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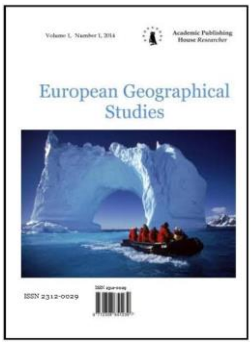


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# Analysis of the Spatial Distribution of Public Portable Water Sources in Misau Town, Bauchi State, Nigeria

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**Abstract**

Access to adequate, safe and equitable distribution of water is fundamental in supporting live hood. The concern about access to water is premised on its multifacet effects on health and well being of man. This paper analyzed the spatial distribution of public portable water sources of Misau town in Bauchi state Nigeria. Location of existing public water points were mapped and analyzed using GIS techniques to guide decision in the study area. The public water taps, bore holes and open wells numbering 33, 59, and 48 respectively were mapped and 200m buffering was made to check their accessibility and adequacy or otherwise. The result indicates areas of high concentration and those lacking the infrastructure visa avis the population density on physical development. The maps and the analysis affirmed the versatility of GIS managerial tool in water distribution management of Misau town.

**Keywords:** Misau town, mapping portable water, GIS.

## Introduction

The fundamentality of water in supporting livelihood on earth is obvious. It is required for biological, domestic, agricultural and industrial purposes. Little wonder the cradles of civilization were close to and associated with sources of water (river valleys) such as the Nile in Egypt, Indus in India, Hangzhou in China, Euphrates and Tigris in Mesopotamia, etc (Ayoade, 1988). Access to adequate, safe and equitable water, now recognized as a human right, is a contemporary global development issue. For instance, the United Nations Committee on Economic, Social and Cultural Rights (General Comment No. 15, 2002) posits that everyone is entitled to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses. The Millennium Development Goals have targeted to reduce by half, the proportion of people without access to safe drinking water by 2015. Some international conferences on water, e.g. The Hague (2000), Kyoto (2003), have underscored the need to support developing countries to improve water supply.

Concern about access to water is premised on its multifaceted effects on the health and well being of man. For example, several diseases are water borne. Schistosomiasis, diarrhea, typhoid and cholera are some of them. Diarrhea alone accounts for an estimated 4.1% of the total daily global burden of disease and is responsible for the deaths of 1.8 million people every year (WHO, 2004). According to water Aid Nigeria, eight children die from water related diseases every hour while about 63.2 million people don't have access to safe water (Olokor,2013)

The average global annual per capita use of water is estimated at 506m$^3$. Globally, about 9087 billion m$^3$ of water is used annually (Fischelli, 2012). The population of the world which increased from 2.5 billion in 1960 to 7.2 billion in 2014, is constantly increasing. Increasing industrialization is the trend of the world economy. The implication of these demographic and economic traits of the world is increasing demand for water, especially for domestic, industrial and agricultural uses. Efforts at keeping pace with the demand appear to be strained. Climate change variables have further widened the strain. Already, about 748 million people world- wide have poor access to clean drinking water. By 2030, the number is estimated to reach 40 % of the expected world population of about 9 billion (Daigle, 2015). In Africa, in which Nigeria is situated, 300 million people lack access to safe water and, by 2025, one in two Africans will be in areas of water scarcity.

Since 2008, majority of the world`s population live in urban areas. As at 2013, 53% of the global population of about 7.2 billion was urban dwellers. By 2050, out of the expected world population of 9.3 billion, 6.2 billion i.e. 67.2% will be living in cities (UN, 2012a in Molen, 2014). This implies that demand for water and competition for access to it is higher and will continue to be so for the rest of man`s tenancy on earth. As a consequence, the supply and management of urban water delivery facilities should be properly planned and integrated in line with Integrated Water Resources Management (IWRM) principles to ensure sustainability. Governments should play pivotal roles in this regard. The recognition of access to water as a human right places responsibilities of respecting, protecting, facilitating and providing water to citizens on governments (Cotula, 2006). The governments, especially in developing countries, have taken responsibility for delivering pipe borne (categorized as public) water to homes with little efficiency. To fill the gap, individuals self-supply themselves with water from ground water reserves in form of wells and boreholes. Water drawn from such self- supplied sources may be for personal use or sold for profit. Thus, access to water is from a mix of sources. For instance, in Akure, the mix is made of pipe borne water (2.57%), wells (51%), and wells and pipe borne water (28.35%) (Adewumi and Babalola, 2001).

