

# Spatial Analysis of Municipal Water Supply in Abeokuta Metropolis, South Western Nigeria

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## 1 ABSTRACT

The study examined the spatial dimension of Public Water Supply in Abeokuta Metropolis with the aim of providing effective planning, development and operation of water supply and distribution networks which is one of the most essential components of urban infrastructure. A number of factors ranging from population expansion to inadequate existing facilities are thought to be responsible for the frequent shortage in water supply to the metropolis. The study delineated the areas within the metropolis that are un-served or underserved by the Water Cooperation. A framework for taking management decisions such as an extension of the supply network and location of new facilities was given. Large scale facility maps that will serve as source of information for vital application for the Ogun State Water Cooperation in carrying out its daily functions were produced. Such maps in digital forms are extremely vital and are useful to integrate collateral data i.e. available within the corporation.

Keywords: water supply networks, questionnaires.

## 2 INTRODUCTION

Water makes life possible as without it; life and civilisation cannot develop or survive. As man's standard of living increases; so does his need for consumption of water. It is therefore not surprising that early civilisations flourished around river valleys such as those of the Nile in Egypt, Indus in India, Hwangho in China and Euphrates and Tigris in ancient Mesopotamia (Ayoade 1988).

In modern times, there is a close relationship between water availability and economic development, especially in the developing countries (Warner, 1995). In Nigeria, water availability controls population distribution. Settlements that are provided with modern water supply networks are usually those situated along the major trade and transportation networks and all improved water supply in Nigeria is from public water supplies (Oyebande, 2005). Though the pattern of water supply varies from one settlement to another, generally as the population of a settlement increases, the service efficiency to the expanding population decreases. This usually creates a great disparity in supply to different zones of the settlement. This problem is more pronounced in the Pre-Cambrian Basement Complex Rocks areas to which the study area belongs.

In terms of personal needs, an average man requires 2.5 litres of water daily for drinking. Apart from drinking, man requires water for various other uses such as cooking, washing, sanitation, agriculture, industrial production, hydro-electric power, etc.

To provide for these various uses, the supply of water must meet the demand of the user, be satisfactory in quality and adequate in quantity, be readily available to users, and be relatively cheap and easily disposed of after it has served its purpose. Necessary works are waterworks or water supply systems or waste works or wastewater disposal systems (Oyebande, 2005). Waterworks tap natural sources of supply, treat and purify collected water and deliver it to the consumer. Municipal water systems generally comprise:

- Collection or intake works
- Purification or treatment works
- Transmission and distribution

## 3 STUDY AREA

Abeokuta, the capital of Ogun state, situated in south-west Nigeria (fig. 1), covers an approximate area of about 40.63km<sup>2</sup>. It lies between latitude 7° 10' N and 7° 15' N and longitudes 3° 17' E and 3° 26' E. Abeokuta is a historic Yoruba town, formed by the Egbas in 1830. The town has become increasingly cosmopolitan as a result of the elevation in status of Abeokuta to state capital in 1976. The town is within the rainforest zone of Nigeria, its geographical location making it easily accessible to Lagos, the commercial capital of Nigeria, industrial state and main seaport.

The terrain of Abeokuta is characterised by two types of landforms; sparsely distributed low hills and knolls of granite, other rocks of the basement complex and nearly flat topography. The rugged rock-strewn relief is prominent towards the north, in the central and south-eastern parts of the city. The city is drained by two major rivers, Ogun and Oyan and many small streams. Some of these streams take their source from local rocky hills while some are distributaries to the two major rivers. Abeokuta is one of the areas in Nigeria with equatorial climate. Two main climatic conditions exist, the rainy season lasting for between seven and eight months between April and October with an interruption in August, and the dry season; running through November till February. Annual rainfall of about 963mm (Ogun State Nigeria, 1986) and the temperature is usually between 26°C and 28°C.

