Dissertation

By

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RURAL WATER SUPPLY IN ISI.ALA-NGWA LOCAL GOVERNMENT C)
·AREA OF IMO STATE, NIGERIA.

Rural water supply in isiala-ngwa local government areas of Imo state, Nigeria

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RURAL WATER SUPPLY IN ISIALA-NGWA LOCAL GOVERNMENT AREA OF IMO STATE, NIGERIA.

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CERTIFICATION

Mr. George Nwabuko Chima, a Postgraduate student in the Department of Geography and with the Reg. No. PG/M.Sc/86/4226 has satisfactorily completed the requirements for course and research work for the degree of Master of Science (M.Sc) in Hydrology and Water Resources. The work embodied in this thesis/ project report is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

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Supervisor.

D E D I C A T I O N

To those that have contributed to the identification and emancipation of the rural people.

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ABSTRACT

This work has analysed the water supply situation in Isiala-Ngwa Local Government Area of Imo State. Investigations were made on the assessment of water demand, sources of water supply, analysis of deficiency of water supply, and strategies for meeting the water needs of the area.

The result of the analysis shows that the total household water demand for Isiala-Ngwa is 1108 litres per household per day (lhd), while the consumption (supply) is 355 lhd. This gives a deficiency of 753 lhd representing a percentage margin of 68%. On the whole, the mean per capita water consumption per person per day for the area is 42 litres per capita per day (lpd). This figure represents some 36.5% of the Federal Government of Nigeria recommended minimum of 115 lpd. The average distance travelled for water collection in the area is about 5 kilometres, while people spend an average of about 2 hours in water collection. About 18% of the day time is spent in water collection. This phenomenon therefore affects some productive activities adversely. Out of the 783 public standpipes (both functional and non-functional) in the area, 564 are non-functional while 219 are functional. Small diameter pipelines (50mm to 100mm) dominate in the area.

Principal components analysis reduced our 19-physical, socio-economic and political predictor variables to 6 components which explains 96.99% of the perceived reasons for water deficiency in the area. The 6 underlying components identified are:

i. The general limitation of the available water sources.

ii. The problem of public water operation/distribution

iii. The influence of locational factors.

iv. The influence of technological/financial inadequacies.

v. The problem of road construction/road grading.

vi. The influence of management/policy inadequacies.

The existing water development strategies adopted by the government and people of the area are inefficient since the water problem still persists. Suggestions for new water development strategies for the area are made.

CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem:

People in the lower end of the income scale in the developing countries reside for most part in rural areas; either in clustered communities or in scattered residences or in city peripheries where urban services are scarce or completely lacking (Jorgensen, 1982). In all these settlements, water for domestic use is often costly in terms of cash, time and energy expenditure, and its quality varies from safe to extremely hazardous.

Rural regions themselves also differ considerably in the availability of safe water. In certain communities the water collection journey is short and convenient. For example, in the riverine areas of Nigeria, any improvements in accessibility of supply will not save significant amount of time or energy. However, there are many communities in which, during certain periods of the year or all through the year, the collection of water involves a significant expenditure of time and energy. Therefore, an improved supply has an obvious potential for reducing these efforts which in turn may lead to labour release and other benefits (Feachem, 1973). Each day women and children throughout the developing world walk several kilometres to fetch the household water. The amount fetched is often only sufficient for the barest survival. That this situation continues to exist generation after generation is according to Obeng (1982), really a crime of humanity against women and children.

In most of Nigeria's rural areas, many social services are entirely lacking. Where some services are provided, the magnitude and quality of supply are ordinarily insufficient. The average Nigerian village, for instance, lacks pipeborne water, or any regular and safe source of water for domestic uses (Igbozurike, 1983). Ready witnesses are the long lines of empty water containers at dry standpipes in some locations, or the hordes of battling water seekers at the few standpipes where water runs.

The battling crowds in such locations must in contrast, be adjudged to be more fortunate. This is because in yet other locations are the long series of now disused standpipes which have been twisted and broken (Plates 1A and 1B) in a crowd's eagerness to fetch water on the rare occasions it flowed. It is a

PLATE 1A: A disused standpipe in Mba village of Okporo-Ahaba Community.

PLATE 1B: Non-functional standpipes in Umuomainta Nsulu. Note the broken standpipe by the left.

fact that 28 years after the attainment of political independence, millions of Nigerians in the rural areas still face the problem of irregular domestic water supply. Many villagers trek (or ride) several kilometres every morning and evening in search of water, while other villagers solve their water problem by collecting and storing flood water during the rainy season. In most cases, the water problem in many rural areas has developed into a crisis situation. This is due to the regularly increasing and uncontrolled population, all competing for fixed natural water supplies.

Chisholm (1968) quotes West African studies which report that the Ngwa of South-eastern Nigeria live up to 13 kilometres from permanent water supplies and that, in eastern Nigeria as a whole, half the rural population live more than 5 kilometres from perennial streams and individuals spend up to five hours per day collecting water in the dry season. Eventhough this figure seems highly exaggerated for Isiala-Ngwa, it shows that there is the problem of water supply in the area which is part of Ngwa clan.

Isiala-Ngwa Local Government Area of Imo State is predominantly rural. There is acute water shortages in the area. The people are faced with the problem of finding water for domestic and non-domestic activities. They thus make use of the few sources of natural water supply, mainly streams, springs and ponds. These few natural water sources are not evenly distributed over the area, this therefore helps to add to the water supply problem. Because of this, the people trek long distances in search of this scarce resource. Many hours which would have been used in other productive activities are wasted in search of water.

Most of the water fetching is done by women and children. Water fetching therefore determines and partitions the structure of the day's activities for the women and children in Isiala-Ngwa. During the dry months of the year, the first morning activity is trekking or cycling to fetch water before going to school, farm or market. At times, because of the long distance and the crowd at the ponds and streams (Plate 2), the children return late before preparing for school. They end up going to school late. Also, when they return from school, they go to fetch water during the hot afternoons. Because of this, there is little or no time for studies and rest as a result of constant fetching of water.

PLATE 2: Children collecting water from a pond ("iyi achara") in Umuosu village in Nsulu community. Note the dug hole from which water is collected with bowls when the pond dries during the dry season.

Again, rural areas with pipeborne water are very few. Some areas without either pipeborne water or surface streams have made many futile attempts toward providing rural water supply through community effort. In areas where pipeborne water exists, the public standpipes seem to be haphazardly located without taking such factors as centrality and population concentration into account. This helps to complicate the water collection journey.

A more serious problem is that these public standpipes rarely run and when they do, rarely exceed three hours. This period usually falls within the busy hours of the day when people are engaged in one business or the other. Observation has shown that women and children leave whatever they are doing to struggle and possibly fight for water during these periods. Hence, a lot of man hours are wasted mainly by women and their children in the search for water. It is important to note that these women are also responsible for most of the food grown for their families and have to fit their search for water in with the rest of their daily tasks. Anon (1977), estimated that in Africa today, 80 percent of the women take a major role in food production, carry 80 percent of the fuel supplies, and supply labour for half of the house repairs and a third of the house building. It is the same people that will go trekking in search of water. This resource has therefore, assumed a strong determinant of how each day's activity is mapped out, planned or executed.

The problem facing Isiala-Ngwa is thus the provision of adequate water supplies in the area. This is because, water is a unique commodity that cannot be replaced by any other substance. Apart from air, there are few elements which have a greater effect on the improvement of living standards as water (Shipman, 1967). It is therefore pertinent that the provision of this resource to any geographical area can act as a driving force to keep the community going as an identifiable group. It can also provide energy for maintaining social relations as well as economic productivity (White and Burton, 1977). Improved rural water supply and sanitation may improve the aesthetic quality of life, they may facilitate other rural development activity. They may save the time spent in carrying water over long distances, but the foremost benefit anticipated is improved health (Falkenmark, 1982). From these statements, it is clear that water acts as a nucleus for improved quality of life and development, and its regular supply and accessibility are therefore necessary in any geographical area, be it rural or urban.

Rural area as used in this work implies all areas (notably villages/communities) which have a major part of their population solely engaged in agriculture. Their peoples are related culturally and traditionally, and lack well established markets/industries. Above all, such areas lack the basic social amenities such as hospitals, electricity, all season motorable roads and pipeborne water.

