 ltr |
| 1 | Wawa | 18 | 19 | 43 | 15 |
| 2 | Makunkele | 70 | 26 | 21 | 20 |
| 3 | Chanchaga | 21 | 40 | 53 | 39 |
| 4 | Enagi | 22 | 16 | 21 | 20 |
| 5 | Badegi | 24 | 20 | 23 | 15 |
| 6 | Rafin gora | 48 | 19 | 22 | 19 |

| | | | | | |
|---|---|---|---|---|---|
| 7 | Lapai | 27 | 50 | 48 | 40 |
| 8 | Kutigi | 25 | 56 | 28 | 45 |
| 9 | Ibeto | 32 | 25 | 25 | 25 |
| 10 | Mariga | 25 | 31 | 33 | 31 |
| 11 | Zugurma | 28 | 16 | 25 | 18 |
| 12 | Gbajibo | 34 | 20 | 28 | 25 |
| 13 | Paiko | 58 | 20 | 34 | 42 |
| 14 | Kagara | 42 | 48 | 56 | 46 |
| 15 | Rijau | 50 | 50 | 42 | 48 |
| 16 | Kuta | 20 | 54 | 50 | 53 |
| 17 | Kwamba | 30 | 25 | 22 | 20 |
| 18 | Sabon Wuse | 32 | 18 | 30 | 19 |
| 19 | Zungeru | 28 | 19 | 33 | 27 |

Source: Author's Fieldwork (2010)

The relationship of water demand within the households is the function of household-size and distance from sources of water. Table 2 reveals that demand for water depend on the viability of the household and capability to afford the required standard of water in need. The dotted lines on demand tend to change based on the socio-economic statues of the household head. The supply level retreats as the demand increases in Fig. 2. The quantity of water obtained by the household is a function of distance and the size of the household from the source. Since r=0.39, there is relationship between the distance of household to the type of sources of water of the household. In Fig. 2 the farther the distance of sources of water from the household, the less water is been obtained by the households. This implies that most households prefer to fetch water from the nearby sources. Whenever there is scarcity the water vendors become the major source they could depend on because they go to any distant to fetch water which is sold to the households.