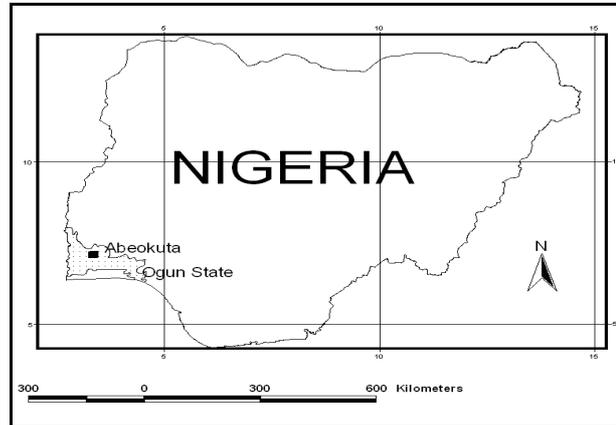


Figure 1: Map of Nigeria showing Abeokuta

#### 4 EXISTING SITUATION

Public water supplies to the residents of Abeokuta are mainly drawn from surface sources. There is only one functioning water station, the Arakanga water scheme which has a pumping capacity of 103.68 million litres per day and relies principally on water from the Ogun River (Ufoegbune et al 2009). The first water scheme in Abeokuta was commissioned in 1914 designed to supply water to about 40000 people. In 1962 the Iberekodo waterworks (now referred to as the old scheme) was constructed due to an increase in the population of Abeokuta. This was designed for about 7 million litres per day to serve a population of about 180000. The capacity was increased to 8.5 million litres per day when in 1974, the Osiele and Odeda waterworks were incorporated and this further increased to 13 million litres per day to meet the peoples' demand. Due to increased water production, the capacity of the treatment plant became inadequate thus leading to the construction of the new water scheme. The new water scheme was redesigned to increase supply of potable water from 13 million litres per day to 163 million litres per day. The new scheme was expected to have brought to an end the endless search for water by the residents of the town and it was planned to have catered for an estimated population of about 660000 by the year 2000.

There are two erected tanks at the waterworks – the backwash tank and the clear water tank with a capacity of 6.83 million litres. There are storage reservoirs for storing treated water at different sites in the town. The Asaran hills with two sets of reservoirs have a capacity of 22.5 million litres, the Oke-egunya hill reservoir has a capacity of 6.5 million litres; and the old waterworks reservoirs have a capacity of 25.5 million litres. The reservoir at Itoko has since been abandoned. Within the new waterworks are 5 high lift pumps, each capable of lifting 19000 litres of water with a driving motor power of 1100 kilowatts through 160 metres every hour.

The major functions of the Ogun state Water Corporation include;

- To manage and control all waterworks within the state.
- To extend, establish and develop existing waterworks as the corporation may consider necessary for the purpose of providing water in order to meet the requirement of the general public, trades and industries in various parts of the state.

The present water supply situation in Abeokuta can best be described as inefficient as most residents cannot be assured a regular and adequate supply of water. This study assessed the spatial dimension of public water supply with the intention of providing ways of enhancing the distribution system in order to greatly

maximise the potential of the utility's facility in the supply of water to the metropolis. In addition, the assessment provided a means that could be used by policy makers in locating distribution networks in new development areas.

## 5 METHOD

The data types collected were primary and secondary data. Primary data was collected by administration of structured questionnaires. For the distribution of questionnaires, the study area was divided into 12 zones based on the zoning method adopted by the state water corporation. Each zone was allocated 200 questionnaires bringing the total number of administered questionnaires to 2400. A total of 2200 questionnaires were however responded to. A GPS was also used in collecting data on the geographic position as well as elevation of the various facilities of the water corporation including reservoirs, pumping stations and the water distribution pipelines. The secondary data used included, topographic map of Abeokuta (1964) to the scale 1:50000, obtained from the Federal Bureau of Surveys, Abeokuta, water distribution facility map of the Ogun State Water Corporation (2000) to the scale 1:30000, obtained from the Ogun State Water Corporation, road network map of Abeokuta (1998) to the scale 1:250000, obtained from the Ministry of Lands and Survey, Abeokuta and population estimate from the Federal Office of Statistics.

