CARD International Journal of Environmental Studies and Safety Research (IJESSR)
ISSN: 2536-7277 (Print) : 2536-7285 (Online)
Volume 2, Number 3, September 2017
http://www.casirmediapublishing.com

Assessment of Water Supply by Non-Institutional Sources in Suleja, Niger State, Nigeria

Gognaje, Sunday Barde
Department of Urban & Regional Planning,
Federal Polytechnic, Bida, Niger State, Nigeria
Email: sgognaje@yahoo.com

ABSTRACT

Water is a basic need of all humans and its accessibility, an important component of human development. Accessibility to safe water is a major concern to every responsible government at local, State and Federal levels. The Sustainable Development Goal number six aims at making water available for all by 2030. Even so, the national water coverage at the end of 2015 (Millennium end-year) was 69% in Nigeria (USAID, 2016). The water board/corporations in Nigeria with the statutory mandate of providing safe drinking water for the people have not been able to do so effectively, hence, the development and proliferation of alternative sources of water including boreholes and wells to meet up with the water need of the people in urban areas. This research examines the contribution of boreholes and wells in meeting the overall water need in Suleja area, Primary data was collected through the use of Global Positioning System (GPS) to record the coordinates of the identified boreholes and wells in each district making up Suleja area. A total of 1124 sources were identified in the area made up of 474 boreholes and 650 wells. The total volume of water supplied by these sources is 2,674,500liters/day representing 17.74% of the total water need by a population of 264, 506 persons in Suleja area (2016 projected population), at 60ltres/capita/day. However, the study recommends that individual landlords and house owners should be encouraged to develop joint mini-water schemes to reduce potential incidences of environmental hazards associated with underground water abstraction and reduce economic stress in digging private individual boreholes and wells.

Keywords: Water Supply, GPS, Accessibility, Alternative Source, Underground Water

INTRODUCTION

Water is among the basic services that support man's healthy and continuous existence and is an important component of human development. According to UNDP (2006), water is not only a substance that supports life, but that water is among the most powerful drives for human development. Safe drinking water is indispensable to sustain life and health and fundamental to the dignity of all. Water is a very strategic socio-economic asset especially in poor communities where wealth and survival are measured by the level of access to water (Ituen, Atser & Edem, 2016, 522). Accessibility to safe water is a major concern to every responsible government at both Local, State and Federal levels The Sustainable Development Goal number six aims at making water accessible to all by year 2030. Even so however, WHO/UNICEF (2012) estimated the Nigeria urban water coverage at 74%. Rural areas are worse off with coverage of 43%. In 2015; the end of the MDGs, national water coverage was estimated at 69% (USAID, 2016).

Lack of safe water predisposes people to water and sanitation related diseases and illnesses such as cholera, malaria, dysentery and typhoid among others. Water related sicknesses put severe burdens on health services and keep children out of school (Christophe, Hommann, Rubio, Sadoff and Travers, 2001, 20).

The manifestation of water service deprivation are clearly seen by the adaptive measures undertaken by the people to cope with the inadequacy of these facilities exemplified by indiscriminate digging of wells and boreholes, use of less water for household and sanitation activities, proliferation of water vendors with doubtful quality and charging exorbitant prices for the water they provide and the use of unimproved water facilities and all of these, not without a cost. Joint Monitoring Program (JMP) of WHO/UNICEF (2006) categorized the sources into improved and unimproved sources and the categories are as follows:

Improved water sources include: Piped water into dwelling, plot or yard, Public tap/stand pipe, Tube well/borehole, protected dug well, protected spring and Rain water collection. Unimproved water sources include: Unprotected dug well, unprotected spring cart with small tank/drum, Bottled water when the household do not use improved water source for cooking and personal hygiene, tanker-truck Surface water such as streams, rivers, dam, lake, pond, canal and irrigation channels.

Gana's research work titled "Assessment of the Availability of Water and Sanitation Facilities in Paikoro Local Government of Niger State (2013), aimed at investigating water and sanitation facilities in some selected communities in the area by taking an inventory of water resource base, examining the level of accessibility to water and sanitation facilities as well as examining water and sanitation stress in the study area. In the collection of data, the author used questionnaire, Global Positioning System (GPS), field observation and focus group discussion. The study discovered that the people in the study area relied heavily on boreholes and wells for their domestic water supply.