The aim and Scope of the Study:

This study is designed to highlight the scope and intensity of water supply problems in Isiala-Ngwa Local Government Area of Imo State. It is also designed to offer suggestions as to how the situation can be ameliorated. Towards achieving these aims, the following objective investigations will be carried out:

(i) To measure estimates of the quantity of water demanded; how much of this is supplied and what is the margin of deficiency in the water needs of the people.

(ii) To determine the causes of water deficiency in the area.

(iii) To analyse the overall effect of water shortage on the people.

iv. To analyse the spatial pattern of water need in the area with a view to determining the most effective water distribution network aswell as a suitable strategy for achieving this.

1.3 The Study Area:

The area covered by this study is Isiala-Ngwa Local GovernmentArea (L.G.A.) of Imo State (Fig.1). It is bounded to the East by Ikot Ekpene Local Government Area (Akwa Ibom State); to the south by Obioma-Ngwa Local Government Area; to the northwest and west by Aboh Mbaise and Owerri L.G.A. respectively; and to the north by Ikwuano/Umuahia Local Government Area (Fig.2). The boundaries of the area extend from about Latitude 05° 15'N to Latitude 05°30'N and Longitude 07°15'E to Longitude o7°30'E, with an estimated area of 996km^2. Isiala-Ngwa is composed of 17 communities (Fig.2) and 144 villages/wards. In three of the 17 communities, are found three growing urban centres of Nbawsi (in Nsulu community), Omoba (in Omoba community) and Okpuala-Ngwa (in Ngwa ukwu community) Fig.4).

1.3.1 Growth and Development of Isiala-Ngwa:

The history of Isiala-Ngwa is related to the history of Ngwa clan. The main body of Ngwa clan is said to have originated from a village called Umunoha, situated in what is now Mbaitoli/Ikeduru Local Government Area.

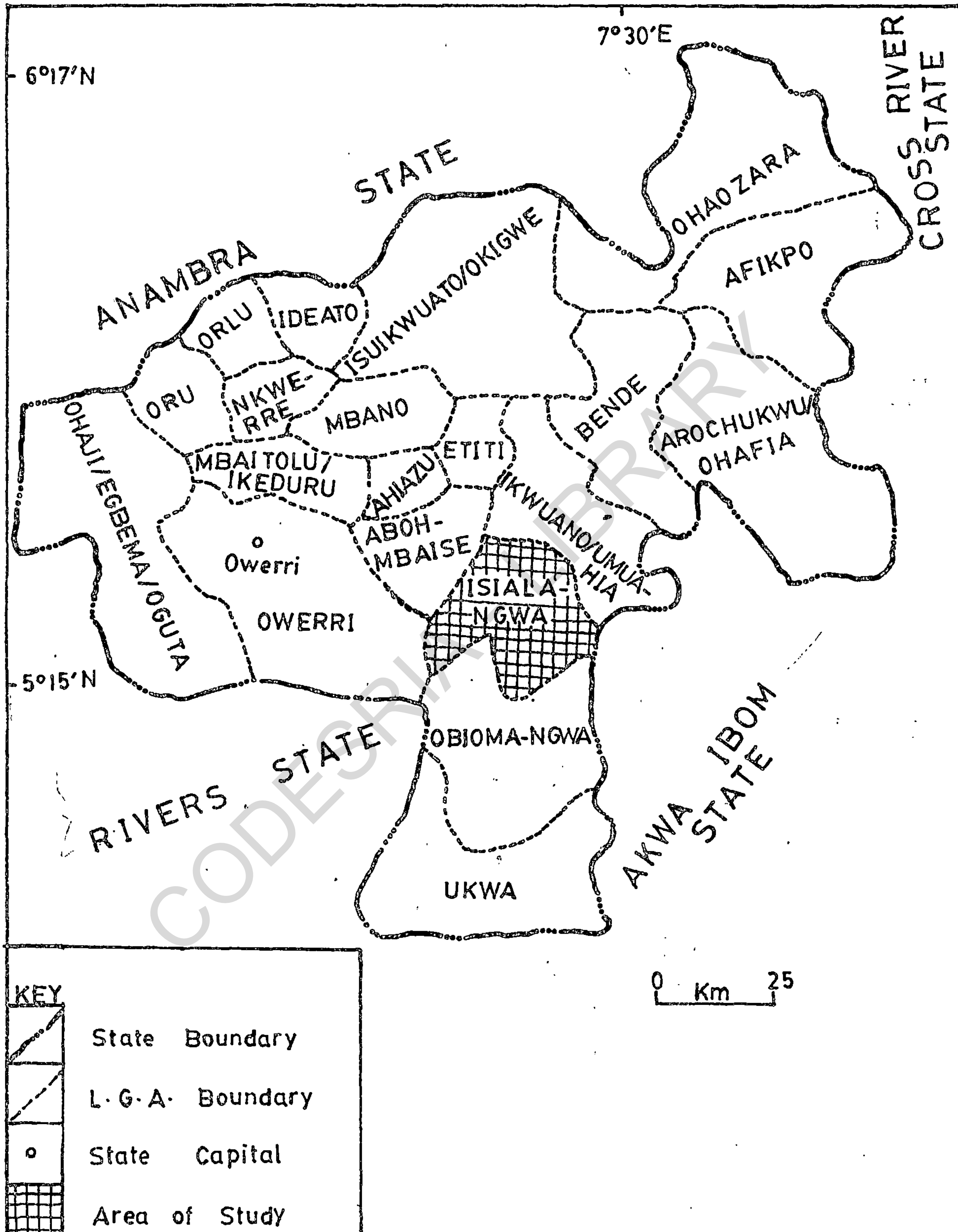


FIG.1 : IMO STATE SHOWING THE AREA OF STUDY.
(Source: Survey Division, M.O.W & H. Owerri, April, 1975.)

Tradition has it that in the dim past a number of persons were on a journey in search of new lands in which to dwell. Three of them - Ngwaukwu, Nwoha, and Avosi crossed over to the other side of the stream (now Imo River). These three persons were given the name "Ngwa" and they first settled at Okpuala-Ngwa where Ngwaukwu established his "Ala Ngwa" juju. The left bank of the Imo River was sparsely inhabited by the Ibibios and covered by virgin forest. As the Ngwas increased in numbers and the natural desire to acquire more land increased, the Ibibios who were their landlords were pushed farther and farther to the east (Allen, 1933).

The population of Isiala-Ngwa by 1933 was about 57,939, of which 15,965 were adult males, 17,282 females and 24,692 children of either sex (Allen, 1933). Table 1 shows the progressive increase in population of Isiala-Ngwa from 1933 to 1987.

