# ASSESSMENT OF ACCESS TO DOMESTIC WATER SUPPLY SOURCES IN GYEL DISTRICT OF JOS, PLATEAU STATE, NIGERIA

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**Abstract**
*Access to clean potable water and good sanitation facilities is a great problem for many households in Nigeria. The issue is particularly very severe in most parts of northern Nigeria with few households having access to safe drinking water and adequate sanitation. This is responsible for high incidences of waterborne diseases, threats to livelihoods of many poor households, and a contributor to low levels of school enrollment, especially among girls. This study therefore seeks to determine the distribution pattern and its effects on the level of user accessibility to domestic water supply sources in Gyel district of Jos South LGA Plateau State, Nigeria. The research utilized the Satellite data, coordinates of various sources of domestic water and their attributes, population data and a structured questionnaire and photographs from field in determining the locations, density and proximity of water supply projects to their target users. ArcGIS 10.3 tool was used in determining the density and proximity, mapping and Geo-processing, while SPSS and Microsoft software were used for the Statistical analysis. Findings showed that hand dug wells had the highest number among the public water sources and 60% of the respondents depends on it as their primary source of domestic water supply. The pattern of the distribution of water supply facilities were clustered around the city centre and well planned cadastral area, this exerts serious pressure on access to water sources especially on those within the unplanned and newly developed area as only 32% of the respondents had access to the public domestic water sources. Most of the built-up areas which constituted the households fall within the basic access level while the thinly occupied areas fall within no-access level where the basic standard for domestic water usage are not met, 71% of the respondents asserted that there was a problem of water scarcity as a result of distance (no proximity) and longer travel time, inconsistency of supply and seasonal effects. The study recommended the provision of more domestic water sources in unserved districts by the Plateau State Water Board (PSWB), private sector and individuals, the Jos Metropolitan Development Board (JMDB).*

**Keywords: Accessibility, Water supply, Domestic sources, Water demand**

## INTRODUCTION

Nigeria is a party to the United Nations Declaration of the Right to Water, which entitles everyone living in Nigeria to sufficient, affordable, safe and acceptable water for personal and domestic uses. While 75% of the urban population is served by improved water supply, often people will collect water from vendors and carry water a good distance after collecting it in containers. In rural areas, only about 42% of households have access to safe water. Thus, Nigeria was not able to meet the MDG target of 75% coverage for improved drinking-water and 63% coverage for access to sanitation facilities by the year 2015. As a step towards addressing equity in access to WASH services, the human right to water and sanitation services is recognized in legislation and Nigeria has a universal access for all policy. However, funds are reported to be largely directed to urban areas and drinking-water services, whereas the number of unserved is mainly for sanitation services and in rural areas (GLAAS, 2014; Felix and Olusola, 2016).

According to Eneh (2007) like manydeveloping countries, access to potable w ater is a common problem in
Nigeria. Indeed, many lives are lost annually

to waterborne diseases arising from unmitigate d poor access to safe drinking water. Statistics show that 36% of urban dwellers and 61% of r ural dwellers are totally unserved safe water. P ublic stand post is accessible to only 21% of ur ban dwellers and 8% of rural masses. Protecte d dug well is available to only 7% of urban dw ellers, while 17% of rural dwellers have access to it. Borehole water pump is available to 7% of urban dwellers and 11% of rural inhabitants . One State in Nigeria is heavily infested with 2,647 cases of guinea worm, and yet another S tate with 1,843 cases. Access to potable water is perceived as the greatest problem to 28% of households and 24% of communities (Eneh, 2007).

There are social, environmental and economic benefits of investing in water supply projects and services, beneficial to the government, individuals, households as well as the environment. The benefits from improved water supply include the time saved in fetching water, cost savings on non-incremental water consumption, reduced incidence of water borne diseases, flood control, employment opportunities, decreased distance to water source, and increase in water consumption per capita and time and travel costs, among others (Ali, 2018).