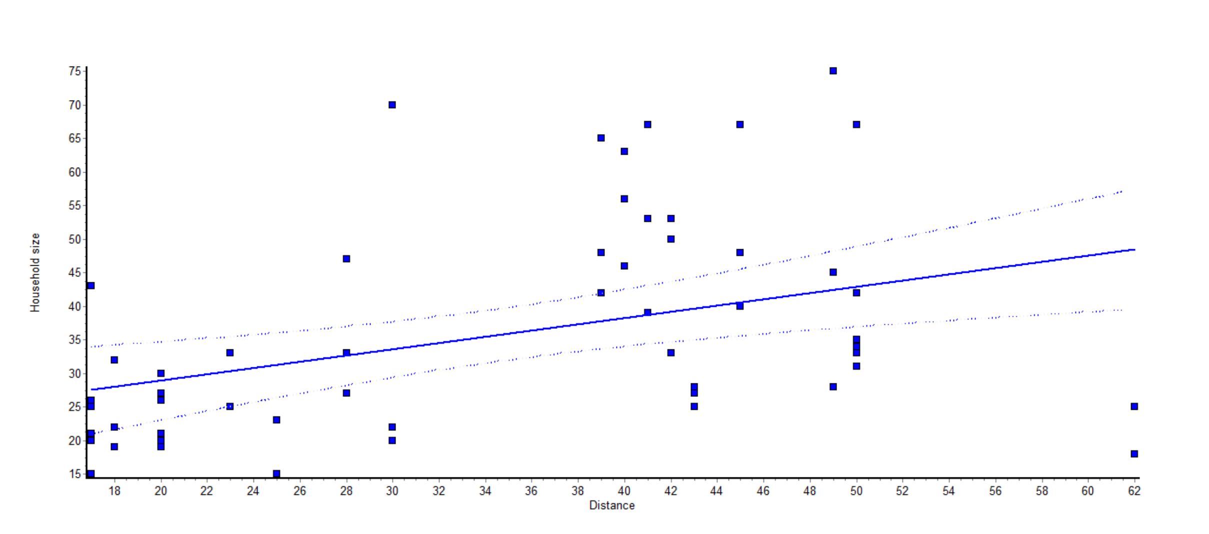


Fig. 2 The Household Relationship of Water demand within the Medium-sized towns

Source: Fieldwork Result, 2010

*Level 2: Sources of Water Supply*

The reliability of sources of water depends on its availability, quality and quantity obtainable at a particular time. It is revealed that well water is 75% reliable in Ibeto, Kuta, Makunkele, Rijau, Kwamba, and Enagi. Borehole water is 65% reliable in Chanchaga, Lapai, Zugurma, Gbajibo, Kutigi, Rijau, Badegi, Sabon wuse and Rafi gora. Majority of households therefore obtain water from the boreholes nearer to their compounds. Water from the borehole easily gets exhausted due to pressure from the people. This is in contrast with [21] carried out in a developed nation's communities, where water rearly ceases to run occasionally. These findings are consistent with that of [22] in Ilorin and [23] in Zaria where taps and boreholes went dry for weeks without water. Due to unavailability of water in most stand points, household's resorts to unprotected wells, streams and some other sources as rain harvesting. Moreover streams and well waters represent the most highly reliable source of water for domestic use in Zugurma, Chanchaga, Badegi, Rafin gora, Mariga and Ibeto especially during the dry season. The reliability of streams and wells as sources of water, does not imply that they are fit for domestic consumption since it is revealed that water from such sources are usually contaminated. Most medium-sized towns have boreholes scattered around the town, only that some of these boreholes are abandoned for lack of maintenance. Those households far away from boreholes, alternate their household water demand with stream and well water. It was revealed that households that fetch water from the streams and wells do treat their water by using alum and boiling only during the dry season. It is noted that the use of alum alone can only improve the physico-chemical quality of the water to some extent and not the bacteriological quality since pathogens like

Streptococcus faecalis, Escherichia coli, Aeromonas hydrophilic and Chromo bacterium violaceum will still be present in such water even after treatment with alum [1, 23, 24, 25]. From this study it is revealed that there is the need for further boiling of water from doubtable sources to reduce the bacteria load after the alum treatment and further filter it with clean cloth in order to complete clarifying the water before consumption.

About 85% of the respondent's households cannot afford drilling of boreholes in their respective houses. Hence most of their women and children go in search of water and some that can afford water from vendors still spend hours waiting to purchase water. This is in agreement with [26] which revealed that most Nigerians households spend their precious time in search of water. It was also revealed that most extended parts of the medium-sized towns are very far from the sources of water initially established for the community. This contradicts [21] and [27] who presented a view that productive water sources are closer to households.

*Level 3: Matching Water Supply and Demand*

In ascertaining the level of water demand and supply data generated from the questionnaire response on Pattern of Household Water Usage, Quantity of Water required in the households and duration of water storage in households were used in Fig. 3. The percentage developed tried to depict the magnitude of domestic water usage level within the communities. Wawa, Chanchaga, Enagi, Rafn-gora, Lapai, Kutigi, Ibeto, Gbajibo, Paiko, and Kagara medium- sized towns' uses about 80% of water for domestic purposes. Only few of the households use water for industrial or agricultural purposes.