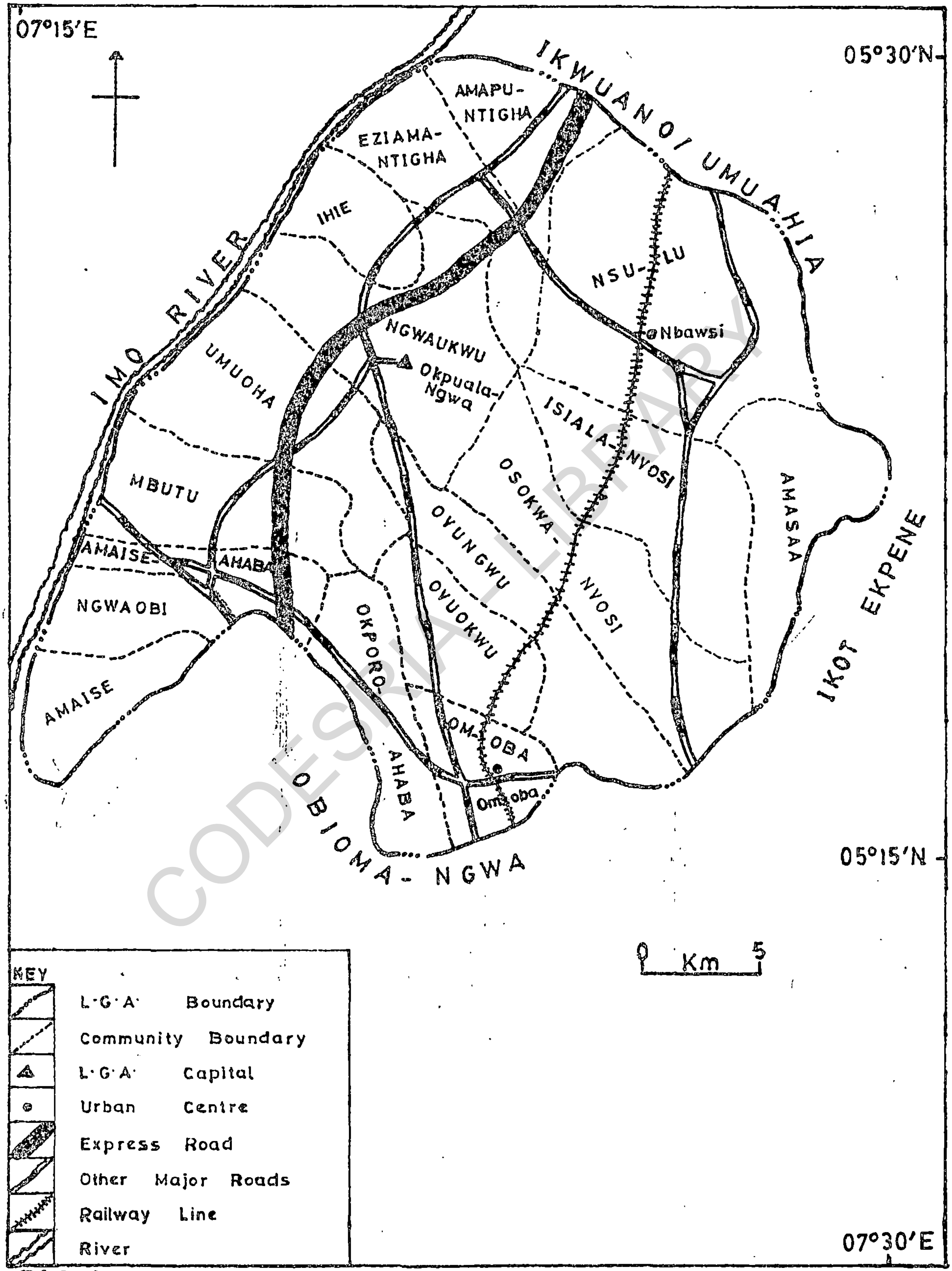


FIG. 2: ISIALA-NGWA SHOWING THE COMMUNITIES. (Source : Isiala-Ngwa Planning Office.)

TABLE 1 : Population of Isiala-Ngwa: 1933 to 1987 (Sources: (i) Allen (1933); (ii) Federal Republic of Nigeria (1963); (iii) Imo State Ministry of Economic Development and Planning (1976)

Year	Population	Remarks	
1933	57,939	Estimate	(i)
1943	74,167	Estimate	(i)
1953	94,940	Estimate	(i)
1963	170,971	Census	(ii)
1973	218,857	Estimate	(iii)
1976	235,683	Estimate	(iii)
1980	260,150	Estimate	(iii)
1985	294,344	Estimate	(iii)
1987	304,245	Estimate	(iii)

The population figures for Isiala-Ngwa show that there was an increase from 57,939 in 1933 to 74,167 in one decade, a period when agriculture was the mainstay of the people. However, the high population increase could be attributed to the migration of people from other areas to Nbawsi and Omoba railway stations, which had become commercial centres. The area also witnessed a tremendous increase in population from 94,940 in 1953 to 170,971 in 1963, the decade in which there was a natural increase in population in the developing countries as a result of improvements in the standard of living and medical care. The decade also saw the full establishment of administrative headquarters at Okpuala-Ngwa, with Nbawsi and Omoba still gathering momentum in commercial and industrial development.

Further increase in the population of the area is also noted for the period between 1973 to 1987. This however, can be explained by the net migration of people into the growing centres of Nbawsi, Okpuala-Ngwa, Omoba, Owerrinta, and "Orie Ntigha". Also, the establishment of new secondary schools, banks, and other establishments such as the recent Ada Palm Industry at Nbawsi in Nsulu community, have helped to attract other people to the area, thus increasing the population. The natural increase in population as a result of improvements in standard of living and medical care also has important contribution to the growth of population of the area during this period.

Isiala-Ngwa was divided into three Local Government Areas (L.G.A.) comprising Ikeala-Ngwa, Isiala-Ngwa and Etiti-Ngwa, in 1982 by the civilian administration. However, these L.G.A.'s were dissolved in 1984 by the preceeding military government.

1.3.2 Climate:

The climate of Isiala-Ngwa is tropical wet-and-dry with annual rainfall totals ranging from 1875mm to 2500mm. The bulk of the rainfall occurs during the rainy season which starts from mid-March and ends in early November. However, there is a break in rainfall, the "little dry season", which lasts for 2 to 4 weeks during the month of August. The dry season starts from the end of November to early March during which the total rainfall is less than 60mm. There is therefore a pronounced wet and dry season. This seasonality affects the stream regimes, with lower-water flow in the dry season, while the high yearly average rainfall over the area ensures adequate groundwater replenishment.

Temperatures are high, usually varying between 24°C - 28°C. The hottest months of the year are February to April, and they coincide roughly with the passage of the overhead sun. During this period, isolation increases with the apparent northward migration of the sun. The dusty harmattan wind becomes dominant in December/January and its attendant haze causes temperature to drop.

1.3.3 Relief and Drainage:

According to the classification of the landforms of Eastern Nigeria made by Ofomata (1975), Isiala-Ngwa belongs to the undulating lowland coastal plains. There is very little physiographic differentiation over the entire areawhich is generally uniformly undulating with altitudes generally below 100meters above sealevel. The characteristic trend of the topography is that of a gradual slow ascent from the Imo plain in the South West to the north east part of the area (around Nsulu community) where it breaks into slight undulations, near the border with Ikwuano/Umuahia Local Government Area.

The geology of Isiala-Ngwa consists of the Coastal plains Sands of Oligocene-Pleistocene age. The Sands are sometimes crossbedded, with clays and sandy clays occuring in lenses (Orajaka, 1975). The sands of this area are generally uncemented and porous. Groundwater occurs in essentially unconfined conditions over the area and the water table generally trends south towards the Imo plain. The average depth to the water table is about 46 meters below ground surface (Ofomata, 1975).

There are four major streams that drain the area (Fig.3). To the western and south western part of Isiala-Ngwa is the Imo River which forms the western boundary with Aboh-Mbaise and Owerri Local Government Areas. Like most other streams which flow across the Coastal plain Sands of Southern Nigeria, the Imo system has very low drainage density because of the high infiltration capacity of these formations (Wigwe, 1975). The Ahii stream rises near Ikwuano/Umuahia and roughly constitutes the eastern boundary of Isiala-Ngwa. The Ahii flows through the Nsulu villages of Umuode, Mbubo, Umuakwu, Ohuhu-Nsulu, and Aruachara until it enters Ikot Ekpene Local Government Area (Akwa Ibom State). Near the point where Ahii enters Ikot Ekpene Local Government Area, it is joined by the Otamiri stream, which has its source near the village of Umuomainta Nsulu. The Otamiri flows through the Nsulu villages of Umuosu, Umuala, Ubaha and Umuakwu until it joins the Ahii stream. The Ahii and the Otamiri streams form the upper and northern tributary of the Kwa Ibo River.

The last major stream in the area is the Oji, which rises in Ikwuano/Umuahia Local Government Area; and drains the extreme westerly section of the communities of Ntigha, Ngwankwu and Umuoha (in Uratta village). It joins the Imo River by a stretch of swamps.

There are other minor streams which are given different local names by the villagers. These streams are mainly concentrated in the northern section of Nsulu community and are: Ihu iyi, iyi okpulu-ukwu, iyi umuosidim, iyi ubi, and iyi ulo. Also found in the northern section of Nsulu community are springs locally called iyi Nkpokoro, Onumiri, and iyi olugele. In the south western part of umuoha community (in Amapu village), there is the Etu Amapu stream which is a small tributary of the Imo River.