According to Meride and Ayenew (2016), it is not only water quality but also water quantity that is important in achieving health improvements. Quantity is dependent on accessibility. The benefits of improved water supply and sanitation are many, including prevention of disease, improved basic health care, better nutrition, increased quantity and access to water, reduction in time and effort required for water collection, promotion of economic activity, strengthening of community organization, improvements in housing, and generally improved quality of life (Ali, 2018). According to Meride and Ayenew (2016) the need for domestic water supplies for basic health protection exceeds the minimum quantity required for consumption (drinking and cooking). Additional volumes are required for maintaining food and personal hygiene through hand and food washing, bathing and laundry. Poor hygiene may in part be caused by a lack of sufficient quantity of domestic water supply which depends on the level of accessibility and efficiency of the existing facilities, in this case accessibility plays key role in domestic water supply.

According to Ilaboya, et al (2014), access revolves around distance and time indices. These indicators show four (4) paramount levels of accessibility; No access, for the worst scenario; Basic access; Intermediate access and Optimal access all on the basis of time and distance. Dinka (2018) sees accessibility as the balance between the demand for and the supply of consumer services over a geographic space, and narrowing or bridging the gap between geographic spaces is all about the significance of transport. Integrating Geographic Information System database can provide utility managers reliable and scientific support decision making on water distribution network management and rehabilitation (Soakodan *et al*., 2011).

This study therefore determines the existing distribution pattern and its effects on the level of user accessibility to domestic water supply facilities and sources in the Gyel district of Jos South LGA, Plateau State, Nigeria.

## MATERIALS AND METHODS

### Study Area

The study area (Gyel District) is located between Latitude 9° 46'0" N and 9° 52'0"N, north of the equator and Longitude 8°48'0"E and 8°52'0"E and is relatively bounded in the North by Tudun wada and Holwshe in Jos North LGA, while in the South by Vom district, West by Bassa LGA and in the East by Dadin kowa,Whytt and Rahol Kanang respectively**,** in Jos South Local Government Area of Plateau State which covers the total land area of 81.9km/sq approximately.