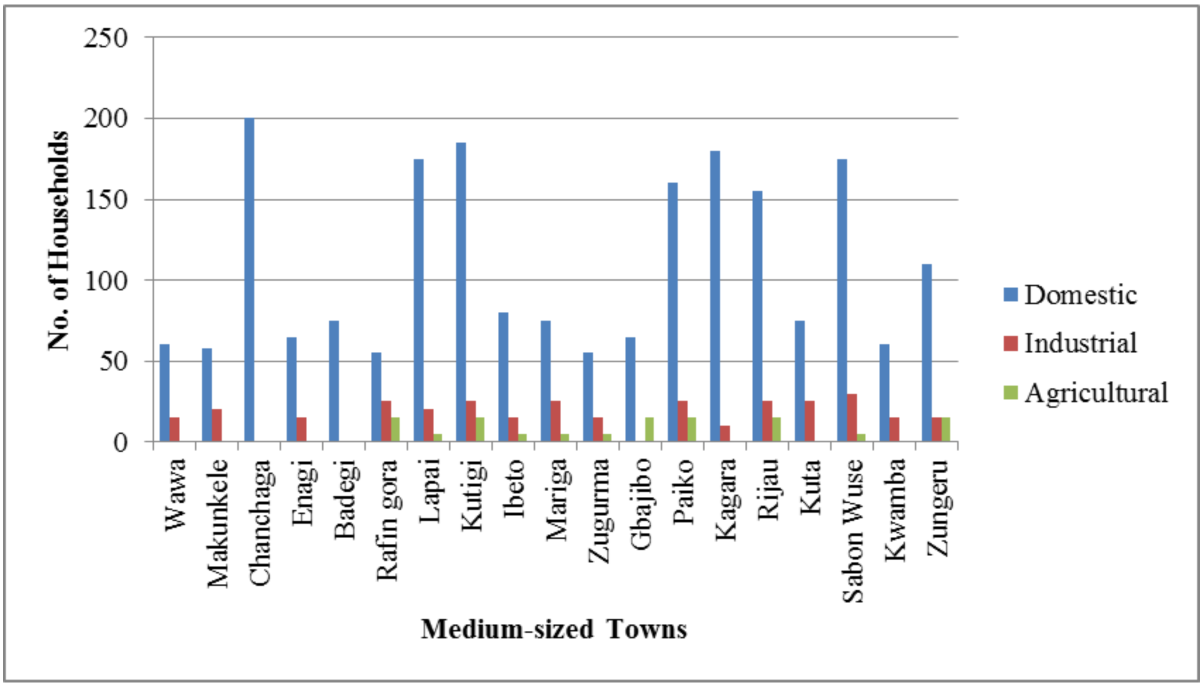


Fig. 3 Pattern of Household Water Usage Source: Fieldwork Result, 2010.