The central, southern and south eastern parts of Isiala-Ngwa are very poorly drained. There are virtually no surface streams. What we have in these areas are natural ponds (Fig.3). These ponds are given different names by the various communities viz:

Local name	Community
Ifanim	Umuoha
Nkara	Ngwaukwu
Nnemeh	Ngwaukwu
Ngwu	Ovuokwu
Iyi-ala	Nsulu
Iyi-achara	Nsulu
Iyi-Ife	Nvosi

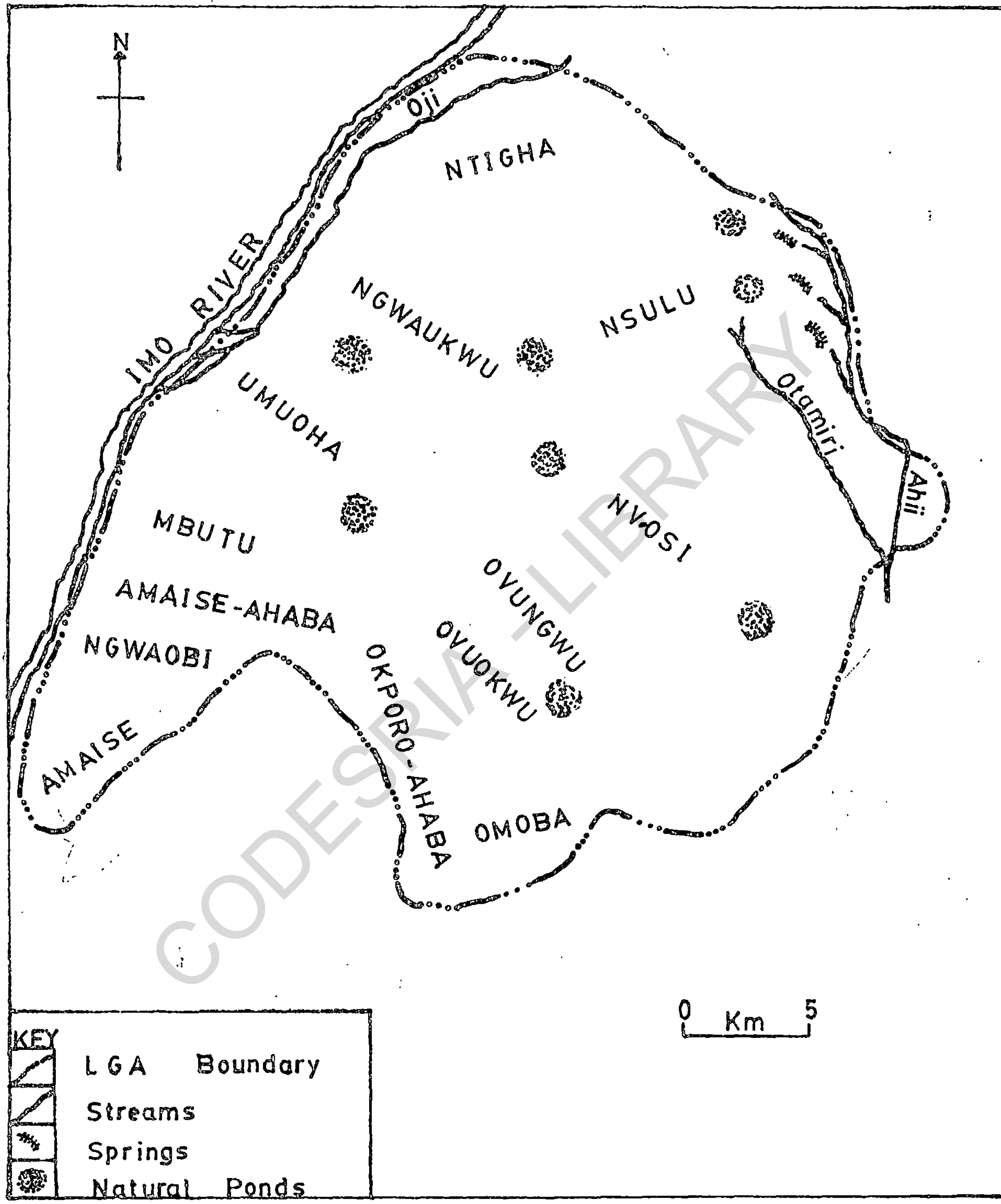


FIG. 3: DRAINAGE PATTERN OF ISIALA- NGWA.

The ponds are formed in natural depressions with floors near or at water table elevations especially during the rainy season. Seepage of groundwater as well as direct runoff of rainfall maintains their water content. The pond levels thus rise and fall seasonally in a rhythm similar to that of the water table, and some dry up during the dry season. These ponds are generally shallow with a maximum depth of about 2meters. The large ponds like Ifanim, Nkara, Nnemeh and Ngwu have an average area of about 8 hectares while the small ones like iyi-ala and iyi-achara are about 3 hectares.

Some villages however neither have streams nor ponds. They are thus forced to dig shallow catchment pits to retain water during the rainy season (Plate 3). The water from these catchment pits may however dry up during the dry season.

1.3.4 The Pattern of Settlement/Residential Structure:

Isiala-Ngwa is made up of 17 autonomous communities viz: Amaise, Amaise-Ahaba, Amapu-Ntigha, Amasaa, Eziama-Ntigha, Ihie, Isiala-Nvosi, Mbutu, Ngwaobi, Ngwaukwu, Nsulu, Okporo-Ahaba, Omoba, Osokwa-Nvosi, Ovungwu, Ovuokwu, and Umuoha (Fig.2). However, for the purpose of this research, the 13 old autonomous

PLATE 3: A 'catchment pit' to retain flood water during the rainy season in Ichi village in Umuoha community.

communities of Isiala-Ngwa will be used. These are the communities used for the 1963 census (Fig.4). They are Amaise, Amaise-Ahaba, Mbutu, Ngwaobi, Ngwankwu, Nsulu, Ntigha, Nvosi, Okporo-Ahaba, Omoba, Ovungwu, Ovuokwu and Umuoha. Apart from Nbawsi (in Nsulu community), Okpuala-Ngwa (capital of Isiala-Ngwa), and Omoba (in Omoba community) which are small urban centres, there are 144 villages/wards in Isiala-Ngwa. There is no marked difference in the pattern of settlement in these 144 villages forming the 13 communities, so they will be discussed together.

The people live in dispersed villages consisting of dwelling units called compounds. Each village is divided into many kindreds ("Onumara"). Members of one kindred are believed to have come from one common ancestor and they live like brothers and sisters. Each kindred is further divided into compounds ("Ezi"). Members of one kindred share a common land, maintain their roads and footpaths as well as control and harvest their oil palm fruits on agreed days. Marriage is forbidden among members of the same kindred and, at times, between members of the same village as a whole. Members of one kindred live together in somewhat dispersed settlements.

The traditional mud houses are square or rectangular shaped with roofs thatched with rafia palm leaves ("Akirika"). Modern cement houses with corrugated iron roofs have presently taken over, and these are owned mainly by the well-to-do members of the village. Every compound has agricultural land ("Uruazulo"), which is permanently cultivated and in which vegetables are grown. The size of the compound varies according to the size of the family and its land - holdings, and may range from 0.2 to 1.0 hectare or more. The compound is usually surrounded by a fence ("Ọgba") which may be made of sticks, earth walls or blocks. This serves the purpose of keeping animals such as goats out, and for privacy.

The availability of farmland and perhaps free drainage have been an overriding factor in the location of settlements. Shortage of land suitable for buildings not only restricts the size of the villages but leads to nucleated housing in small settlements. This is clearly manifested in the northern parts of Nsulu community, around the villages of Mbubo, Umuakwu, Umuode, Umuosu, and parts of Ntigha villages. These areas correspond to the areas with high relief. In these areas (northern Nsulu), compounds at times do not have any 'Kitchen garden' farmland ("Uruazulo"). The increasing number of farmers leads to the absorption of the outlying farmlands and their conversion into part of the settlement complex.

Generally in Isiala-Ngwa, the compounds are grouped along the major roads radiating from the village square which serves as the service centre consisting of the churches, schools, markets, and retail shops. The village squares can be a favourable site for the location of water projects because of their centrality. No village boundaries are discernible. Compounds of one village may border the compounds of adjoining settlements, and ru ral settlement is continuous.