Also, Sanusi (2010, 14-29) studied water, sanitation and human development in urban fringe settlements in Nigeria. The focus of his work was on investigating water supply and sanitation services in Dama, Jatapi, Gidan Kwano, Epigi and Lunko, all suburban settlements of Minna, Niger State. The settlements are located along Minna Bida road absorbing the development pressures from the main city and those posed by National Examinational Council (NECO) and Federal University of Technology (FUT) Minna, all along the same development corridor. The objectives however, were to investigate access to water and sanitation facilities, determine the coping mechanisms and effects of the level of these facilities on the people.

The work of Kortatsi, and Quansah (2004, 83), was aimed at determining the feasibility of using groundwater for water supply to Sunyani and Techima urban areas. The authors discovered that 75% of the boreholes supply above $3.0m^3h^{-h}$ with high water yielding aquifers and therefore, can be developed for urban water supply

Toit, Holland, Weidemann and Fanie (2012, 394) undertake a study in Limpopo. They discovered that while most water service authorities in the province have been randomly developing new boreholes with limited success rates, the analysis of datasets in the newly established groundwater data repository, the Limpopo groundwater Resource Information Project (GIRP) demonstrates that large quantities of groundwater can be obtained and used for bulk supply if the drilling sites are scientifically selected. The 300 out of the 400 boreholes sampled, can provide a combined yield of 109m3/a based on 24hr abstraction rate. This shows that ground water then can be developed as a viable potential bulk water source.

The safety of water for drinking and other domestic uses is determined by the quality of the water. Petkovic, Gregoric, Slepcevic, Blogogjevic, Gajic, Kljujevic *et al* (2011, 84) researched on the contamination of local water supply in suburban Belgrade. This research focused on the quality of the local water supply system in suburban Belgrade the capital of Serbia. Their concerns were on the compliance of these supply systems with the WHO standard for safe drinking water supply. The quality of the water by World Health Organisation (WHO) can be measured by its microbiology, chemical and physical standards for value compliance. The research discovered that the contamination observed were due to some factors such as presence of septic tanks and pit-latrines near the water source some of which were shallow wells and uncontrolled waste water discharges into subsurface from residential area located on a hill in the valley of the creek. The research thus suggested the prevention of pollution of the ground water sources within the vicinity of the local supply sources and advocated for the alternative use of waste water.

Also, Ololade, Adewumi, Ologundudu, and Adeleye, (2009, 21) studied the effects of household wastes on surface and underground waters in Ikare – Akoko in Ondo State, Nigeria. The goal of the research was to examine the effects of household wastes dumps on water sources and demonstrate that effective environmental management and protection of water sources could improved drinking water quality. It was discovered on the overall, that majority of the natural water sources were polluted from the indiscriminate dumping of wastes into the environment and hence, suggested effective disposal mechanisms of household waste in Nigeria cities and enhance monitoring program per waste disposal.

However, this study examines the contribution of boreholes and wells in the overall water supply in Suleja area in Niger State. The outcome of this research provides an opportunity for the government and nongovernmental organisations to know the situation of water supply in the area, and use the recommendations provided to improve water supply in the area.

Aim

The aim of this research is to examine the distribution and contribution of non-institutional water sources (Wells and Boreholes) to water supply in Suleja area, Niger State.

Objectives

1. Identify the alternative water sources in the area
2. Examine their distribution within the area
3. Determine their capacity and contribution to the total water supply
4. Suggests ways to improve water supply in the area.