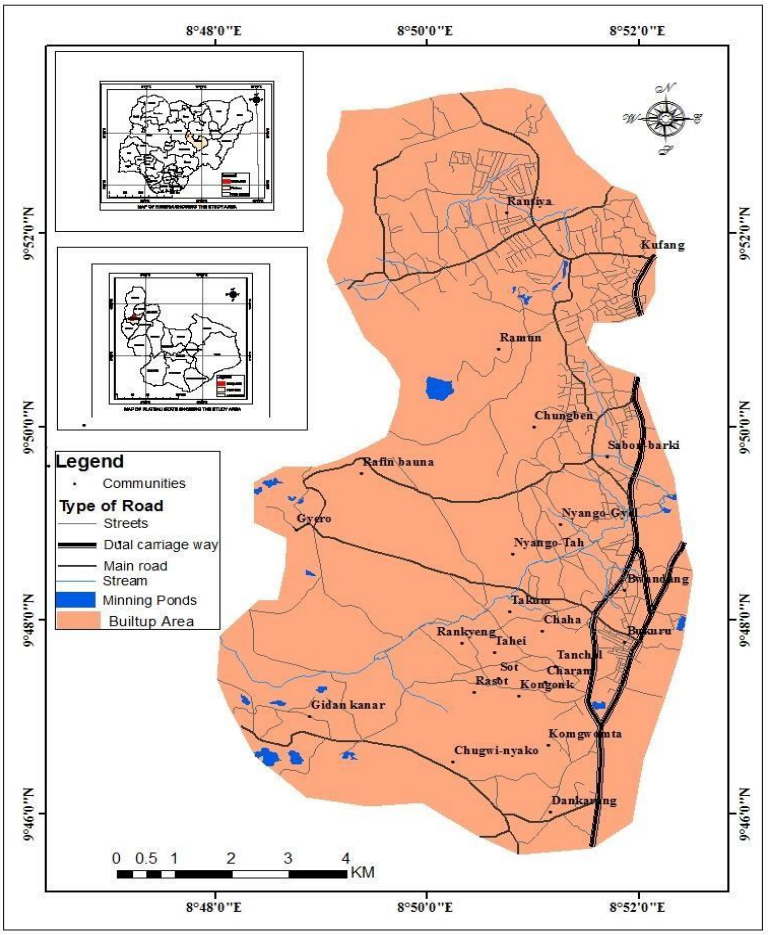


**Figure 1** Map showing Gyel District
Source: Modified from Quickbird Satellite Image, 2019

Ojo, Gbuyiro and okoloye (2004) asserted that the influence of the oscillation of the Inter Tropical Discontinuity (ITD) is completely modified by the high altitude of the Plateau. The area has more cold weather than most parts of Nigeria on the same latitude**.** It is characterised with an average monthly temperatures range between 21–25 °C, these cooler temperatures have made it a semi-temperate like area. It receives about 1,400 millimetres rainfall annually between April and October with the precipitation arising from both convectional and orographic sources, owing to the location of the area (Omada, 2018).

Gyel district is an area of younger granites intruded into the older basement complex rocks which covers the entire locality and other neighbouring localities. These younger granites are thought to be about 160 million years old and created unusual scenery of Jos. There are numerous hilly rocks with gentle slopes, characterized by a long period of weathering and erosion (Omada, 2018).

According to Omada (2018), two soil types can readily be identified at the superficial level. These are the sandy loam and grey loam soils. Most Soils are stony, fertile and hard to work on for the agriculturalist. This seems to result from the washing away of the top soil by denudation processes. The major soil is characterized by tropical ferruginous soils, which comprises of hills rock outcrops containing younger granite rocks extensively intruded into the older basement complex rocks characterized by a long period of weathering and erosion

Omotosho (2007) asserted that the average elevation of the Jos Plateau is about 1150 meters above mean sea level and the highest peak on the Shere hills which is about 1777 meters above sea level. However, the area is dominated by relief average altitude of

1,217m, with depressions which pave way for drainages adjoining the plain area.

Also according to Omada (2018), the drainage pattern on the area is in a radial pattern where the many rivers and streams diverge from the top of the plateau and flow away to different directions. Some of them drain into Rivers Ganawuri and Kaduna

The population of the area was 145,750 from 2006 population census conducted, it comprises 24communities mostly dominated by the Berom, Hausa, Yoruba, Ibo and other minor tribes from within and outside plateau state which most of them are Christians combined with the Muslims. The area is known for vegetable farming, animal grazing; rock quarrying, tin mining and marketing, (Ali, 2018).

**Nature, Types and Sources of Data**

This study utilized both the primary and secondary data sources. Different types of data for the research work were obtained from many sources. Field work was undertaken to determine the coordinate of Public Reservoirs, hand dug well, water supply pipes network, bore holes, Photographs of the current situation of water supply sources and water hydrants and this was complimented by information from Plateau State Water Board, Jos. Quick bird satellite image (0.6 m resolution) of 2015 and Population Data on the other hand were gotten from National Centre for Remote Sensing and National Population Commission, Jos respectively. Structured questionnaire were used in generating the statistical data from the respondents.

**Method and Data Pre-Processing**

This include geo-referencing, delineating the study area using the data collected to create of geo-database and feature classes which were digitized into map format used for the spatial analysis. All the maps acquired were properly geo-referenced in ArcGIS software and Geo-corrected to a common Projection System (UTM, Clarke 1880), and to a common Geo-TIFF data format. The maps were also geo-coded to a common resolution with the quick bird satellite image at a resolution of 0.6m to ensure both compatibility and data standard.

A shape file was created in ArCGIS to delineate the boundary of the study area and to show the extent of features necessary for the research analysis.

**Sampling Technique and Size Determination**

Stratified random sampling technique was adopted for the administering of the questionnaire for the study, a total number of three hundred and eighty-four (384) questionnaires were administered, in which the entire 24 communities within the study area covering both the urban and rural areas were randomly and proportionally represented with the total population of 145,750, using the formula by Krejcie and Morgan (1970);

$$n^1/n \times N = N^1/N \times Q \qquad (1)$$

Where $n^1$: Sampled population for individual community

n: Sum total for the population of the whole sampled communities

$N^1$: Sampled proportion for individual community

N: Proportion of sample size (100%)

Q: Total Questionnaire Administered

During the field work, 384 questionnaires were distributed to households and 263 retrieved, personal observation was also undertaken to gain more insight on domestic water supply facilities in the area. GPS receiver was used to collect the coordinates of various water facilities and digital camera for photographing. The coordinates of pipe-borne taps, hand dug wells, boreholes, reservoirs and water supply pipes were determined and transferred into excel sheet and imported to ArCGIS 10.3 environment to create the geo-database (Omada, 2018).