Arcview 3.2a was used to perform the spatial analysis. A proximity analysis to show areas to be included in design of the utility network and those left out was first carried out. This having been carried out, the optimal location of reservoirs and pumping station was determined using the overlay functionality to identify the best positions to locate new reservoirs bearing in mind the criteria for sitting a reservoir. Possible reservoir locations were suggested using queries module. Areas suitable for reservoir were those with an elevation of above 100 metres. This is because reservoirs must be located at the highest possible elevation in order to maximise gravity flow of water. It also reduces additional costs usually incurred in constructing booster stations. Hence a digital elevation model was produced from topographic map and data from GPS. Another criterion considered was distance from inhabited areas. For the purpose of this study, a buffer of 750 metres was created from all inhabited areas within the metropolis, major roads and streams.

Statistical analysis was carried out using the SPSS software to determine the water consumption trend of the population of the study area.

## 6 RESULTS AND DISCUSSION

This study is carried out to examine the spatial dimensions of existing public water facilities with the intention of providing information that would help improve on the facilities. Figures 2a and 2b shows the existing facilities of the Ogun state water corporation in terms of existing reservoirs, booster stations and utility pipes networks. From the map it will be seen that some areas including Bode-Olude, Sabo, Itan-Osin, Oke-Ata, Adigbe and Onikolobo do not have adequate pipeline connection. From this map it could be seen that the pipe network needs to be expanded to cover these areas more effectively for new development areas that have not been adequately catered for. Figure 2b also shows the different development areas of the town.

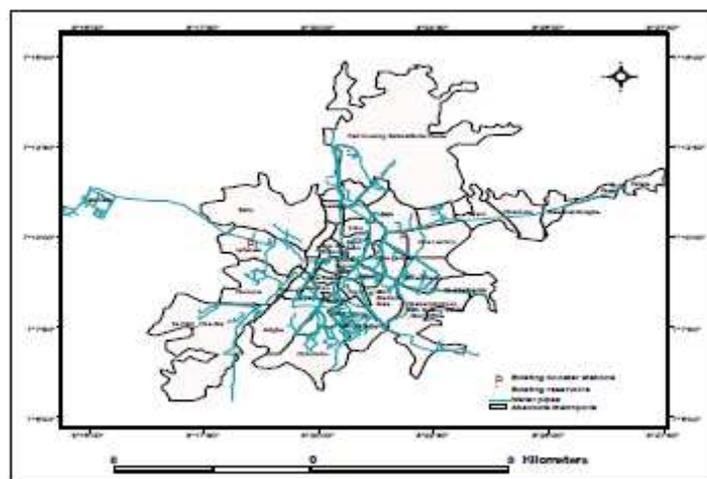


Figure 2a: Map of existing facilities

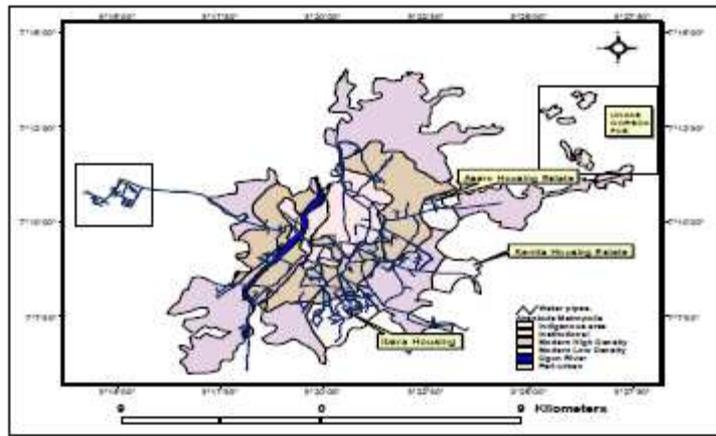


Figure 2b: Map of Abeokuta metropolis showing utility pipes networks

The facilities of the water corporation, with the pipelines, include three booster stations (Adatan, Ibara and Lafenwa), four reservoirs (Asaran hills, Iberekodo, Itoko and Oke-Egunya). It is noted, however, that the reservoir at Itoko had since been abandoned thus reducing the number of working reservoirs to three. This cannot possibly cater for the water requirements of the metropolis especially as the population of the city keeps expanding.