The need to manage and improve access to water cannot be overemphasized. Perhaps the first step at achieving this requires an inventory of the points where water is accessed. Such inventory is best portrayed in maps. The advent of Geographic Information System (GIS) has widened the versatility of mapping and its application as a guide in decision making about many human endeavors (Chang, 2012).The purpose of this write up is to demonstrate the application of mapping, using GIS techniques, in guiding decisions about water supply in an urban area. Misau, a town in Bauchi State, Nigeria, is the location of the study.

**Objectives**

The objectives of the study were to;

1 Identify and map the locations of the public water points in the study area

2 Create 200m buffer zones around each of the water points

3 On the basis of the buffer zones, identify parts of the study area that lack water points

**The study area**

The mapping was carried out in Misau (latitude, $11^{o}30^{I}$N---$11^{O}$ $35^{I}$N; longitude, $10^{O}$ $40^{I}$ E- -- $10^{O}$ $45^{I}$ E), a town in Bauchi State, Nigeria. The town is in the Sahel savanna and has a semi tropical climate. There are two distinct seasons; the wet and the dry. The wet season begins in June and ends in October. Mean annual total rainfall is 763mm. Temperatures range from $19^{o}$C in the cold hamattan season to $39^{o}$ C in the hot season. No surface water bodies exist and on account of the high average temperatures evapotranspiration is high. The 2006 census (the last official census in Nigeria) gave the population of the town as 76, 240. At a growth rate of 3.5%, the population is expected to be 100,252 in 2015. The town is water stressed .Tse and Amadi (2009) gave the borehole yield in the town as 98.67m$^3$. According to Dike (1990) the total daily water yield from all boreholes tapping the same aquifers was 4.8 million litres. At an average consumption of 96 litres per day per head, this was just enough to supply the water needs of about 50,000. Comparing this to the 2015 population projection of the town implies that only half of the per capita water need of the population is available.

**Discussion**

The locations of the public taps and the buffer zone of 200m for each of them are shown in Figure 1.

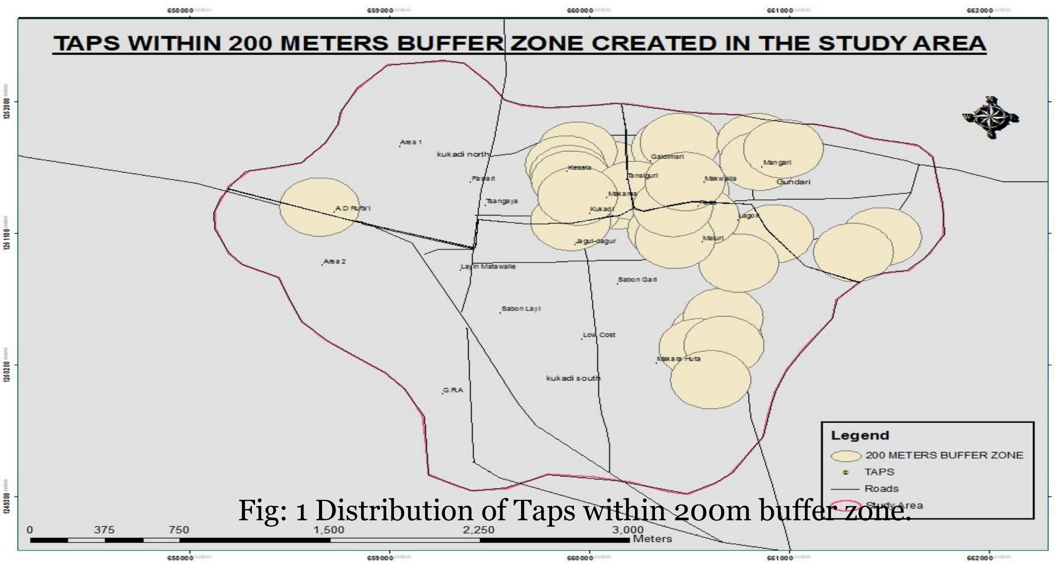


Fig: 1 Distribution of Taps within 200m buffer zone.

The distribution of the taps shows that they are concentrated in particular areas of the town. The other parts are without the facility. This implies that public access to water delivered by the government (presumably, the safest) is grossly inadequate.

As for boreholes, their locations are shown in Figure 2.