TABLE 3 ILLUSTRATING THE DEFICIT LEVEL OF WATER DEMAND IN MEDIUM-SIZED TOWNS

| S/N | Medium-sized Towns | Expected Water Demand in Litres per day | A1 Expected Water Demand in Litres per Household | B1 Obtainable Water per person in the Household | Water Supplied to the Household | A2 Amount of Water obtained per Household per day | B2 Amount of Water Obtained per day | A3 Deficit per Household | B3 Deficit per person |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Wawa | 62800 | 690.1 | 98.6 | 15600 | 171.4 | 24.5 | 518.7 | 74.1 |
| 2 | Makunkele | 76300 | 942 | 134.6 | 24650 | 304.3 | 43.47 | 637.7 | 91.13 |
| 3 | Chanchaga | 2188600 | 8136.1 | 1162.3 | 143160 | 531.9 | 76 | 7604.2 | 1238.3 |
| 4 | Enagi | 125300 | 1457 | 208.17 | 75380 | 876.5 | 125.2 | 768.8 | 83 |
| 5 | Badegi | 78600 | 970.4 | 138.6 | 46950 | 579.6 | 82.8 | 390.8 | 55.8 |
| 6 | Rafin gora | 86300 | 854.5 | 122.1 | 34100 | 337.6 | 48.23 | 516.9 | 73.9 |
| 7 | Lapai | 1867700 | 6742.6 | 963.2 | 57900 | 209 | 29.9 | 2309.8 | 933.3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **8** | Kutigi | 177200 | 637.4 | 91.1 | 142600 | 512.9 | 73.3 | 124.8 | 17.8 |
| **9** | Ibeto | 128800 | 983.2 | 140.5 | 26600 | 203.1 | 29 | 780.1 | 111.5 |
| **10** | Mariga | 107300 | 609.7 | 87.1 | 39300 | 223.3 | 31.89 | 386.4 | 55.2 |
| **11** | Zugurma | 48600 | 615.2 | 87.9 | 23400 | 296.2 | 42.31 | 318.99 | 45.57 |
| **12** | Gbajibo | 79900 | 998.8 | 142.7 | 19599 | 245 | 35 | 755 | 107.7 |
| **13** | Paiko | 454300 | 2153.1 | 307.6 | 63815 | 302.5 | 46.14 | 1850.6 | 261.5 |
| **14** | Kagara | 178800 | 856.6 | 122.8 | 59900 | 288 | 41.14 | 568.6 | 81.7 |
| **15** | Rijau | 126300 | 478.4 | 68.3 | 60700 | 229.9 | 32.9 | 248.5 | 35.4 |
| **16** | Kuta | 441200 | 1640.1 | 234.3 | 135300 | 503 | 71.9 | 1137.1 | 162.4 |
| **17** | Kwamba | 455400 | 3960 | 565.7 | 49200 | 427.8 | 61.11 | 3532.2 | 504.6 |
| **18** | Sabon wuse | 661300 | 7601.1 | 1085.9 | 88900 | 1021.83 | 145.97 | 6579.3 | 939.9 |
| **19** | Zungeru | 479200 | 3216.1 | 459.4 | 71500 | 479.9 | 68.55 | 2736.2 | 390.85 |

Source: Author's Fieldwork Result, 2010

In Table 3 the variation that exist between water demand and supply in medium-sized towns using the data expresses A1 as the minimum average quantity of water demand a particular medium-sized town is expected to obtain per day, B1 is the minimum amount of water demand a household can afford to obtain per day, A2 is the average quantity of water acquired for use in a medium-sized town, and B2 is the minimum average quantity of water obtainable for use by household in a medium-sized town. The products of Medium-sized town's population and a minimum as recommended by [27, 29] derive the total amount of water required to be obtained in a day. Hence from Table 3 it is revealed that most medium-sized towns are grossly experiencing inadequate water supply. Wawa town requires 68,200 litres of water but only able to obtain 15,600 litres of water per day. In Wawa town there is deficit of 47,200 litres per day. In Makunkele town, 76,300 litres of water is expected to be supplied to the town but they are only able to obtain 24,250 litres of water, thereby having deficit of 52,050 litres of water daily. Chanchaga town require 2,188,600 litres of water per day, but only obtain 143,160 litres of water. Hence the town has deficit of 75,600 litres of water. More also is the household's deficit of water as the case of the community water demand is not satisfactory. Enagi town is expected to obtain 125,300 litres of water per day, but are only able to obtain 75,380 litres of water having deficit of 49,920 litres per day and a total household deficit of 580.5 litres per day. The problem is due to distance from the source, inability to have enough container in keeping water as well as few numbers of either boreholes and wells need to meet the need of the increasing population.

In Table 3, A3 and B3 are the gaps identified in every medium sized towns, therefore (A1-A2=A3, and B1-B2=B3). By using Coefficient of Variance (CV) the study is able to reveal that relative variation of A3=117.77 exist between water demand and supply in medium-sized towns and B3=119.01 is the relative variation of quantity of water obtainable by the household.