Figure 3 shows the population dot map of the metropolis (2000 estimate) along with the suggested extension of the utility pipes. The suggested extension of the pipeline network is as a result of the newer development areas forming. Communities without adequate pipeline including Bode Olude, Sabo, and Oke-Lantoro should be given priority for future pipeline development because of the growing size of these communities. The new development areas around Oke-Ata, Obantoko and Ita-Osin should also be considered for additional pipelines.

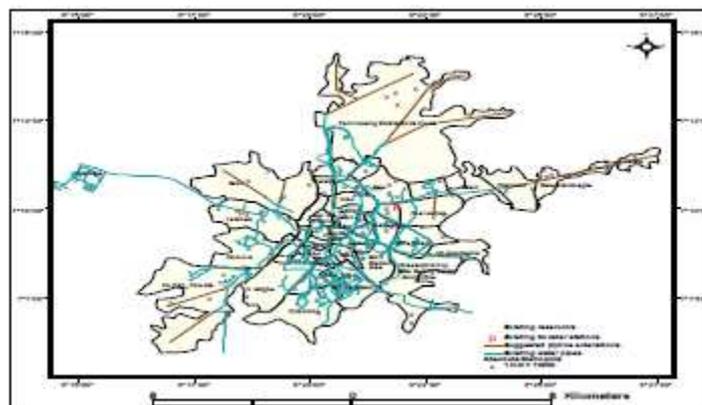


Figure 3: Population dot map of the Metropolis and the suggested extension

It is suggested that a reservoir be sited at the Asero – Oke-Aregba axis from figures 4 and figures 5, considering the digital elevation model existing services and population. This is in consonance with Chaudhery (2005). It is also suggested that the capacity of the booster station at Adatan be increased to adequately supply water to the proposed reservoir which will cater for the high lying areas in that zone.

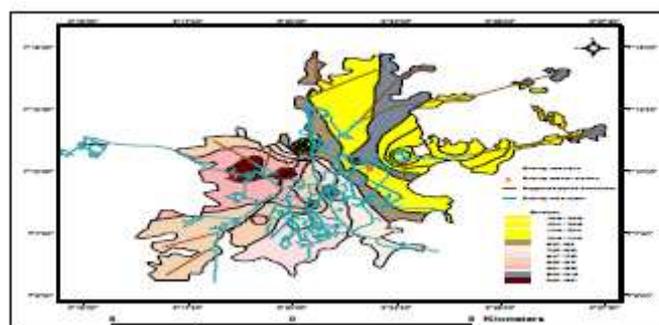


Figure 4: Elevation of the Metropolis

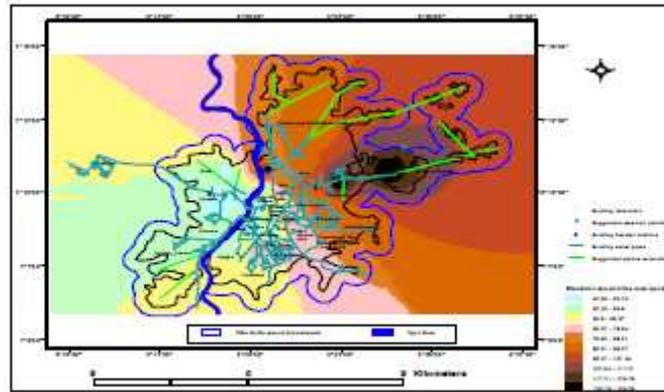


Figure 5: Map showing digital elevation model of the metropolis with proposed location of new facilities

Various frequency tables were produced following statistical analysis of the questionnaires. These include frequency tables showing access, type of connection and water supply per week.

Access	Frequency	Percent
Yes	1290	58.6
No	910	41.4
Total	2200	100.0

Table 1: Analysis showing Access

For the table 1, on access to water supply, it is seen that 59% of the questionnaires responses have access to water supply from the water corporation. 41% however have no access, either through public taps or house connection. Although the ratio of people without access seems to be high, it should be noted however that this group may include respondents who have defaulted in the settlements of their monthly bills and as a result, have been disconnected; those with private boreholes within their compounds and are not connected to the supply network of the corporation and those who have no public taps within their vicinity thus relying solely on other sources of water such as wells.