1.3.5 The Economy of the Area:

The economy of Isiala-Ngwa is largely agricultural. This is of the subsistence type. About 90 percent of the 309,245 people living in the area are rural. There is land hunger for agriculture which is, in fact, the mainstay of the people of the area. However, the degree of participation in agriculture varies from one area to the other. For instance, around the urban centres (especially in Nbawsi and Omoba) with high population mix as illustrated in section 1.3.1, there is a joint attention on agricultural and trading activities. This is as opposed to areas like Ovungwu or Ovuokwu that are mainly agricultural.

The level of farming technology is very low. Traditional farm implements such as hoes, matchetes and digging sticks are employed. The old system of land tenureship is still prevalent in the area. In fact, it could be said that the dispersal of compounds derives mainly from the land tenure system. Farm sizes are consequently small and vary from one land owner to the other. This is a consequence of the variation of man-land ratio as well as the intense parcellisation common in the area since land ownership is mainly by inheritance (Chima, 1985). This results in poor agricultural turnover which leaves the farmer within the subsistence level.

The types of crops grown in the area are yams, cassava, cocoyam, maise, okra, melon, beans, groundnuts, peppers and vegetables. Livestock such as goats, sheep, dwarf cattle, and poultry are kept. They are kept in pens or small huts or attachments within the house and they are not allowed to graze freely. However, the poultry are reared in free range. Only very few farmers have poultry houses where they raise their birds in confinement. Also, dogs and pussy cats are kept as pets. The farmers have traditional attitudes to some crops like yam and cassave which are the dominant crops. Even when the land does not give them enough economic returns, they keep on growing these crops because it has become their way of life.

The farmer and the members of his family supply the labour for the farmwork. In some cases however, outside farm labourers may also be employed. Such labourers are paid on a daily basis. Presently (1988), the rate is ₦4.00 for morning hours and ₦2.00 for evening hours. Men do the bush clearing while the women do the cultivation and weeding. The sources of capital for the farming activities are from past savings, borrowing from friends, and borrowing from "Umunna" (related families) meeting account. When the farm work is over and the crops harvested, the farmers take to other occupations like trading and hunting. They thus get money from these other occupations and use them to supplement their agricultural income.

Oil palm harvesting and processing is a major agricultural activity in the area. In fact, it has been said that the oil palm is the sole means of livelihood possessed by the Ngwas (Allen, 1933; Mbagwu, 1970). The major problem facing the people of the area in their oil palm processing is lack of water especially during the dry months of the year which will be fully discussed in section 4.4.2. It has been the tradition that all the oil palms in a village belong to the members of the village as a whole. No matter who might be the owner of the land on which they stand. In order to ensure that individuals do not harvest palm nuts from the communal trees to the detriment of others, fixed days are usually earmarked for the harvesting. These days usually occur four times in every three months. This date is subject to any agreed change.

In addition to farming, some of the villagers are carpenters, artisans, tailors, block moulders and maason men, blacksmiths, gospel preachers, and traders. It has been observed that people engaged in these minor occupations combine them with agriculture.

1.4 Literature Review:

The profound inadequacy of social services such as water supply in Nigeria's rural areas is as longstanding and unfortunate as calls for its rectification are loud and recurrent (Seers, 1969; Ajaegbu, 1972, 1976; Onyemelukwe, 1977; Igbozurike, 1977, 1983; Mabogunje, 1980; Atte, 1980; Adefolalu, 1982; Nwosu, 1983; Baba, 1984; Bello-Imam, 1986; and Oleru, 1987). Baker (1982), in his investigation on the supply of water to rural areas of Kenya for domestic purposes argues that there is a need for proper coordination and amalgamation between the rural water supply programme and the self-help water programme in order to avoid wastage of scarce financial resources and bring the year 2000 goal (Water for all) close to reality. Jorgensen (1982) while investigating the problem of water supply in rural Africa looked on the factors that affect the choice of a source, the quantity of water used, and the ways in which it is used. And thus came out with the proposition that water fetching does much to determine the structure of the day for the women in the household. Alternatively, some investigators, Carruthers (1972); White, Bradley and White (1972); and Feachem (1973) have placed a monetary value on the water collection journey by costing the amount of staple food required to produce the number of calories which are needed to collect water. Whereas in the New Guinea highlands, an average of only 1.6% of the total available daytime energy is spent in water collection (Feachem, 1973), in East Africa, a mean figure of 1.8% of the total available energy is reported while individual communities can expend up to 4% and individual households expend up to 14.4% (White et al, 1972).

In a study carried out in the small village of Kpomkpo in south-east Ghana by Dalton and Parker (1973), women were asked how they would allocate their time if a new water supply system saves them about twelve hours per week. Their responses were for productive work (57%), household jobs (35%) and leisure (8%). Depending on the season, location, and terrain, water carriers in many parts of the world could be expected to spend more than one hour each day carrying water or, in some cases, up to four hours (White et al, 1972). Examples have been cited where many of the women walk more than one kilometer or even three kilometers (Chisholm, 1968; Warner, 1969; World Bank, 1972; Obeng, 1980).

The problems of rural water supply vary from one region to another. Athikomrungsarit (1971) and Anderson (1974) looked into the problem of water supply systems not working as planned in rural Thailand and Bangladesh, respectively. In Thailand, a survey by students at the Asian Institute of Technology in 1971 showed that 69 of 79 rural water supply systems studied had some difficulties in operating their plants. Among the more frequent complaints catalogued were:

(i) Continuing difficulty in collecting money from consumers because of broken taps, the great distance to public fountains, and the people's low income.

(ii) Inadequate tanks or water sources.

(iii) Insufficient pipes to extend the distribution system.

(iv) A lack of knowledge about system operation and chemicals, and

(v) A lack of assistance from the central water supply authority (Athikomrungsarit, 1971).

In almost all countries with viable water supply programmes, it is difficult not to find villages where the water supply system is either not working as planned or not functioning at all (Shipman, 1967; Athikomrungsarit, 1971; Anderson, 1974; Pacey, 1977; and Ufuah, 1986). It is because of this problem that appropriate evaluation and assessment (Warner, 1968, 1970, 1973) of rural water supply programmes are necessary. This is done in order to find the impact and economics of investing on rural water supply (Kally, 1965; Holloway, 1970; Wolman, 1970; Heijnen and Conyers, 1971; Carruthers, 1972; and Saunders, 1975).

Thus, the quantitative relationships between community water supplies and economic development was done by Logan (1963), while Warner (1969) compared rural water supply development in Tanzania using nine villages.

VanDamme (1982), asserts that the rural water development strategies which integrate past experiences and new thinking are not readily available. There is then need for a new approach which is geared towards integrating past experiences with new thinking in order to solve the problem of rural water supply. Thus, Pacey (1977) while investigating the provision and maintenance of appropriate water supplies in the developing countries concluded that the technology required for rural water development is not enough. Pacey (1977) then looked at the role of intermediate technologies in water use and found that technology only has a role in its environment and in its socio-economic context. The most appropriate technology is often missed because the range of options offered to most communities and considered by governments is too restricted. Pacey (1977) further suggested that by going back to the objectives of water improvement and sometimes disregarding rules-of-thumb formulated elsewhere, and by choosing among the vast range of technological devices those which are most appropriate to the particular situation, water supplies for the "thousand million" can be improved.

Many approaches have been adopted in the developing countries to solve the problem of rural water supplies. In rural Guatemala, the dominant technology for the provision of potable water has been the tapping of surface water (Springs) by gravity flow (Annis and cox, 1982). In Afghanistan and Iran, there are some 40,000 qunats comprising more than 270,000km of underground channels that supply 35 percent of the country's rural water (Hussain, 1980). In Burkina Faso, small hill dams, and lakes are being built and the technology, financial and technical means are within the scope of the villagers (Collin, 1986). Handpump programmes have been initiated in Malawi, Sudan and Zambia (Jong and Hofkes, 1986). The Mali Aqua Viva (MAV) is planning on the provision of 1,700 boreholes which will mean 900 villages and a population of 350,000 people would be provided water supplies by 1991 (Eggers, 1986). In some developing areas, water is provided by a village well, which supplies the water to people who carry it to their homes in buckets or jars (Brewster, 1986). In Yatenga (Burkina Faso), there is the idea which started in 1985 to sink 280 wells and boreholes in addition to the 400 provided previously (Eggers, 1986).