Description of the Study Area

The study area is the Suleja town made up of ten Districts namely, Gauraka, Iku, Wambai, Hashimi, Magajiya, Bagama, Zuma and Madalla housed by three local governments in Niger State namely: Suleja, Gurara and Tafa (Figure 1). Parts of these local governments and of course the study area, fall into Suleja Emirate with similar physical, geographical and socio-economic characteristics. The region lies between latitude 9^0 15"E and 9^0 30"E; longitude 6^0 55^0 N and $7^0$15"N. It is bounded on the north-east by Kaduna

State, in the south by FCT- Abuja and on the west by Paikoro and Lapai local governments. (See figure 1)

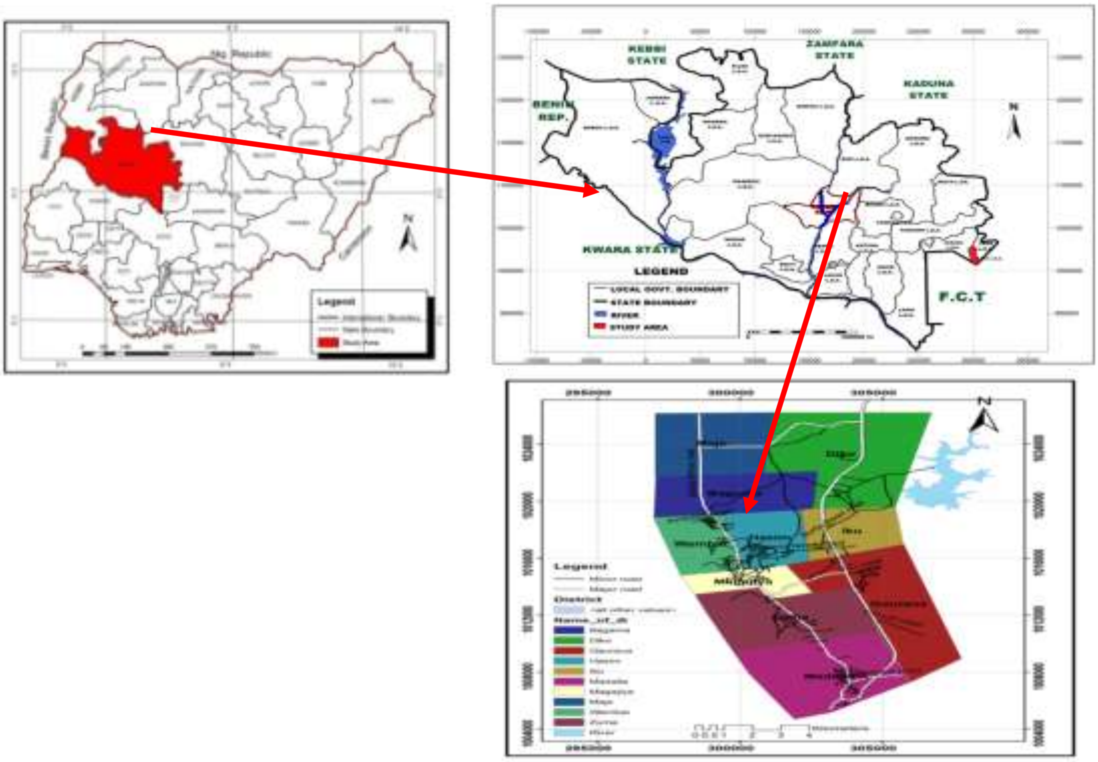

Figure 1: Suleja showing districts
Source: SGI Department, FPB (2015)

The population of the area under study in 2016 is 257,308 made up of the following components as shown in Table 1

Table 1: Population of the study area (2016)

S/no	District	Population (2016)
1	Maje	6,641
2	Diko	9,998
3	Gauraka	13,483
4	Iku	15,316
5	Wambai	42,570
6	Hashimi	50,594
7	Magajiya	48,220
8	Bagama	46,185
9	Zuma	9,543
10	Madalla	14,758
Total		**264,506**

Source: Projected from 1996, population figures (NBS, 1996)

From the Table 1, Suleja area (the study area) has an estimated population of 264,506 people. The study area is made up of 10 districts, and all the districts in the study area are under Suleja emirate, with similar geographic and economic characteristics such as vegetation, weather condition, agricultural potentials, soils, rock types, topography and interconnected markets. They also share major hydrological characteristics and particularly, the common Kopma earth dam from where the area is supplied with potable water. The study area is not only delineated by homogenous physical and socio-economic characteristics, but also by functional elements such as interconnected markets.