ArCGIS 10.3 version was used to create a file geo-database for this research work, which consist of Built-up area, Road network, water supply pipe network, public reservoir, taps, boreholes, hand dug well, water hydrant, stream and ponds feature classes within Gyel district area and their necessary attributes such as location, diameter, condition, function and distance covered which was conceptually organized. Integrated approach was used to achieve the objectives which includes both the GIS and Statistical analyses.

Density analysis determined the pattern of distribution of public hand dug wells and

boreholes and line density for the distribution of water supply pipes. This was also used to describe the pattern of domestic water source distribution and concentration showing the area of high, moderate and low concentration within the study area. Proximity analysis was used to depict four levels of accessibility which includes; optimum, intermediate, basic and no-access levels were on the following distance interval 1-30m, 30-100m, 100-1000m and 1000m above to analyse the level of accessibility to domestic water sources by the residents of the study area.

The statistical analysis includes the results from administered structured questionnaires,The statistical packages for social science (SPSS) is used to compute simple percentage and statistical diagram for the source, pattern and level of accessibility to domestic water supply source in the study area.

## RESULTS AND DISCUSSION

This section dwells on the reasons (problems) of inaccessibility to domestic water supply facilities, locations, density and solutions to problems of access to domestic water supply.

### Reasons for Inaccessibility to Domestic Water Sources and Solution

There are diverse reasons of inaccessibility to water supply projects in Gyel District by most residents as shown in Figure 3.