Connection type	Frequency	Percent
Not required	910	41.4
Connection	750	34.1
Public tap outside	540	24.5
Total	2200	100.0

Table 2: Analysis showing type of connection

Of the residents that responded to the question on connection type (Table 2), 34% of them have house connection while 25% have access to the water corporation's supply by means of public taps outside their homes. The residents of the indigenous areas such as Oke-Itoku, and Ikija have mainly public tap connection outside their homes. This is may be because many of the residents of these areas can hardly afford to pay the charges of the corporation or that the buildings within this area are distributed irregularly thus making individual house connection difficult.

Weekly supply	Frequency	Percent
Not required	910	41.4
Once a week or less	390	17.7
2-3 days per week	620	28.2
3-4 days per week	280	12.7
Total	2200	100.0

Table 3: Analysis showing frequency of supply per week

Going by the response of the respondents (table 3), 18% have running water from the corporation once a week or less, 28% received water between two and three days weekly while 12% received water more than thrice weekly. The areas receiving water once weekly include Obantoko, Adigbe, Oke-Aregba and Asero. This may be as a result of the elevation of these locations. In the case of Adigbe and environs however a number of problems have existed ranging from power outage, insufficient pipelines and rapid expansion of the area.

## 7 CONCLUSION

This work looked at the spatial content of Municipal Water Supply in Abeokuta. It was found that the only functional water reservoir in the town was not capable of supplying the inhabitants of the town adequate water supply. From the map it was seen that some areas including Bode-Olude, Sabo, Itan-Osin, Oke-Ata, Adigbe and Onikolobo do not have adequate pipeline connection. It was ascertained that communities without adequate pipeline including Bode Olude, Sabo, and Oke-Lantoro should be given priority for future pipeline development because of the growing size of these communities. The new development areas around Oke-Ata, Obantoko and Ita-Osin should also be considered for additional pipelines. It is suggested that a new reservoir be sited at the Asero – Oke-Aregba axis considering the digital elevation model existing services and population. It is also suggested that the capacity of the booster station at Adatan be increased to adequately supply water to the proposed reservoir which will cater for the high lying areas in that zone (Ufoegbune et al 2009).

Despite the substantial investment of the Ogun state government in this sector over the years, it is evident that a significant portion of the populace does not have access to adequate water services. The insufficiency in the access to potable water by the residents of the city could be attributed to the following;

- The current population of the metropolis exceeds the design population of the water scheme at inception.
- With the incessant power outages, the water corporation is handicapped in meeting its daily pumping requirements to the metropolis. The water corporation gets about four hours of power supply every day and even this power supply is not steady. Furthermore, the cost of running on generators when there are power outages is considerable therefore generators can not replace the public power source on a full-time basis.
- The lack of maintenance culture that pervades almost all sectors of the Nigerian polity. This is responsible for the frequent breakdown of facilities of the waterworks resulting in water shortages affecting various locations within the metropolis at almost frequent intervals.
- Inadequate funding, which has been the bane to the operations of most government establishments is also very relevant to the Ogun state water corporation's functions such as necessary repairs will not be carried out unless funding is available and adequate.
- The Ogun State Water Corporation is yet to explore the option of groundwater exploitation in meeting the demands of the residents of Abeokuta who reside in areas where the distribution network of the corporation is not present, rather it employs the use of water tankers to supply water to those distant communities in its ORUWA project which could be more expensive on a long term basis.

The services of the Ogun State Water Corporation are fraught not only by the inadequacies of the corporation in meeting its requirements but also by the acts of vandalism of some the residents of the metropolis. Worthy of mention is the Fajol junction at Obantoko, where petty traders and shop owners deliberately vandalise the water lines in order to fetch water from the burst pipes. Also the apathetic attitude of some of the staff towards their jobs, especially on the subject of unattended complaints may be responsible for some of the problems of the organisation.

To improve on the quality of services rendered by the corporation, the following is suggested;

- An expansion of the water scheme to meet a more realistic demand for water as a result of population increase.
- Manpower development and training in modern relevant technology for water resources management should be facilitated by the organisation for its staff.
- A more detailed database management strategy as proposed in this study ranging from facility data to customer data should be adopted by the corporation.

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