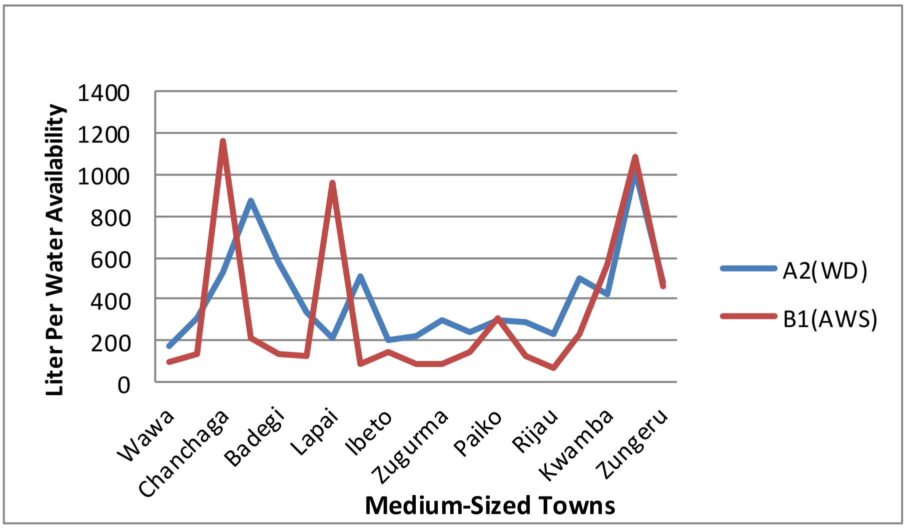


Fig. 4 Water Demand and Average Water Supply in Medium –sized Towns

Source: Fieldwork 2010

Domestic water supplied to household tends to defer greatly to the rate of water demand. Fig. 4 reveals that A2 (WD) is the rate at which domestic water is obtained from different sources for domestic activities. While B1 (AWS) is the rate of substantial domestic water available for domestic use. This figure reveal that most of the medium-sized towns have water available for domestic use but the amount obtained is often less than what is expected to be used in the household. The paramount problem is due to the facilities used for conserving water in the various household. The socio economic income of the people is so low that they are not able to obtain the facility required for conserving sufficient water to be used in the household.

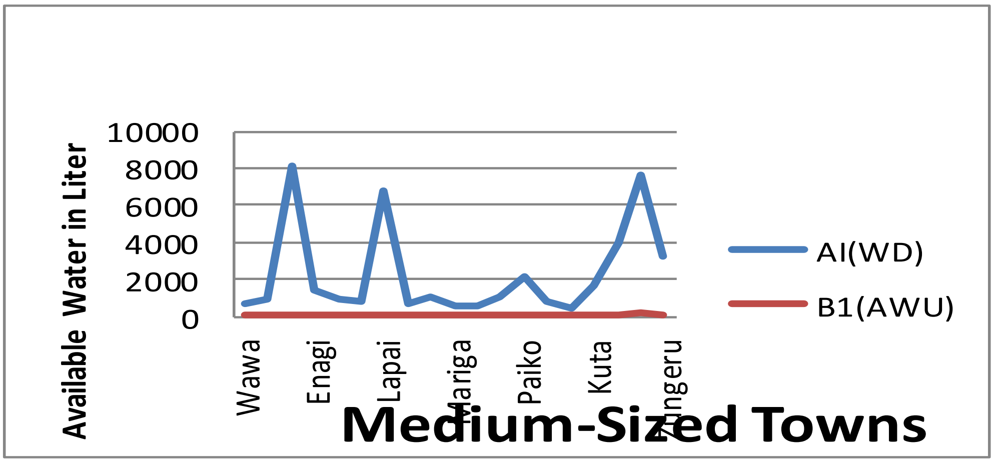


Fig. 5 Amount of domestic water demand in relation to actual water used

In Fig. 5, the amount of water required from sources is not enough for domestic activities. A1 (WD) amount of water demand within the communities for domestic utility is beyond the amount of water obtained in B1 (AWU) and put to use by the households. Due to this gross fall in the amount of domestic water supply, many households experience inadequate sanitary efficiency. Most household thereby depend on vulnerable sources of water.

