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*Full Length Research Paper*

# Spatial analysis of municipal water supply in Abeokuta metropolis, South western Nigeria

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**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 sale 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 that is available within the corporation.**

**Key words:** Water supply networks, questionnaires.

## INTRODUCTION

In Nigeria, water availability controls population distribution (Ayoade, 1983; 1988). 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.

Abeokuta, the capital of Ogun state, situated in south-west Nigeria (Figure 1), covers an approximate area of about 40.63 $km^2$. It lies between latitude 70 10 N and 70 15 N and longitudes 30 17 E and 30 26 E (Ufoegbune et al., 2008). 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 rain forest 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 963 mm (Ogun State Nigeria, 1986) and the temperature is usually between 26 and 28°C.

## EXISTING SITUATION

Public water supplies to the residents of Abeokuta are

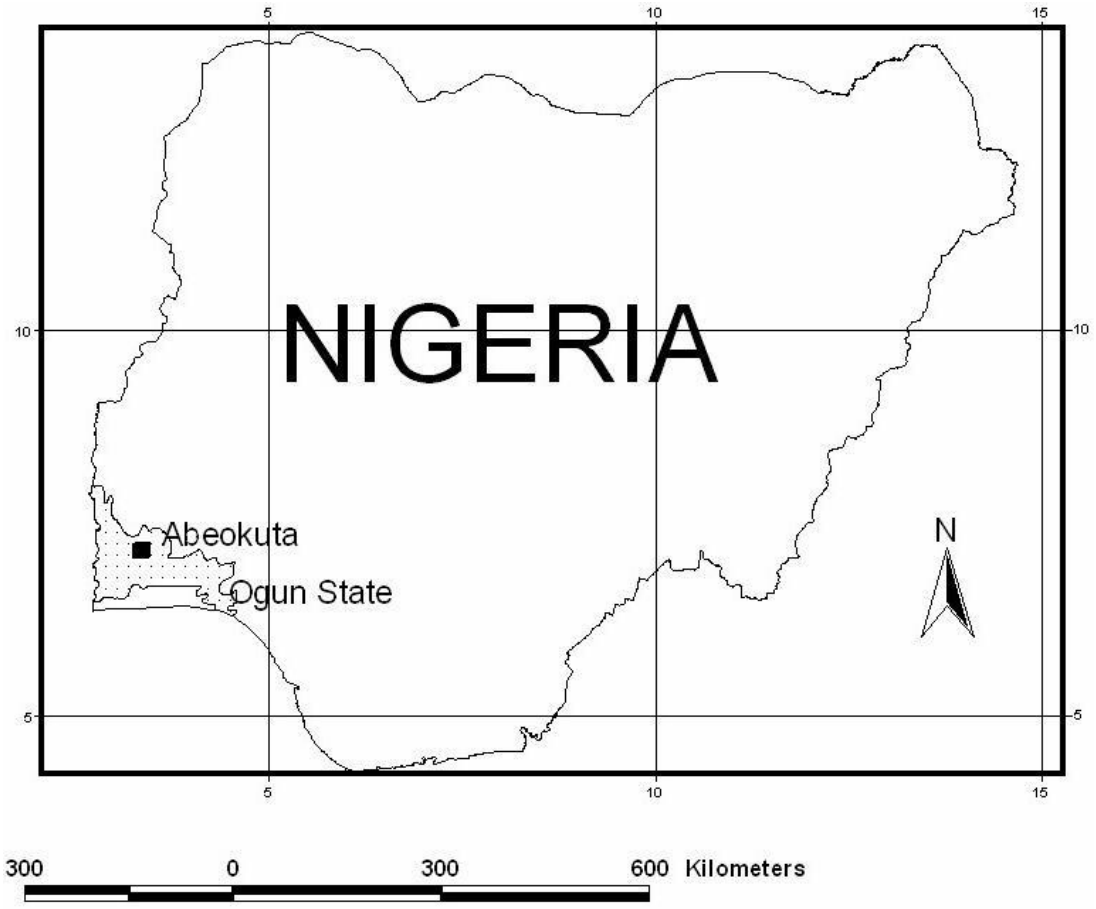


**Figure 1.** Map of Nigeria showing Abeokuta.

mainly drawn from surface sources because the town, Abeokuta, belongs to the Basement Complex where groundwater occurrence is precarious (what do you mean by surface sources, you need to explain further?). 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 was 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 due to inadequate maintanance (why was it abandon? Could you provide us with any information? Your readers are curious to know whether it is political reasons or economic or pure administrative errors or worse still technical). 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 m/h.