METHODOLOGY

Data collection methods and procedures are a key to a successful research. The quality of the research result is dependent on the quality of data obtained, therefore, this section deals with the data collection methods, presentation and analysis used in this study. Data needed for this research was obtained from both the primary as well as secondary sources. The primary sources provided first hand and critical data for the study and include: Global Positioning System (GPS) readings of the water points and water point photograph to show the condition of the sources. Secondary sources of information from literature provided theoretical basis and support for the study. A hundred (100%) sample size of the districts was adopted for the physical survey which entails taking coordinates of all the identified water sources using GPS.

The research used the current map of Suleja from high resolution GIS software where constituent's districts/wards as well as clusters were identified. The area was divided into Districts /wards for the purpose of survey and analysis. Hand-held Geographic Information System (GPS) was used to record the coordinates of the identified water sources and the coordinates of the water sources were plotted on the acquired map using ArcGIS 10.1 software. An analysis of the distribution characteristics and the total water yield of all the identified sources was made and compared with the total water need of the area to determine water gap using geo-statistical tools and models. Data collection and analysis instruments used for this research include: Hand held GPS for taking coordinates of the identified sources of water, Camera for taking photographs of water points and ArcGIS 10.1 soft ware for plotting and querying the developed maps.

RESULTS AND DISCUSSION

(a) Sources of Water in the Area

The major community water sources include: Niger State Water Board, Boreholes and Wells. Minor sources include rivers and streams were not included in water supply analysis in this research because of their insignificant contribution to the overall domestic water supply in the area. Table 2 shows the various sources of water facilities and their numbers in the study area.

Table 2: Number of Boreholes and Wells in the Area

S/No.	Type of water source	Functional	Not functional	Total No.
1.	Bore holes	412	62	474
2.	Wells	547	103	650
	Total	**959**	**165**	**1124**

Source: Author's Field survey, 2016

From Table 2, there are a total of 474 boreholes and 650 wells. However, there are 412 functional and 62 non-functional boreholes, 547 functional and 103 non functional wells in the area. There are therefore, a total of 1124 sources made up of 959 functional and 165 non functional sources. The implication of this finding is that only 959 water sources are actually supplying water to the households in the region. The 165 sources are dysfunctional and cannot at the present be used to estimate water supply in the area. Table 3 however, shows the distribution of boreholes and wells according to the districts.

Table 3: Sources of Water in Suleja Area According to Districts

S/no	District	No. of Motorized Boreholes	No. of Hand pump Boreholes	No. of Covered wells	No. of Uncovered Wells	Total
1	Bagama	14	1	30	5	50
2	Diko	35	11	130	16	192
3	Gauraka	57	6	91	19	173
4	Hashimi	33	6	32	4	75
5	Iku	19	2	20	2	43
6	Madalla	56	1	15	12	84
7	Magajiya	29	13	18	3	63
8	Maje	65	6	90	18	179
9	Wambai	26	4	21	0	51
10	Zuma	76	14	112	12	214
	Total	**410**	**64**	**559**	**91**	**1124**

Source: Author's Field Survey, 2016.

From Table 3, there are 1124 water sources comprising of Boreholes and wells. The table gives the distribution of these sources according to the districts as follows: Bagama – 50; Diko – 192; Gauraka – 173; Hashimi – 75; Iku – 43; Madalla – 84; Magajiya – 63; Maje – 175; Wambai – 51 and Zuma-214.however, Table 4 shows the condition of the water sources according to districts.

Table 4: Condition of Water Sources by Districts

S/No	District	MB		HPB		COV WELL		UNCOV WELL	
		F	NF	F	NF	F	NF	F	NF
1	Bagama	13	1	1	0	25	5	1	4
2	Diko	30	5	3	8	110	20	9	7
3	Gauraka	57	0	2	4	84	7	7	12
4	Hashimi	30	3	4	2	30	2	2	2
5	Iku	17	2	2	0	20	0	2	0
6	Madalla	51	5	1	0	12	3	7	5
7	Magajiya	26	3	8	5	16	2	1	2
8	Maje	63	2	4	2	80	10	10	8
9	Wambai	26	0	3	1	20	1	0	0
10	Zuma	63	13	8	6	104	8	7	5
	Total	**376**	**34**	**36**	**28**	**501**	**58**	**46**	**45**

Source: Author's field work, 2016.