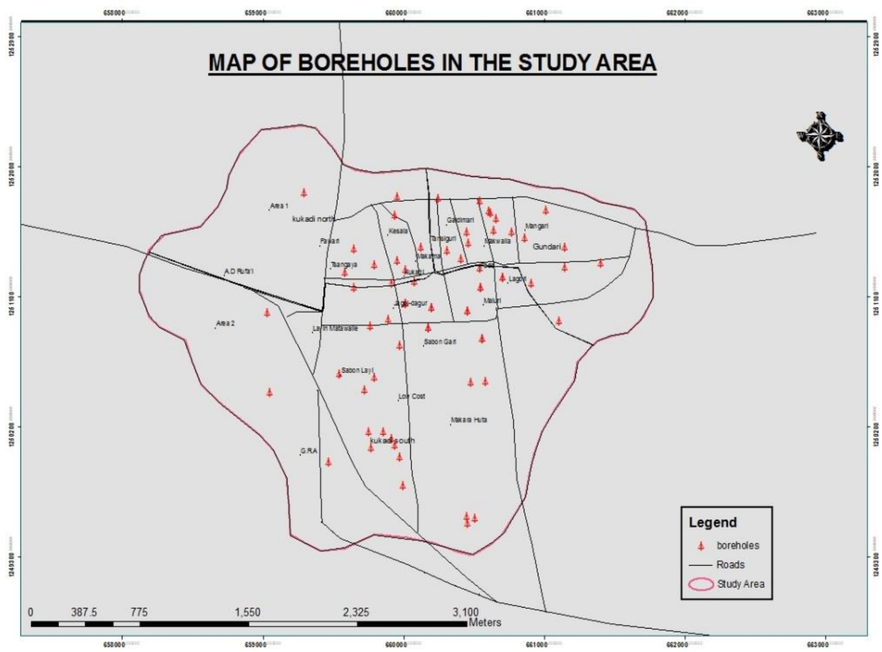


Fig: 2 Distribution of Boreholes in the study area.

The boreholes have a wider spatial coverage of the town. They were established by the government to augment the shortfall from the water supply from taps. Water vendors draw water from the boreholes and retail to needy houses. It was found out that 26 (representing 44%) out of the 59 boreholes are out of use. The distribution of public wells is represented in Figure 3.

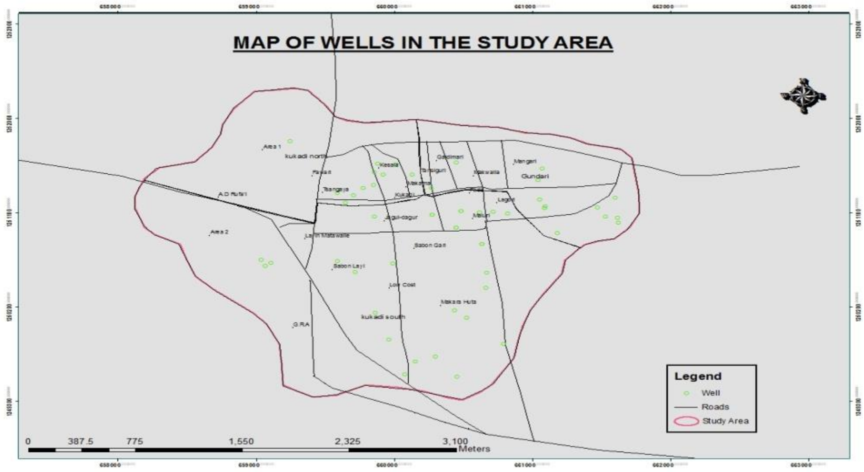


Fig: 3 Distribution of public wells in the study area.

The distribution of wells shows an almost similar coverage like that of boreholes. Out of the 48 public wells in the area, 22 have dried up.

The outcome of the 200m buffer zone analysis of the three public sources of water in the study area is presented in Figure 4.