In Nigeria, the problems of rural water supply vary from one region to another. Udo (1970), on a broad regional approach, notes that people in some parts of Nigeria, like Abakaliki, Abak, Ifia, Biu Plateau, Shan Plateau, and the Scarplands of Eastern Nigeria, suffer from acute shortage of water for domestic purposes. Emezie (1980), Kanu (1983) and Obot (1984), in terms of water supply and demand, examined the problem of water shortage in Nkwerre, Uzuakoli and Cross River State respectively.

The causes of water shortages in Nigeria also vary from one place to another. In Nnobi, they include lack of adequate supply of pipeborne water and absence of surface water (in the central parts) of the area (Ezeonu, 1983). Olofin (1983) also observes that the climatic conditions, in conjunction with the structure and topography of the Nigerian Sahel zone, have created a natural condition of water scarcity in the area. Emezie (1980) found that the problem of water shortage in Nkwerre was as a result of both shortages of natural sources of water and imbalance in the distribution of the available supply sources, while the latter include financial, technological and management difficulties. Obot (1984), dealing with the spatial problem of water resource management in Cross River State, pointed out that the main causes of water shortage in the area were financial, technological and policy inadequacies.

As a result of these water shortages, no part of the rural areas in Nigeria has been able to obtain the standard of 115 litres per capita per day recommended by the Federal Government of Nigeria for the Third National Development Plan of 1975-1980 (Federal Republic of Nigeria, 1975). It has been found empirically that Nnobi has an average water consumption per capita per day (Pcpd) of 41 litres (Ezeonu, 1983). While that for Nkwerre is 23 litres (Emezie, 1980). In Cross River State, Obot (1984) found that the average water consumption pcpd in 1977 ranged from about 3 litres in Ugep/Ediba to 7 litres in Ogoja. In short, Ayoade and Oyebande (1983) found that all states, except Lagos, Kano and Borno, have per capita water use very much lower than 115 litres.

Udo (1978), Emezie (1980), Ayoade and Oyebande (1983), Ezeonu (1983), and Obot (1984) have all variously noted that water shortage in Nigeria's rural areas and even in the urban centres, a sector on which so much has been invested in hydrological research and water supply development, causes a real hardship. Water shortage creates economic, socio-economic and health problems in these areas. In many rural areas, long hours are spent in travelling to fetch water from the nearest natural source - stream, spring and pond, which may be located from one to ten kilometers from the village. Some of those sources may dry up completely during the hot dry season. In deed, where water can be bought, it is very expensive. It is because of this problem that Ayoade (1976) looked into the planning to match water demand in the year 2000.

From the literature so far, adequate attention has been given to the quantity of water used and supplied (Bernard, 1955; Almquist, 1967; Feachem, 1973; Anderson, 1974; and White and Burton, 1977) and the problem of water unavailability (Udo, 1978; Emezie, 1980; Ayoade and Oyebande, 1983; Obot, 1984; and Ufuah, 1986). Fairly sufficient but not enough work has been done in planning and evaluation of rural water supply development

(Oyebande, 1976; Cairncross, Carruthers, Curtis, Feachem, Bradley and Baldwin, 1980; Hussain, 1980; Annis and Cox, 1982; VanDamme, 1982; Eggers, 1986; and Gondwe, 1986).

In Nigeria, very little or no work has been done to determine and delineate spatial patterns of water need (Priority zones) of rural water supply. Nor has any work been done to suggest suitable rural water development strategies for meeting the people's water need and thus determine the most effective water distribution network to adequately serve the population of the area. These aspects have been scantily treated by workers in Nigeria and this research hopes to bridge the gap. These, among others listed in section 1.2, are the lines of investigation we hope to follow in this research. This, not only lends credence to the study but justifies it as imperative.

1.5 Theoretical Framework:

Water supply can be the catalyst for the local organisation required for community development. According to Falkenmark (1982), water is one of the location factors in urban and rural planning, a particularly relevant factor in the developing countries, where scarcity of capital does not permit transportation of water from distant sources. Prost (1986) has vividly emphasized the importance of rural water supply when he said that drinking water supplies and sewage systems are prerequisites for better health. There can be no lasting improvement in health situation unless people have enough decent water within easy reach. From this, it is pertinent that investiment on rural water supply will help to improve the living standard and welfare of the rural people and also stimulate the growth of other rural development projects. According to Kaul and Mathiason (1982), since water supply systems may affect, positively or negatively, the development process in various sectors of the village economy and society, it has sometimes been argued that although water by itself is unlikely to have a significant developmental effect, its absence will prevent, or at least greatly hinder development.

According to Saunders and Warford (1976), a water supply system is both a consumption and an investment good. It is a consumption good in that people begin using it immediately upon its completion. It is an investment good in that it is part of the local infrastructure and can indirectly generate additional, future economic activity by attracting and assisting local commerce and village industry. The improved health of local human resources in turn can improve production. From these statements, it is clear that water occupies a central web in any community development process. Apart from this, water is a constituent of body elements and helps in metabolism. This commodity therefore cannot be replaced by any other substance. Because of this, it is of high demand by man, and in fact, the demand is perfectly inelastic. But, unfortunately, the demand for water always exceeds the supply in most of the developing countries with particular reference to the rural areas. There is therefore water deficiency (shortage) in relation to the demand. Many factors have been adduced from the literature to be responsible for this deficiency in supply (Emezie, 1980; Olofin, 1983; and Obot, 1984).

In this thesis, it is our opinion that the causes of water shortage in the area of study lie within the variables listed below:

1. Few streams within the area
2. pollution of water sources, mainly streams and ponds.
3. Shortage of water as a result of seasonality of rainfall, slope and geological differences, and low water table.

4. Long distance to the streams, ponds and standpipes.
5. Damages to standpipes/pipes during road construction/road grading.
6. lack of governmental support.
7. Insufficient functional standpipes in the areas having pipeborne water.
8. Lack/insufficient pipes to extend the distribution system.
9. Careless attitude of the people in handling the public standpipes.
10. Water leakage from pipes.
11. Insufficient boreholes.
12. The drying of village wells
13. Inadequate fuelling and repairs of pumping plants.
14. Misappropriation of community funds for water projects.
15. Lack of any form of pipeborne water in some villages.
16. Lack of co-operation from members of the water Board to listen to water complaints from members of the public.
17. Infrequent running of the taps (both public and private).
18. Lack of personal/village storage tanks.
19. Political differences in the area.

The variables incorporate geo-physical, socio-economic and political factors and are a fair reflection of the factors responsible for water shortage in the rural areas of the country. Eventhough some of these hypothesized variables may seem the same at first glance, there are subtle differences between them. For instance, variables 1,3,4 and 12 may look alike. In actual fact in the area, seasonality of rainfall, slope and geological differences, and low water table, do not differ much as to warrant the occurence of streams in one area and the occureace of ponds in another area or even the non-existence of any water source at all. For instance, Umuogu and Umuosu villages of Nsulu community have the same type of slope and geology, and the water depths are 23 meters and 42 meters below sealevel respectively. Yet, Umuogu with water table depth of 23 meters has ponds while umuosu with the water table at 42 meters has streams and spring as well as a pond. One would have expected the reverse to be the case. In the case of variables 3 and 12, one may say that the drying of the wells is related to the seasonality of rainfall, geology and the depth to the water table. But here, we discover that other factors like engineering inefficiency, where the wells are shallowly dug without reaching the permanent water table aquifer and the careless attitude of the people in throwing stones into the wells may lead to the wells drying up. In the case of variables 1 and 4 , one may argue that the location of human settlement is a function of the availability of water sources. Yes, but there are other factors such as the availability of enough space and cultivable land as was well noted by Basden (1938) when he remarked that in Igboland, the land, "Ani", is ranked as a god. Here then, the availability of water fails to be the major locational factor, rather it is available landspace (for settlement and agriculture), which may be very far from the water source. Also, variables 11 (insufficient boreholes) and 15 (lack of pipeborne water in some areas) may seem the same. But here, the existence of a borehole does not mean that the water is piped and there are some areas that have boreholes and yet, they suffer from shortage of pipeborne water. In the case of variables 13 (inadequate fuelling and repairs of pumping plants) and 17 (infrequent running of the taps), there are times when the pumping plants are in order and well fuelled, yet, the taps do not run as a result of water rationing or administrative inefficiency on the part of the workers of the Water Board.