Note: MB (Motorized Borehole), HPB (Hand Pump Borehole), COV WELL (Covered Well), UNCOV WELL (Uncovered Well), F (Functional) and NF (Non-functional).

Table 4 indicates that out of the total 410 motorized boreholes; only 376 are functioning while 34 are not. From the total of 64 hand pump boreholes, only 36 are functioning and 28 are not. There are also 501, and 46, functioning covered wells and uncovered wells, respectively. Functional source (F) in this study refers to the sources that provide water for household use every day while non-functioning source (NF), provides water once in a long while or do not provide water at all such as dried wells or spoilt boreholes. Those non functioning sources therefore, do not provide daily water needed and were therefore exempted from further analysis.The total number of non-functioning sources is 165 representing 14.67% of the total water sources in the area. This is a large and significant portion with a great potential for adding up to 433,500 litres per day to the supply capacity of the area.

(b) Distribution of Boreholes and Wells in Suleja Area

The spatial distribution of all the water sources can be seen in Figure 2.

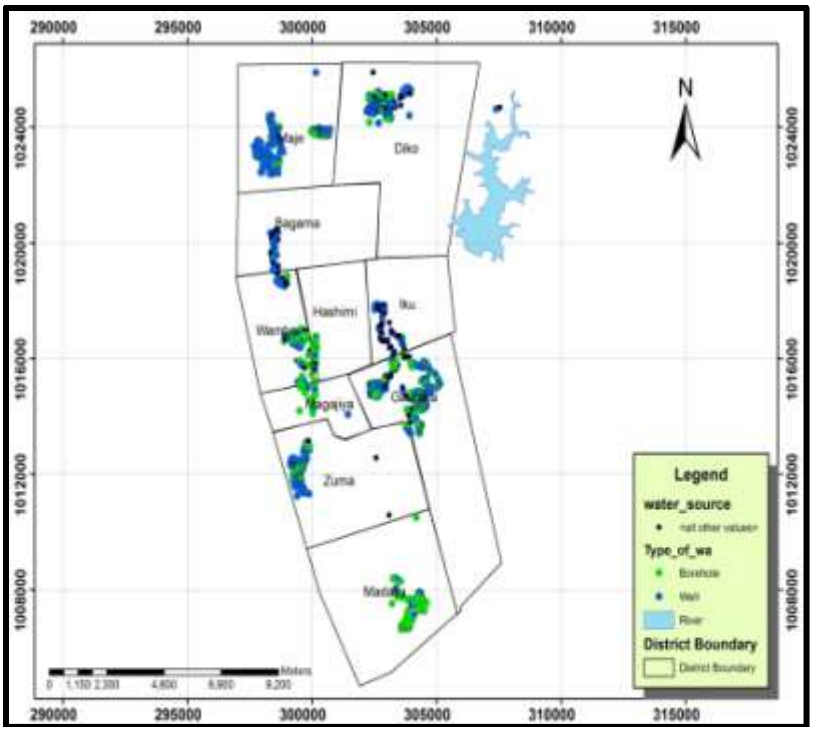

Figure 2: Distribution of Water sources in Suleja Region

The spatial distribution of water sources in the districts are shown in Figure 2. The different colours represent types of source as can be seen from the Legend contained in this Figure. The constituent districts have variation in the number of water sources shown earlier in Table 3. However, it is observed that these water sources are located in the built-up areas in all the districts.

Geo-Statistical Analysis of Spatial Distribution

Spatial cluster analysis is employed to explore the water facilities distribution in the study area. This study adopts global view of spatial cluster analysis to help us determine the spatial distribution of water facilities in the study area. In this report, this method considers all set of water facilities as a global view in the study area, and makes use of Average Nearest Neighbour Analysis in Arc Toolbox. However, this tool sets the null hypothesis that there is no difference between a random distribution and the distribution of water facilities in the study area.