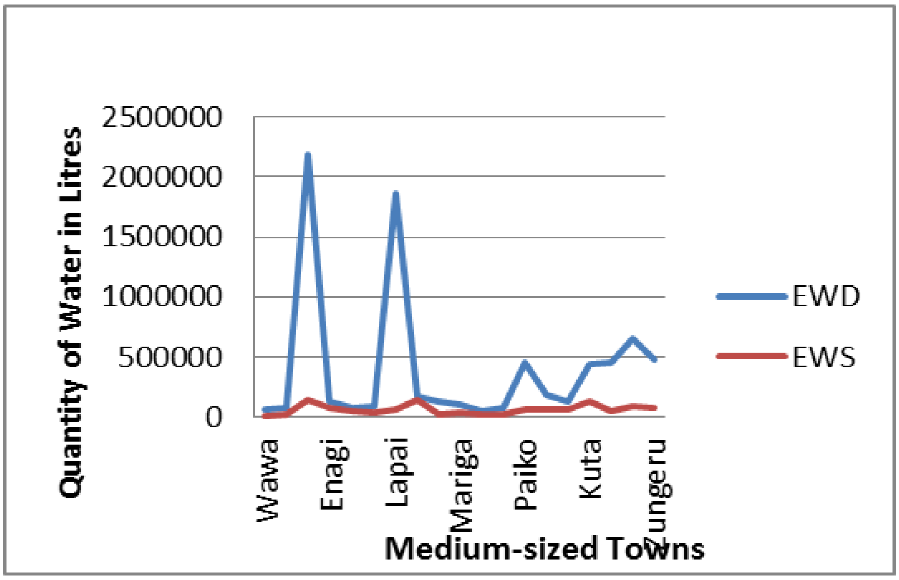


Fig. 6 The Expected Water Demand visus Expected water supply

Fig. 6 reveals the relative water deficit in domestic water demand due to inadequate water supply. The relationship between the expected amount of water demand (EWD) in the households and the expected water supply (EWS) from the various sources deplit the deficit level of water supply. Domestic water demand (WD) increase is dynamic due to the improvement in livelihood among the communities while the average water supply (AWS) has been static. The inadequacy does grossly affect the health, sanitation and this narrow down type of household utensils, industrial machines that could require lubrication in domestic household work.

## IV. CONCLUSIONS

Conclusively, the availability and use of water through functional infrastructure is a potential of social amenity that constitute development catalyst. There is negative significant relationship between water demand and supply in medium-sized towns since cal. t is higher than tab. t (t=11.94 and t=2.06). This is why most of the households experience deficit of water supplies. The distances of households from sources of water greatly affect the amount of water demand for household use.

Since T-distribution test has r=0.39 less than 1, shows that there exist great relationship between the distance and the sources of water supply. The amount of water required is beyond the amount of water obtained for domestic activities. A1 (WD) > B1 (AWU) which put most households into great deficit.

## RECOMMENDATION

The study recommends the need to create public awareness in respect of the dangers associated with the consumption of sub-standard water. By strengthen the existing water policy and ensuring adequate maintenance of water treatment plants. Establish a workable policy of having maximum threshold of twenty-five households per borehole or ten households to a well by water project groups. In addition, water management agencies should be independently policed by the user community and be politically and financially accountable to the government. Electric powered boreholes should be established alongside water reservoir tanks. Modern techniques of water storage and treatment plants should be provided in every medium-sized town. The government and communities should collaborate in creating maintenance culture and potentials for sustainable water supply in Niger State.

This study has revealed the causal variables responsible for water crisis in most medium-sized towns in Niger State. It is expected that this study should avail stakeholders and policy makers the opportunity to consider improvement strategies and tactics that can assist in stemming down water shortages not only in Niger State but also other emerging towns in Nigeria.

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