The present water supply situation in Abeokuta can best be described as inefficient as most residents cannot be assured of 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.

**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 during the dry season when water scarcity is greatly felt(this number is quite huge. Could you let us know the time of the survey - Dry season or wet season and what was the duration of the survey). A total of 2200 questionnaires were however responded to. A geographic positioning system (GPS) (What is 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 (Marble, 1979; Martin, 1991). 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 m (Could you please identify these areas in your write up?). 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 m 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.

## 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 b 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.

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.

It is suggested that a reservoir be sited at the Asero – Oke-Aregba axis from Figures 4 and 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.

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.

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.

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

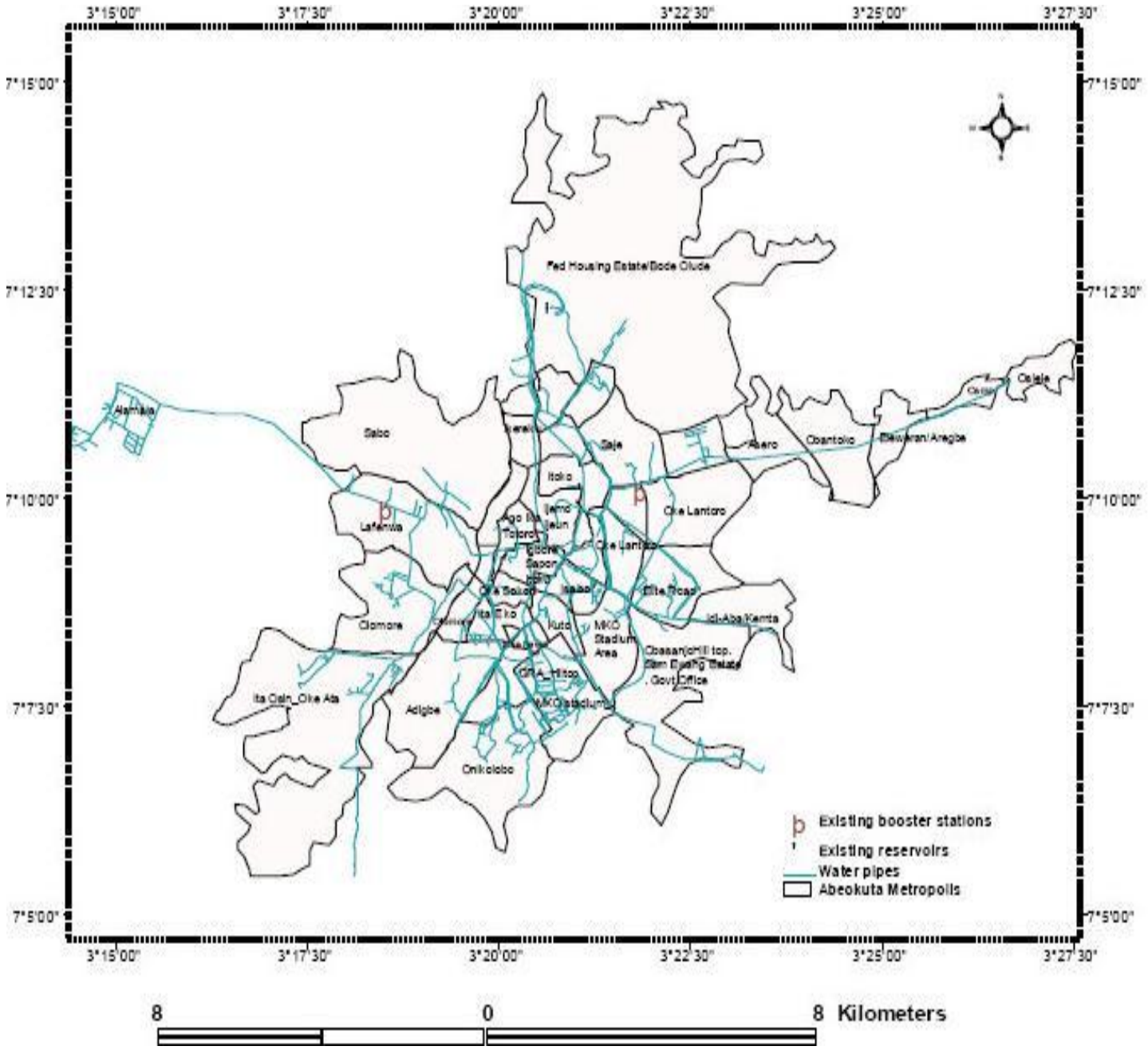


**Figure 2a.** Map of existing facilities.

distributed irregularly thus making individual house connection difficult.