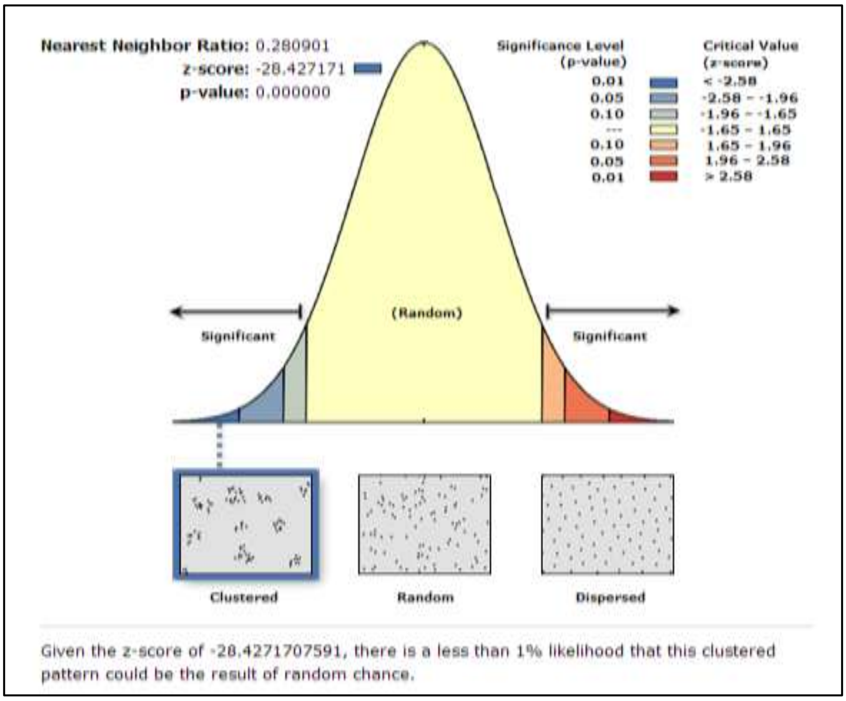

Figure 3: Spatial Distribution of Borehole Facilities

Table 5: Average Nearest Neighbor Analysis Summary of Borehole Facilities

Observed Mean Distance	73.0651 Meters
Expected Mean Distance	260.1100 Meters
Nearest Neighbor Ratio	0.280901
z-score	-28.427171
p-value	0.000000
Input Feature Class	Borehole
Distance Method	EUCLIDEAN
Study Area	115558485.552304

Table 6: Average Nearest Neighbor Analysis Summary of Well Facilities

Observed Mean Distance	53.7546 Meters
Expected Mean Distance	215.2839 Meters
Nearest Neighbor Ratio	0.249692
z-score	-37.264950
p-value	0.000000
Input Feature Class	Well
Distance Method	EUCLIDEAN
Study Area	124951925.109680

Figure 3 and Tables 5 and 6 are the outcomes of spatial cluster test of boreholes and wells facilities. When the p-value of 0.000000 and given the z-score of -28.427171 is examined as in Table 5, the pattern appears to be clustered which is significantly different from random. Therefore, we reject the null hypothesis that all boreholes facilities are randomly distributed in the study area. The result in Table 6 also shows that just as the boreholes, wells are rather clustered in the study area. It is therefore, not surprising to find these sources clustered within the built up area in each district.

Point Density

Conventional Point Density Analysis using un-weighted density estimation highlights areas or regions with high concentration of sample points. Point density tool in Arc Toolbox is used to establish areas with high concentration of water facilities with automated contour values.