It is our belief that these hypothesized variables which are subject to and amenable to quantitative analysis will adequately address the major causes of water deficiency in the area. We also believe that water deficiency in the area varies spatially.

Water is a demand that is constantly increasing as personal standards of living and economic development of a country increases. This has been noted by Shipman (1967); Bishop and Bartell (1975); and Biswas (1981); in their study of developing countries. One of the welfare services lacking in the rural areas is water supply. Thus, different steps and approaches have been made to solve the problem of rural water supply in the planning programmes of different governments especially the developing countries.

In a region considering the implementation of a rural water program, one of the important questions to be examined early in the planning stage is which areas or villages, should receive priority. The question is discussed under the heading of cost, economies of scale, growth - point strategies, income redistribution, "worst-first" strategies, financial viability and community enthusiasm. All these criteria are frequently used by countries to choose towns or villages to receive water first (Saunders and Warford, 1976). Growth-point strategy involves the creation of points or centres of rapid economic growth in the rural areas. These areas could have reasonable transportation access to the surrounding areas and, preferably, having natural or marketing advantages that have brought about generally higher levels of economic activity. In income redistribution, especially where subsidization of village schemes is involved, investment in rural areas might result in a high to low income redistribution, because rural populations are generally poorer than urban populations.

Methods currently used by countries for selecting areas which should have a high priority for water services are somewhat diverse, and are generally not well defined. An exception is the well defined system of village selection used in Thailand, a country in which a "worst-first" strategy has been pursued. There, villages are ranked according to their need for water and those villages with "very extreme need" or "extreme need" are given the highest priority (Saunders and Warford, 1976). In countries with a viable rural water supply program, however, there seems to be built-in bias in the system of selection which, for several reasons, works against the very poorest villages and areas. In most Latin American and several Asian countries, villages must contribute some portion of the cost of the construction of the system, a contribution to be made in terms of money, labour or both. Many times, the required local contribution is more than can be feasibly given through labour and local materials so that at least some monetary contribution is necessary. Villages too poor or to backward to raise the required local contribution are therefore usually unable to participate in the water supply programme.

In countries where the criteria for selecting villages for participation in rural water supply programmes are loosely defined, those villages that agitate, petition and frequently demand assistance are those that receive the systems first. And those villages first to recognise the value of potable water system, and to be the most effective agitators for water supply systems, are generally populated by relatively better educated and higher income people. Here again, it is not the poorest rural areas which receive the first systems. Examples are found in Peru (Saunders and Warford, 1976).

The Inter-American Development Bank (IDB) and the Pan American Health Organisation (PAHO) have discussed a formula for choosing which villages in a country or region be supplied with water first. One version of the formula developed by the PAHO and used experimentally by the IDB is as follows:

$$I = 100 . \frac{P}{C - A} . r.k \quad \text{------------} \quad (1)$$

where I is the index of project selection priority; P/C-A is the inverse of the cost per capita of the system (excluding distribution network cost); P is the design population; C is total cost, A is the counterpart contribution supplied by the community; r is the index of physical availability of water; while k is the index of the concentration of houses in the community. This index (I) tends to assign a higher priority to villages which require the lowest per capita investment by the national water agency. The result would be consistent with a strategy of maximising the number of villages served (Saunders and Warford, 1976).

The plans for public water supplies in Nigeria have been based on projected increase in the total population (Akintola and Areola, 1980), and although financial allocations to these plans in Nigeria have also increased over the years, in real terms, the percentages of the total expenditure allocated to water supplies have been decreasing (Table 2).

TABLE 2: Financial allocation to water supply in the National Development Plans of Nigeria (Ayoade and Oyebande, 1983).

Period	Capital expenditure on water (million Naira	Percentage of total capital expenditure
1946-1955	17.125	15.1
1955-1960	35.000	7.7
1962-1968	54.000	4.0
1970-1975	105.400	5.0
1975-1980	930.400	2.8

Despite the large amount of money allocated and spent on water supply provision inadequacy of public water supply still prevails in Nigeria. Although about ₦518.5 million was spent by all the state governments on water supply projects during the Third Plan period, representing 48.7 percent (%) of the total plan allocation for the sub-sector (social sector), water supply problems still persist in the rural areas. This can be seen in Table 3 showing the water supply coverage for fifteen states in 1978.

From Table 3, it can be seen that inadequacy of public water supply still persist in Nigerian rural areas, with only 18% of the rural areas served with water. This leaves a lag of 82% of rural areas of Nigeria with public water supply. Also, an insignificant value of 2% of the rural areas of the fifteen states of Nigeria have pipeborne water. Generally, only 16 million people representing 27% in the 14 states (with 60 million people) were served with piped water supply. This is very small indeed.

It is because of the inadequacy of water supply and considering its important role to the health, well-being and general quality of life of citizens in human settlements, that the Federal Government of Nigeria increased its allocation on water supply in the Fourth Plan period (Table 4).

The total provisions in the plan by all Governments for this sector is ₦3.116 billion as shown in Table 4. The Federal Government's direct contribution in the area of water supply during the plan period will take two main forms:

1. The exploitation of underground water resources under which the Federal Ministry of Water Resources would drill 1500 boreholes all over the country, at an estimated total cost of ₦104 million.

TABLE 3: Coverage of water supply in fifteen states in 78 (Federal Republic of Nigeria, 1981)

	Area '000 km²	Total Pop. (million)	No. of centres (urban)	Urban % served	Rural % served	Rural % served by piped water	pop. served by piped water (million)
Anambra	17	5.69	32	37	64	9	1.0
Borno	117	4.53	18	70	0	-	0.5
Benue	43	3.53	8	80	88	-	0.2
Cross River	28	5.08	19	85	8	5	1.1
Gongola	100	3.50	17	31	2	-	0.2
Imo	12	5.00	9	100	20	1	0.7
Kaduna	70	6.40	22	31	13	4	0.7
Kano	43	8.36	20	n.a	n.a	n.a	n.a
Kwara	154	2.70	21	85	13	2	0.8
Lagos	134	4.53	4	94	4	-	2.2
Oyo	22	7.60	24	79	n.a	n.a	6.0
Ogun	16	2.60	10	100	14	10	0.8
Plateau	53	2.19	19	83	0.0	-	0.6
Rivers	28	2.02	13	66	35	1	0.3
Sokoto	64	6.55	16	100	39	-	0.9
Total		68.13	239	68	18	2	16.0

Note: n.a. = Not available.

2. The design and construction of five storage reservoirs per state, at an estimated total cost of ₦35 million. These two projects are designed to supplement the effort of the State Governments especially in rural areas (Federal Republic of Nigeria, 1981).

The State Governments' water supply programmes are to bring immediate relief to many areas of the states which had been without adequate water for a long time. To this effect, the drilling of many boreholes has been undertaken by many states particularly those in the north. Also, states like Ogun, Oyo, Ondo, have adopted a strategy of constructing earth dams to create reservoirs from which a host of villages around could be served with pipeborne water. The total estimated expenditure by all state Governments for the plan period (1981-1985) is ₦2.805 billion. The Local Governments will be expected to make modest but useful contribution to water supply in their various areas. The projects they will undertake consist mainly of boreholes drilling in villages that are distant from the existing pipelines. The total estimated investment by level of Governments for the plan (1981-1985) period is ₦311.824 million.

From the above analysis of the different allocations made by the Federal Government in her different development plans, it can be seen that the allocations are constantly increasing. That the problem of rural water supply in Nigeria still persists despite all these huge plan allocations makes one to doubt whether these plan allocations are really implemented. Nevertheless, the problem of rural water supply is a challenge that must be tackled since the rural people constitute a major part (over 75%) of the general polity of the people of Nigeria. These rural peoples are also the nucleus of the agricultural production of the country. Why then do the rural areas not have potable water and other basic social amenities (at least half) like their counterparts in the urban areas. The rural people are hardworking, productive, obedient, and pay their taxes despite their low income. They also provide for themselves the basic social amenities such as electricity, health care centres, schools and pipeborne water through village/community effort. This, not only marginalises their already scanty income but leaves the rural man in a state of perpetual poverty and hunger.