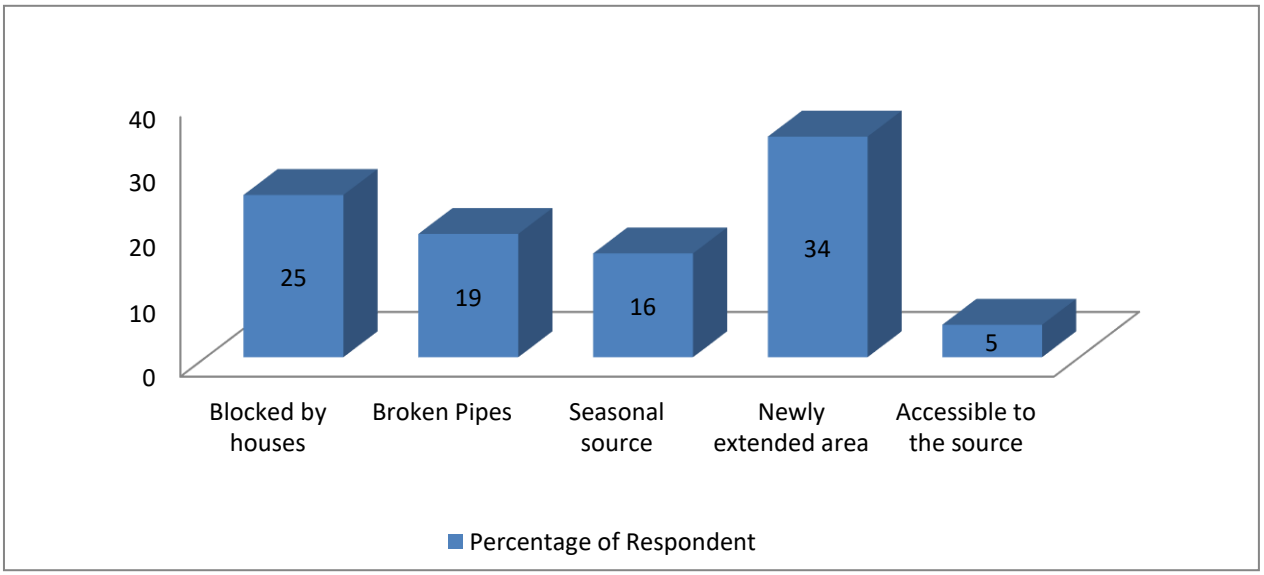


**Figure 3** Reasons for Inaccessibility (Problems) to Water Supply Sources
Source: Field survey, 2019

Reasons for difficulty in accessing water supply facilities include blockages of public water sources by houses as a result of unplanned cadastral layout, broken water supply pipes which were not noticed to be replaced by water board management, effect of seasons on the water source most especially the well, boreholes and stream during dry season and newly extended built-up area (Figure 3). Plate 1 also show that the domestic water users are clustered along the road with water supply sources around Bukuru low-cost and Kufang area, this finding is inconsistent with that of MacDonald, Dochartaigh and Welle (2009) who mapped water and sanitation in Ethiopia and found that water supply failures in this region were that of the reduced yield of the aquifer and deep seated water level during the dry season. Also similar to the findings by George, George and Jacob (2010) inaccessibility of water services in Kisumu municipality which revealed that the proportion of households with access to piped water supply within a distance of 200m is 77.1%, only 65.6% of the basic water requirements of the residents are met and that only 25% of the households access the minimum recommended 50 l/c/d.

**Table 1** Possible solutions to poor access to water supply infrastructure

| Solution to the reasons | Number of respondents | Percentage |
|---|---|---|
| Sinking Boreholes | 60 | 23 |
| Laying of water supply pipes | 103 | 39 |
| Digging wells | 88 | 33 |
| Buying from water supply vendors | 12 | 5 |
| Total | 263 | 100 |

Source: Field Survey, 2019

Table 1 shows the possible solutions suggested by the respondents to solve the problem of domestic water supply in the area. Extension of water supply pipes will widely solve this problem especially for the newly extended area, followed by digging wells and others.

**Accessibility to Domestic Water Supply Sources**

There are diverse sources of domestic water supply in the area. These include; drilled boreholes equipped with hand pumps, collection tanks and protected springs as well as concrete lined wells, surface flowing rivers and streams, lakes, shallow wells, deep wells and pipe borne water (Carter, *et al*., 2005; Felix and Olusola, 2016).