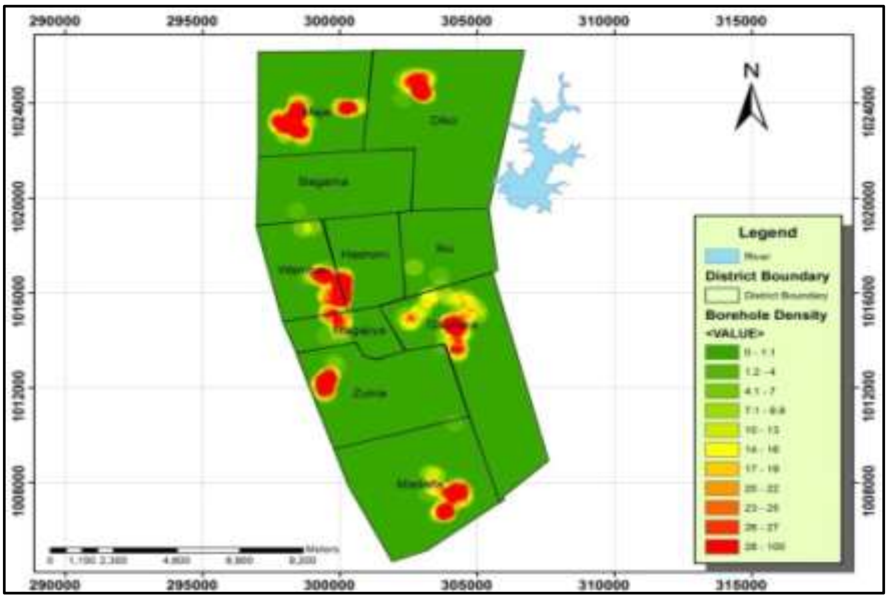

Figure 4: Density of Borehole Facilities

Figure 4 revealed that regions with filled contour value of 28 – 100 have more boreholes facilities than those with lower values. From the Figure it can be seen that central area of Maje district has high concentration of borehole facilities, while in Diko it is more concentrated in the north western part. In Gauraka, the concentration of borehole facilities is in the north while in Zuma it is to the west and Madalla to the south. There is high concentration of borehole facilities between Wambai and Hashimi. Although Iku and Bagama have less to the south west. This observed pattern of distribution may be due to some factors such as geological, locational and economical characteristics of the districts.

(c) Water Supply Capacity of Sources and Volume Contribution to Suleja Area

The total water supply by boreholes and wells in the area is shown in Table 7. This estimation is based on average daily yield of water by boreholes and wells of 4,500l/d and 1,500l/d respectively (Sanusi, 2010).

Table 7: Volume of Water Supply by Alternative Sources in Suleja Area

Source of water	Average yield /day (lit)	No. of facilities	Total water supply (lit)
Borehole	4,500	412	1,854,000
Well	1,500	547	820,500
Total			**2,674,500**

Source: Authour’s field survey, 2016

Table 7 shows that the total water supplied by functional boreholes and wells is 2,674,500l/c/d. The non functional boreholes and wells were discounted off from the calculation of the total water available. This was done because these sources were not supplying water at the time of the study. The contribution of boreholes and wells can also be seen at the district levels as shown in Table 8.

Table 8: Water Supply by Alternative Sources According to Districts

District	Volume of Water by source (lit)		Total water
	Boreholes	Wells	supplied (lit/d)
Bagama	63,000	39,000	102,000
Diko	148,500	178,500	327,000
Gauraka	265,500	136,500	402,000
Hashimi	153,000	48,000	201,000
Iku	85,500	33,000	118,500
Madalla	234,000	28,500	262,500
Magajiya	153,000	25,500	178,500
Maje	301,500	135,000	436,500
Wambai	130,500	30,000	160,500
Zuma	319,500	166,500	486,000
Total			2,674,500

Source: Author's field survey, 2016.

From Table 8, Zuma, Maje and Gauraka have supply of water above 400,000 from boreholes and wells signifying a high contribution to the water supply in these districts. Bagama, Iku and Magajiya districts have lower contribution of boreholes and wells to the total water supply among the districts. One of the reasons for this observable pattern, is that the later districts experience more water supply from Water Board than Zuma, Gauraka and Diko districts. Maje district is totally not connected to the Water Board and that account for the high number of boreholes and wells in that district.

Water supply capacity of a source is measured by its estimated yield per day while total water need of an area is the total population of the people in the area multiply by water need per capita. The National Water and Sanitation Policy (NWSP, 2000), estimated water need per capita for rural areas at 30l/c/d while those of small towns and cities at 60l/c/d and 120l/c/d respectively. Suleja area (study area) falls in the category of the 60l/c/d. Therefore, the total water need for the area considering the total population of 264, 506 (Table 1) at 60/c/d is 15,070,000l/d but the water supplied by boreholes and wells in the area is 2,674,500lit/day which represents 17.74% of the total need of Suleja area.