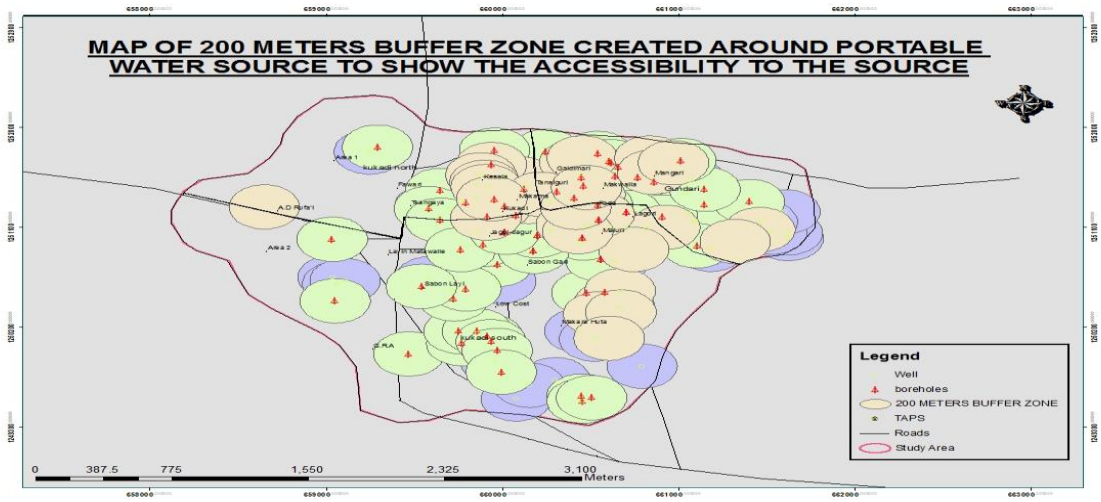


Fig: 4 Outcome of 200m buffer zone created.

The buffers suggest an overlap between the three sources of water in most parts of the town. As suggested by Figure 5, nine areas of the town are inadequately served by the three sources of water.

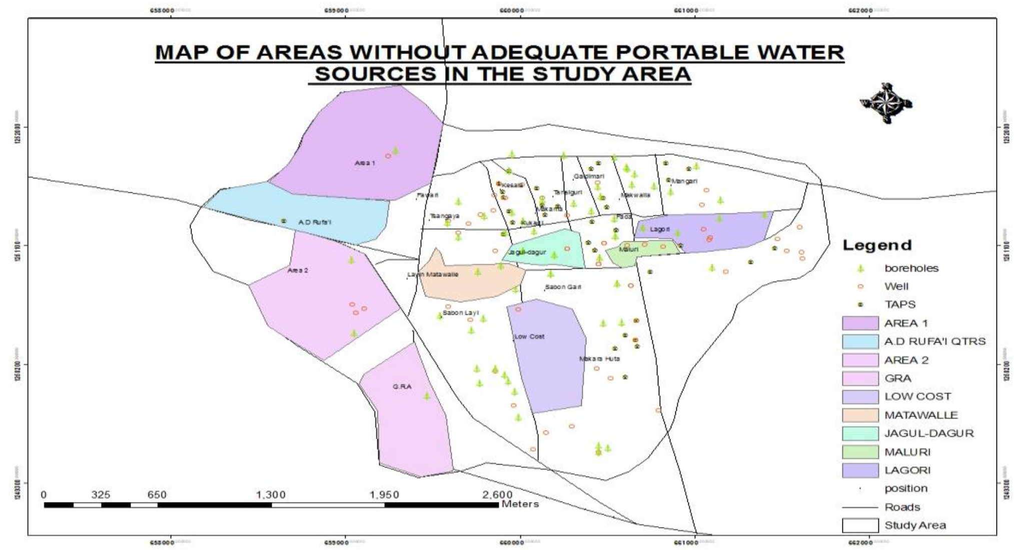


Fig: 5 Areas that are inadequately served by the three sources of water.

Interviews with residents of the areas that are under served by public water sources reveal that they rely exclusively on buying from local water vendors. The vendors fetch water from the areas with water in 25 litre jerry cans which they push over long distances in carts that contain ten of such cans. Usually, families that can afford, buy the ten jerry cans (250 litres) of water daily. This quantity of water is grossly inadequate for domestic uses; hence, the water is strictly rationed among the uses. Each jerry can is sold at N20.00, implying that households expend about N200.00 (equivalent to about one dollar) on buying water daily. By local economic conditions, this amount is high and constitutes a drain on family income. In some instances, difficulty in accessing water for cooking has made families to skip meals. Also, many man hours are lost in efforts to search for water for domestic use. Though no study has been conducted in the study area about the health implications of transporting water in jerry cans, water contamination and associated water borne diseases is a possibility. Because of these difficulties, there is an observed reluctance of residents of the town to live in these parts of the town. On the positive side, the water stress has created off farm employment for the water vendors most of whom are migrant farmers from surrounding rural areas. The income they earn from water vending is utilized for their up keep and purchase of inputs required for their farmlands. These areas should command priority in plans by the government to avail water to the population of the town.