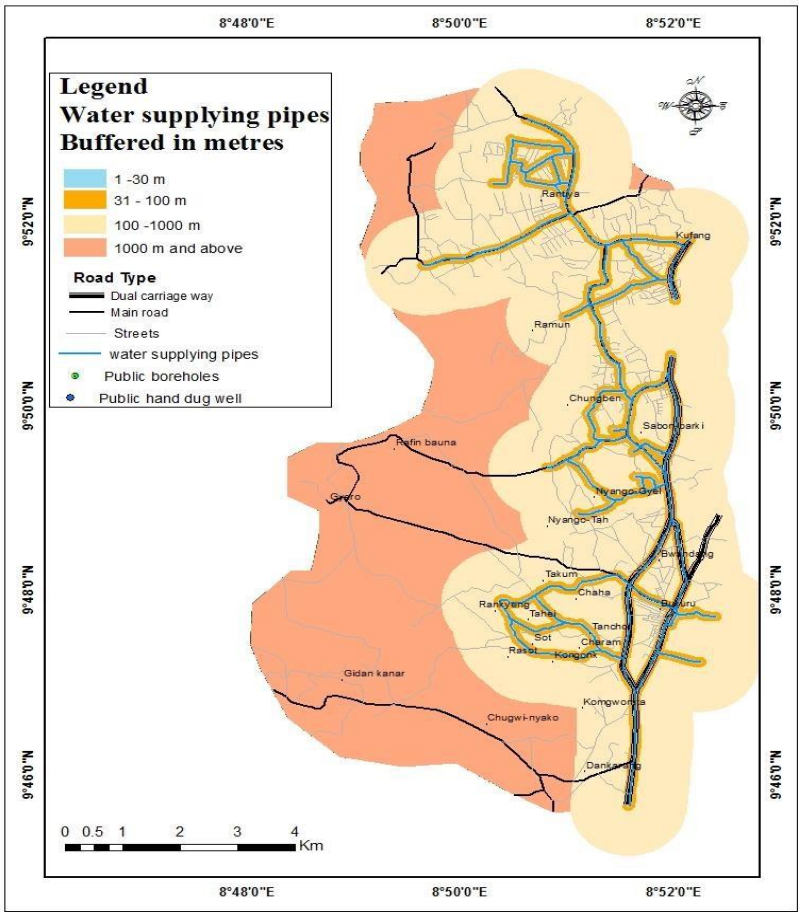


**Figure 4** Multiple Ring Buffer Map of Public Water Supplying Pipe

**Access to domestic water sources in Gyel District**

The proximity analysis techniques used include the multiple ring buffer, with the standard of distance 1-30,31-100,100-1000 and 1000 meters above, depicting the four level of accessibility which are; optimum, intermediate, basic and no-access, which were used on the various public water supply sources in the study area, as shown in Figures 4,5,6,7,8, show the following results respectively. This results agrees with that of Chia, Ijir, Iwar and Nduluen (2014).

**Regularity of pipe-borne water supply from the source**

The regularity of pipe-borne water supply also affects access to domestic water supply in the study area as shown in Figure 4 and Table 2.

**Table 2 R**egularity of pipe-borne water

| Regularity of pipe-borne water source | Number of respondents | Percentage |
|---|---|---|
| Everyday | 3 | 17 |
| Once in three days | 5 | 28 |
| Once in a week | 6 | 33 |
| Once a month and beyond | 4 | 22 |
| Total | 18 | 100 |

Source: Field Survey, 2019

Table 2 shows that of 18 respondents that had access to pipe-borne water supply it were only 17% of the sampled households have access to domestic water supply on daily, This was as a result of irregular supply from the stations coupled with the problem of pipe damaged due to construction activities especially road construction and illegal connections and natural factor such as weakening and rusting of pipe material which were not replaced in time by the water board service.

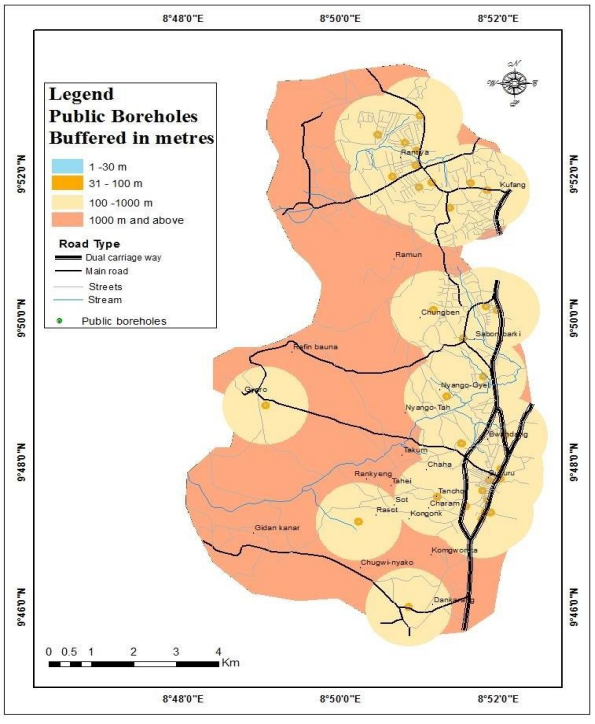


**Figure 5** Multiple Ring Buffer Map of Public Boreholes
Source: GIS LAB, NCRS, Jos

Figure 5 shows the spatial distribution of drilled boreholes and their level of accessibility within the built-up area, large area falls within the level of no-access which takes them more than 1000 metres to reach the source, likewise the hand dug wells, streams and ponds as shown in Figures 6, 7 and 8.