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.

## Conclusion

This study examined the spatial content of Municipal Water Supply in Abeokuta. It 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

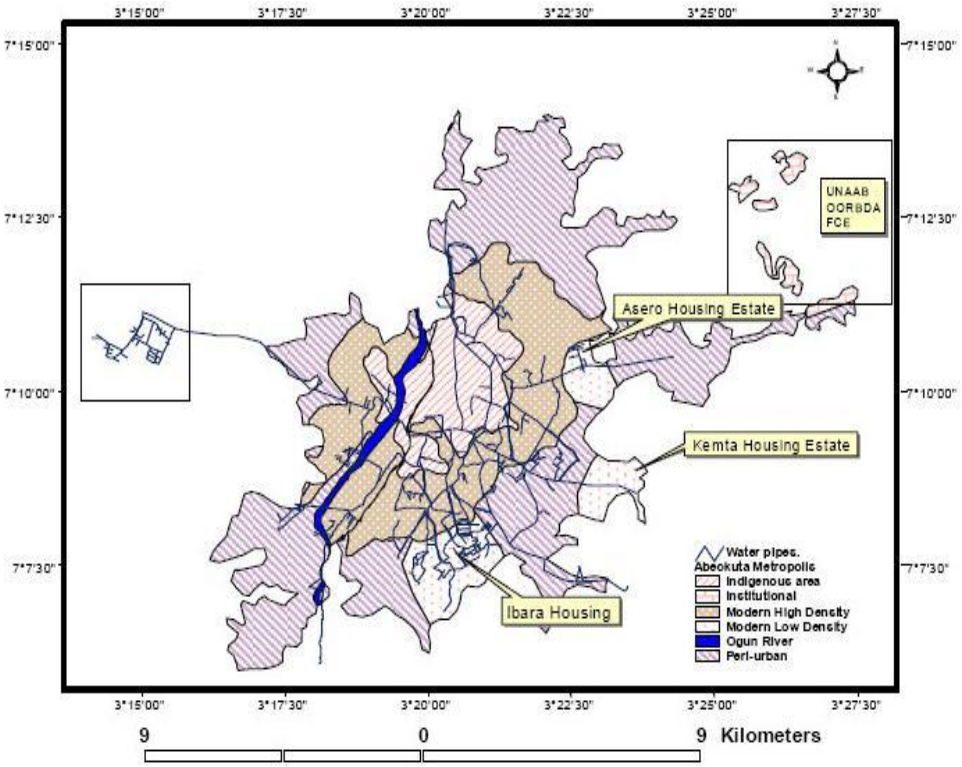


**Figure 2b.** Map of Abeokuta metropolis showing utility pipes networks.

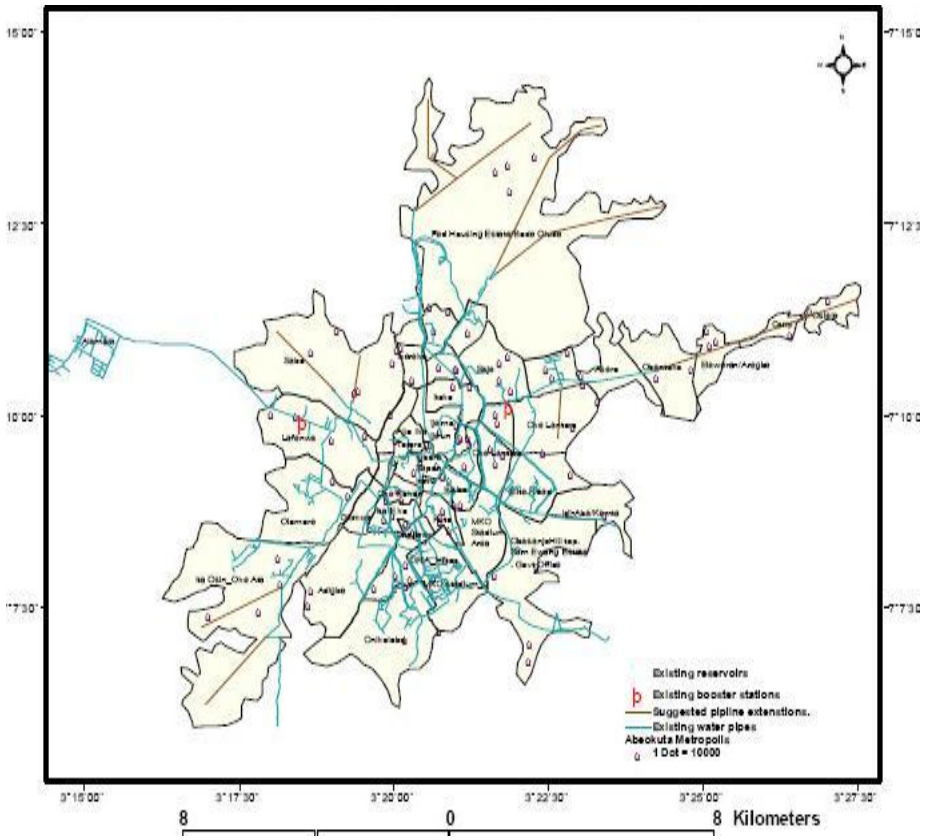