CONCLUSION

Water from boreholes and wells play a significant role in the overall supply of water in most urban areas in the developing countries. From this study, boreholes and wells supply 17.74% of water need in Suleja area. This water sources are clustered in the built-up areas in all the districts suggesting a common water shortage in all the districts. The water scenario painted by this study suggests also that the Niger State Water Board is ineffective in its statutory supply of water in the area. The overall picture set by this research is that there is water deprivation and concrete planning and actions must be put in place to solve this perennial problem.

RECOMMENDATION

Considering the proliferation of the digging of boreholes and wells orchestrated by dare water need of the people in the area, the following recommendations are made to solve the water problem as well as the potential environmental problems consequent upon their proliferations:

1. Niger State government needs to step up water provision to the area through its water board to fulfil its statutory role of water provision for the people and truly make borehole and well water an alternative supply as their name suggest.
2. The people need to be enlightened on the environmental consequences of over withdrawal of underground water-such hazards include earth tremors, landslide, land subsidence as well as faster underground water pollution.
3. Landlords and house owners could be persuaded to develop joint mini-water scheme to supply water to a lager cluster of houses without necessarily digging so many boreholes or wells. This would go a long way to reduce environmental and economic problems associated with proliferation of boreholes and wells in urban areas.

REFERENCES

Christopher, B; Hommann, K; Rubio, G.M; Sadoff, C. and Travers, L. (2001). *Water, Sanitation and Poverty.* Draft Comments, Water and Sanitation Program, 2-23.

DFID (2011) Assessing the Impact of a Right to Sanitation on Improving Levels of Access and Quality of Services: Executive Summary. UK.

Gana, E (2013) Assessment of the Availability of Water and sanitation Facilities in Paikoro Local Government Area of Niger State. An Unpublished Master's Thesis in the Department Geography, Federal University of Technology, Minna.

Ituen, U; Atser, J; and Edem, S.N (2016). Analysis and Depiction os Accessibility Levels of Water Supply Schemes in Rural Akwa Ibom State, Nigeria. *Iranian Journal of Health & Environment. 3(2), 518-527.*

Kortatsi, B and Quansah, J (2004). Assessment of Groundwater Potential in the Suyana and Techima Areas of Ghana for Urban Water Supply. *West African Journal of Applied Ecology. 15(1), 75-92*

National Water and Sanitation Policy (NWSP) (2000). Federal Republic of Nigeria. First Edition.

Nigeria Bureau of Statistics (NBS, 2009). Social Statistics in Nigeria. Lagos: FGN.

Ololade, I.A; Adewumi, A; Ologundudu, A and Adeleye, A (2009). Effect of Household Wastes on Surface and Underground Water. *International Journal of Physical Sciences.* 4 (1), 22 – 29.

Petkovic, S; Gregoric, E; Slepcevic, V; Blogojevic, S; Gajic, B; Kljujevic, I; Zarkovic, B; Djurovic, N; and Draskoic, R (2011). Contamination of Local Water Supply Systems in Suburban Belgrade. *Urban Water Journal,* 8(2), 79 – 92. Retrieved @http://www.tandfoline.com/loi/nurw200.

Sanusi, Y.A. (2010). Water, Sanitation and Human Development in Urban Fringe Settlements in Nigeria. *Theoretical and Empherical Researches in Urban Managements*, 8(17), 14-29.

Toit, W, D: Holland, M: Weidmann, R and Botha, F (2012). Can Ground Water Successfully be Implemented as Bulk Water Resource in Rural Limpopo Province? *Water SA, 38(3), 391-397.*

UNICEF/WHO (2006). Core Questions on Drinking Water and Sanitation for Household Surveys. Geneva. @www.ohchr.org.

UNDP (2006). Beyond Scarcity: Power, Poverty and the Global Water Crisis. UNDP Human Development Report. New York. @http://hdr.undp.org/hdr2006.

WHO/UNICEF (2012) Joint Monitoring Program for Water Supply and Sanitation updated for Nigeria. Retrieved from www.unicef.org on 19/09/2014.