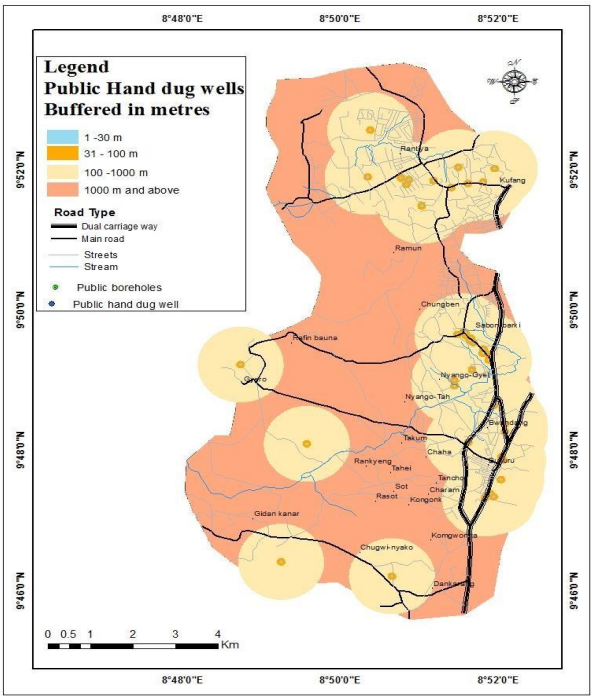


**Figure 6 M**ultiple Ring Buffer Map of Public Hand Dug Well

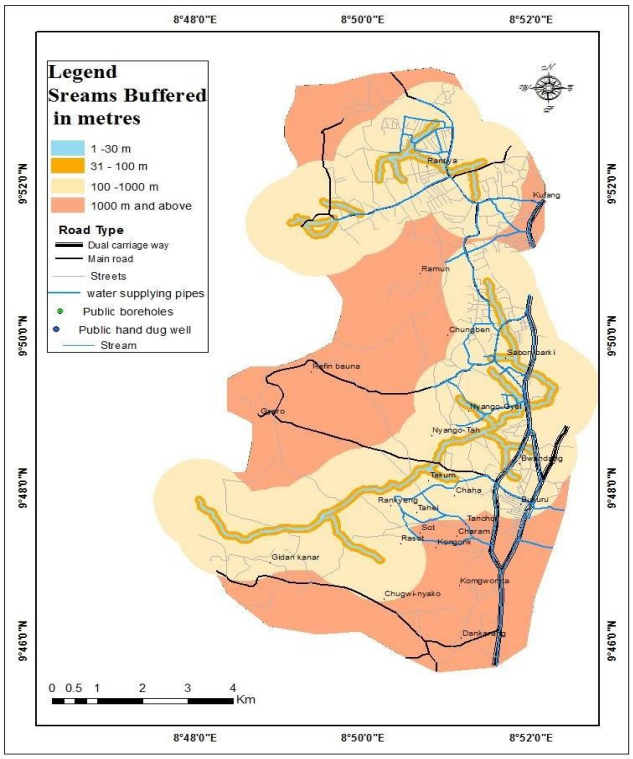


**Figure 7** Multiple Ring Buffer Map of Streams in the Area

**Availability of Wells, Boreholes and Streams**

Availability of ground water such as well, boreholes and stream sometimes were affected by seasonal variation as the aquifer goes down in the dry season and also no runoffs from rainfall this can be seen in Table 3.

**Table 3** Availability of well, borehole, stream

| Water availability | Number of respondents | Percentage |
|---|---|---|
| Throughout the year | 135 | 55 |
| Seasonal | 106 | 43 |
| Not at all | 4 | 2 |
| **Total** | **245** | **100** |

Source: Field Survey, 2019

Seasonal influence is a threat to domestic water source in this study area as the quantity reduce during the dry season thereby leading domestic water scarcity in the area and this supported that of Odafivwotu and Abel (2014) whose findings revealed that the quantity of water supply was inadequate and the distances to sources of major water supply reduces during dry season. This has been revealed earlier by MacDonald, Dochartaigh and Welle (2009) which mapped water and sanitation in Ethiopia and found that water supply reduced deep seated water level during the dry season, in addition to the streams Figure 8 shows the distribution of mining ponds as they are also useful in domestic water supply.