**Figure 3.** Population dot map of the Metropolis and the suggested extension.

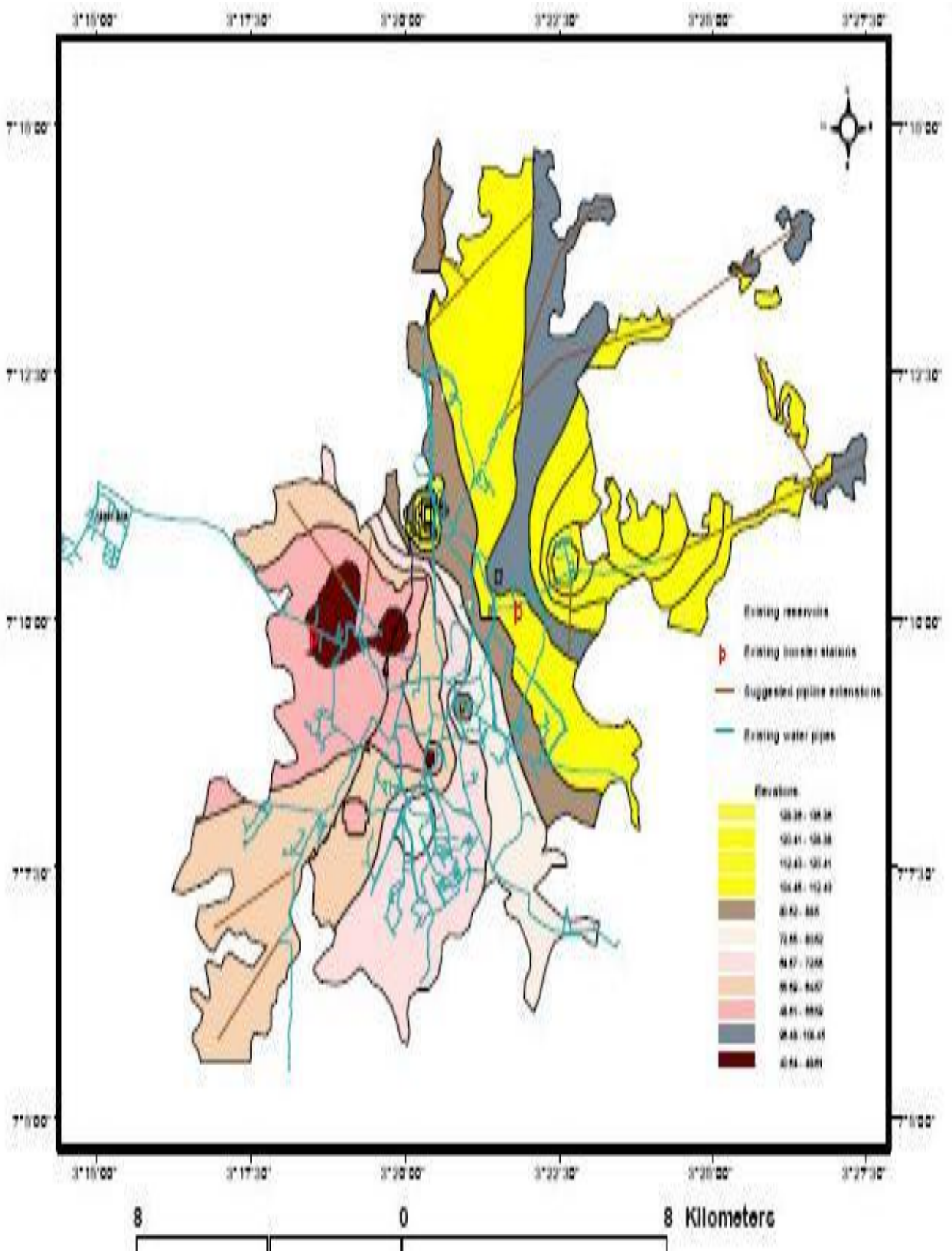


**Figure 4.** Elevation of the metropolis.

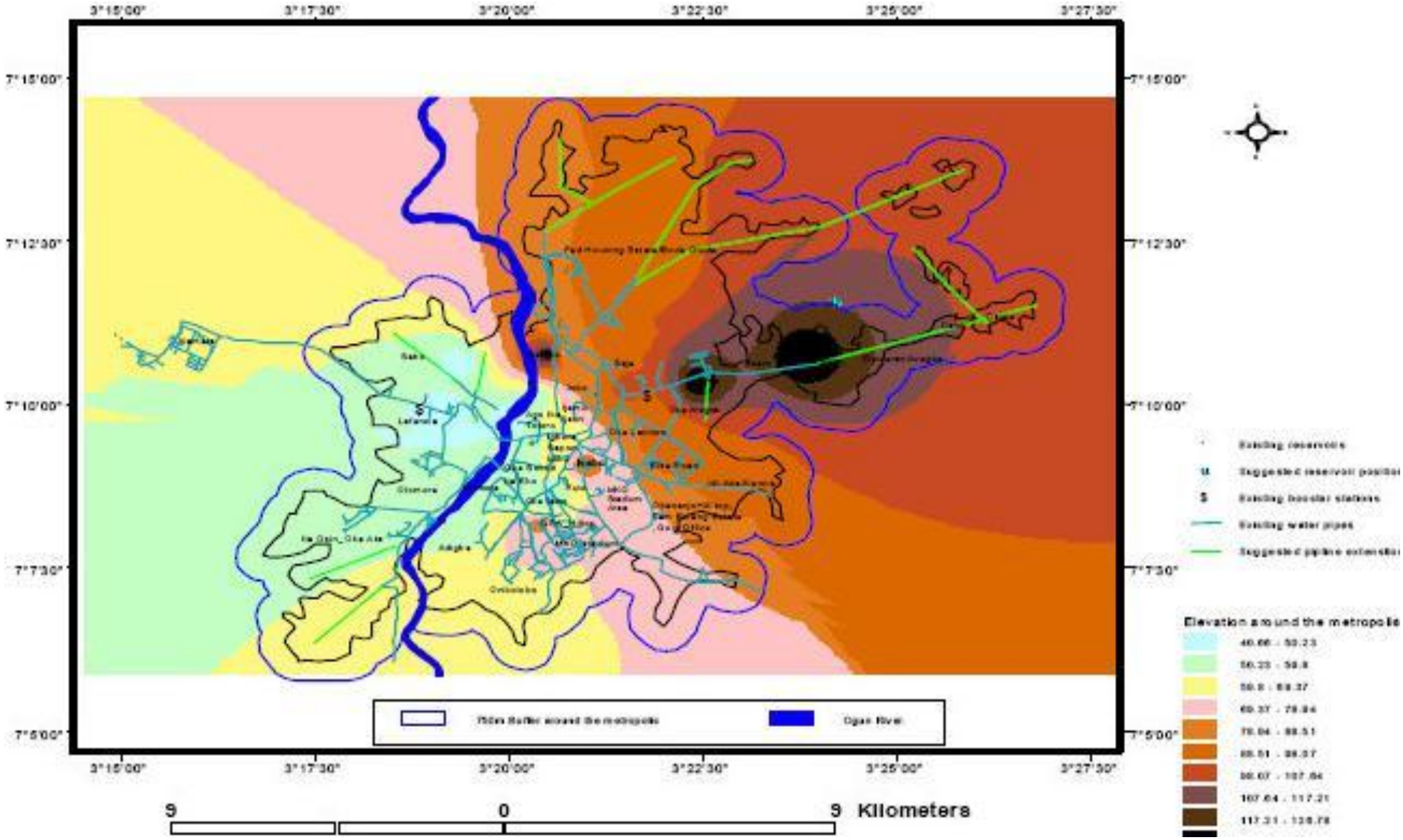


**Figure 5.** Map showing digital elevation model of the metropolis with proposed location of new facilities.

**Table 1.** Analysis showing access to water supply.

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

**Table 2.** Analysis showing type of connection.

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

**Table 3.** Analysis showing frequency of supply per week.

| 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 |

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).

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