It is also noteworthy, as revealed by Table 1, that out of the one hundred and forty public sources of water, seventy two (representing 51.4%) are non functional. This indicates a poor maintenance culture of public facilities. If not rectified, initial investments made in providing the facilities will become wasted.

**Methodology**

A 1: 10,000 analogue map of the study area was obtained from the Bauchi State ministry of lands and survey. The map was scanned using $A_0$ scanner which was taken to into Arc catalog environment where it was spatially referenced to WGS 1984, zone 32. The coordinates of the four selected corner points that relatively appears on the Google earth image were used for the geo-referencing and update was made in the arc map work station. A pyramid was created for both the image and the map which appears in three color Red, Blue and Green (RBG).Both the image and the map were later added in to an Arc map work station. Since both image and the map are not of the same scale, transformation was carried out in order to bring them in to one origin. It was referenced using Arc Map work station. For the purpose of digitization, three shape files (point, polyline and polygon) were created in Arc catalog. Points were used to depict locations of point features (wells and boreholes), polyline were used for linear features (roads), while polygons were used to represent the shapes and locations of homogeneous features (residential areas).

An attribute table was created in a tabular form where the location and type of water sources were recorded. For easy decision making, queries were established in the database to obtain information that will be needed to support decision making such as where there is inadequacy in public water sources. Below are the points used in the georeferencing their coordinates and description. Interviews were conducted with residents of the water stressed areas to gain insight on how they cope with the problem of accessing water.

| Points | Easting | Northing | Description |
|---|---|---|---|
| P1 | 657156.08 | 1251913.73 | AREWA CERAMIC |
| P2 | 661112.82 | 1251976.82 | MANGARI PRI. SCH |
| P3 | 661180.26 | 1251114.78 | LAGORI |
| P4 | 659116.13 | 1251082.46 | GENERAL HOSPITAL |

Source: Google Earth (2015)

**Results**

Table 1: Number of Public Water Sources

| S/N | Water Source | Total of Water Sources | Functional water source | % of Total | Non Functional Water Source | % Of Total |
|---|---|---|---|---|---|---|
| 1 | Boreholes | 59 | 33 | 55.93 | 26 | 44.07 |
| 2 | Taps | 33 | 9 | 27.27 | 24 | 72.72 |
| 3 | Open wells | 48 | 26 | 54.17 | 22 | 45.83 |
| | | 140 | 68 | 48.57 | 72 | 51.43 |

Source: Field Survey (2015)

The sources of water mapped were public taps, boreholes and wells. Their respective numbers were 33 (25%), 59 (41%) and 48 (34%). This gives a total of 140. Out of the 59 boreholes, 33 (55.93%) were functional while 26 (44.97%) were not in use due to disrepair. The numbers and percentages of functional and non functional taps were 9 (27.27%) and 24 (72.72%) respectively. As for open wells, 26 (54.17%) were in use while 22 (45.83%) were out of use. Out of the total public water sources, 68 (48.57%) were operational while 72 (51.43%) were not in use.

The result of the query about areas poorly served by public water sources revealed that nine parts of the town were affected (refer to Figure 5). An enumeration of the sources of water in these areas is presented in Table 2.

Table 2: Areas with Inadequate Public Water Sources

| S/N | Name of Location | No. of Taps | No. of Boreholes | No. of Open Wells |
|---|---|---|---|---|
| 1 | Area 1 | 0 | 1 | 1 |
| 2 | A.D. Rufa`i | 1 | 0 | 0 |
| 3 | Area 2 | 0 | 2 | 3 |
| 4 | GRA | 0 | 1 | 0 |
| 5 | Low cost | 0 | 3 | 1 |
| 6 | Matawalle | 0 | 2 | 1 |
| 7 | Juggol dagur | 3 | 4 | 3 |
| 8 | Maluri | 3 | 3 | 3 |
| 9 | Lagori | 1 | 4 | 3 |
| | Total | 8 | 20 | 15 |

**Conclusion**

Geographic Information System (GIS) is a versatile tool for displaying diverse spatial phenomena. This study demonstrated its use in showing the distribution of the sources of water used in Misau, a town in Bauchi State, north eastern Nigeria. Buffer zone analysis has graphically displayed the areas of the town that are deficient in the supply of public water facilities. The maps produced can guide local administrators on where to locate water facilities in the study area. It is further recommended that in addition to providing more sources of water, the dysfunctional ones should be repaired. Periodic checks on the functional water sources should be carried out to safeguard them from damage.

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