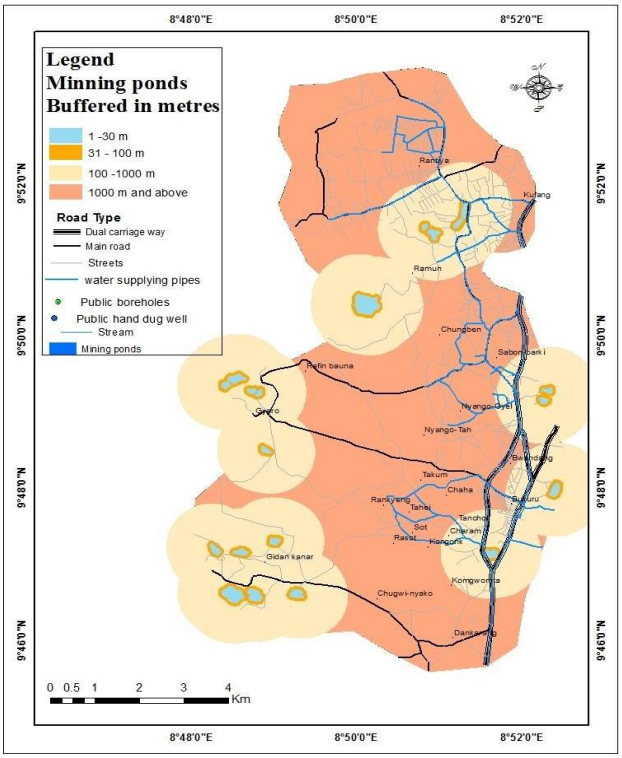


**Figure 8** Multiple Ring Buffer Map of Ponds in the Study Area

Using multiple ring buffer analysis of the location of various sources of domestic water supply from Figures 4, 5, 6, 7 and 8, have shown that most percentages of the households were within distance of basic access and no-access level of accessibility. This is similar to the findings by George and Jacob (2010) in accessibility of water services in Kisumu municipality which revealed that the proportion of households with access to piped water supply

within a distance of 200m was 77.1%, Only 65.6% of the basic water requirements of the residents were met and that only 25% of the households access the minimum recommended 50 l/c/d. Also MacDonald, Dochartaigh and Welle (2009) mapped water and sanitation in Ethiopia and found that low income households and low levels of investment in water infrastructure are related to reduced access to water services.

**Access to public domestic water supply**

The result of access to public water source in the study area is show in Figure 9.

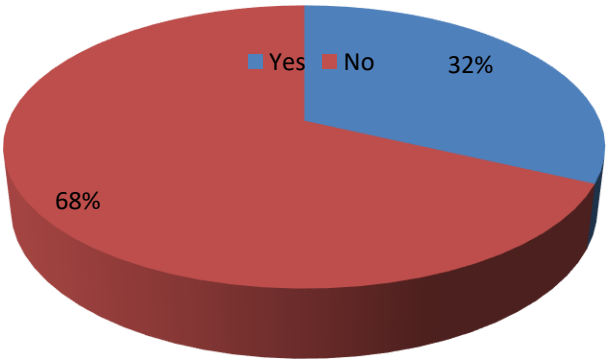


**Figure 9** Access to Public Water Supply
Source: Field Survey, 2019

In the area only few people had access to the public water source which is just 32% of the population in the area.

## CONCLUSION

The application of spatial analytical tools such as density and proximity analysis using GIS with the aid of Satellite, Global Positioning and population data is important in spatial analysis of access to domestic water supply. It can identify and map patterns of water sources distribution and examine the effects on accessibility in terms of distance and time travelled to water sources.

In determining the spatial distribution of most public water supply sources (facilities) and their level of accessibility within the built-up areas, a large area falls within the level of no-access which takes the residents more than 1000 metres to reach. The hand dug wells, boreholes, streams and ponds are also inaccessible to lowest income households and low levels of investment in water infrastructure also reduce access to water services in the area.

The study therefore recommends the following:

(1) Encourage the provision of more domestic water sources by the Plateau State Water Board, private sector and individual households to boost water supply. Also create awareness on the importance of various sources of domestic water supply as they complement each other especially during dry season in the area.

(2) The Jos Metropolitan Development Board should ensure that built-up areas adopt town planning standard rules to ease laying of water supply pipes and other public water supply facility extensions, especially in the developing built-up areas.

(3) Plateau State Water Board, Jos should engage in periodic pipeline extension services to be able to cover the newly developed areas, regular replacement of damaged facilities to enhance the supply of water in the area.

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