Water should be provided to the rural areas free to justify their large numbers and to justify the taxes they pay since they lack virtually most of the basic social amenities. The rural people should be brought into the system by providing the essential basic amenities free

TABLE 4: Summary of allocation for the water supply sector, 1981-1985 (Federal Republic of Nigeria, 1981

State	State Govt., Allocation	Local Govt., Allocation	Total Naira (million
Anambra	126.728	52.000	178.728
Bauchi	123.231	20.000	143.231
Bendel	260.585	30.000	290.588
Benue	60.000	10.007	70.007
Borno	150.000	28.523	178.523
Cross River	102.300	33.500	135.800
Gongola	84.590	9.580	94.170
Imo	120.000	21.000	141.000
Kaduna	217.850	10.090	227.940
Kano	180.000	14.455	194.455
Kwara	104.000	5.105	109.105
Lagos	453 790	0.040	453.830
Niger	94.700	14.340	109.040
Ogun	102.631	1.637	104.268
Ondo	139.090	1.830	140.920
Oyo	164.871	2.587	167.458
Plateau	143.160	48.330	191.490
Rivers	71.700	8.800	80.500
Sokoto	105.800	-	105.800
Total all States	2,805.026	311.824	3,116.850
* Federal	-	-	-
Grand Total	2,805.026	311.824	3,116.850

* Federal Government contribution is taken care of under water Resources sub-sector of the agricultural sector.

(or at least the rural people contributing a small percentage of the total cost) of the charge. We take the view that since the urbanites do not pay directly for their tarred roads, hospitals, electricity, schools, and pipeborne water, all lacking in most rural areas, rural water should be equitable to tarred roads or electricity, provided in urban areas. This is because it is when the people have clean and constant water supply that they can have the strength and time to pursue other economic activities. This is a challenge to the 'Directorate of Foods, Roads and Rural Infrastructure (DFRRI)' established by the Federal Government of Nigeria in 1986. This Directorate is charged with, among others, to mount a virile programme of development monitoring and performance evaluation, and to undertake the construction of about 60,000 kilometres of rural feeder roads.

Isiala-Ngwa suffers from acute water shortage which has persisted over time despite the numerous attempts by the people to salvage the situation. It is therefore our opinion that since this water problem in the area remains unsolved for decades, whatever water development strategy adopted or is existing in the area is inadequate and therefore ineffective, and not in tune with the public water needs of the people. In this thesis, it is our basic assumption that the problem of rural water supply in Isiala-Ngwa can be minimised if not fully corrected by the adoption of the following facets of water development strategies. Thus:

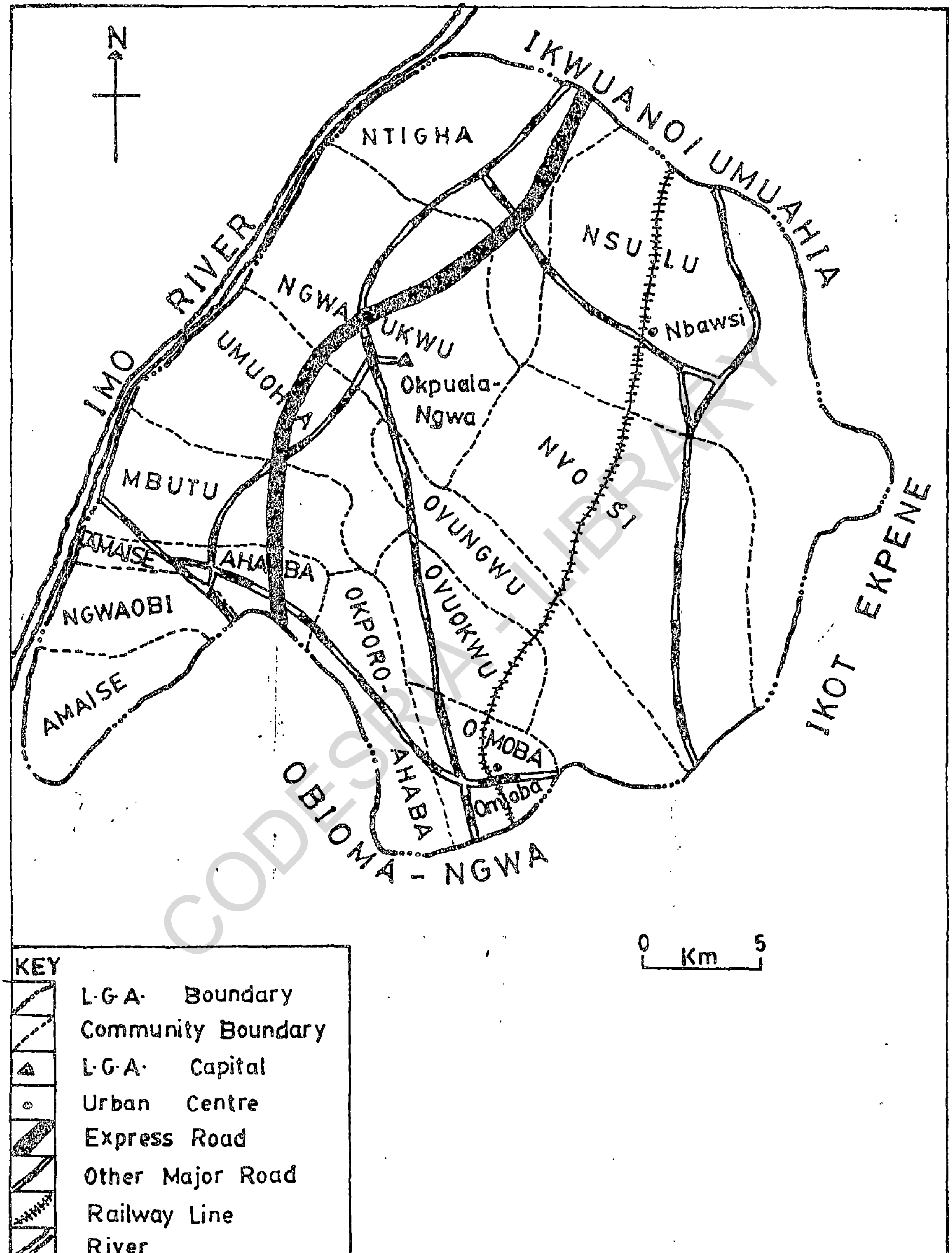
1. Provision and maintenance of boreholes and pipeborne water. This can be in form of the provision of mono-hand pumps in some selected villages having acute water problem.
2. The construction of deep village wells.
3. Pumping water from streams to serve areas with its catchment area.
4. Building of large central storage tanks.
5. Increase in the numbers of public standpipes and repairing those that are non-functional.
6. Protection of water sources against water pollution.
7. Grading the access roads leading to streams, springs and ponds, and providing adequate drainage on the side of the road.
8. Provision of water tankers by the state/local governments to serve villages that face acute water problem.
9. Provision and proper maintenance and fuelling of pumping plants by the water Board to facilitate constant supply of water.

1.6 Research Methodology:

In carrying out this research, questionnaires were designed and utilized (Appendix A). A questionnaire survey of 644 households in Isiala-Ngwa was conducted from July to November, 1987.

For the survey, Isiala-Ngwa was divided into the 13 major communities discussed in section 1.3.4 (Fig.4). Random samples of the people in churches, schools, market places and residential areas were served the questionnaires. The respondents sampled outside their places of residence indicated the part of the community where they reside. With this information, it was possible to separate the questionnaires into the 13 communities based on the addresses. However, some people did not respond to the questionnaires. This may either be due to some personal reasons or because they did not understand the necessity for filling out the questionnaires. Because of this, it was impossible to recover the anticipated 644 household questionnaires and on the whole, 501 households responded. A household in this case is defined as a married person with a family or an unmarried person of at least 20 years of age living alone and catering for himself/herself.

The distribution of the 501 sampled households among the 13 communities is presented in Table 5. The 501 sampled households represents a total sampled population of 4,309



FIG·4: ISIALA-NGWA SHOWING THE SAMPLED COMMUNITIES·
(Source: Isiala-Ngwa Planning Office·)

for the whole area. We used the mean number of persons per household in each community to find the total sampled population for each community. This is done by multiplying the number of sampled households by the mean number of persons per household as shown in Table 5. This is because we are dealing with households and not individuals.

As shown in Table 5, when the total sampled population of 4,309 people is compared with the 1987 projected population of 310,245 to find the percentage of sampled population, we got a mean of 2.15% (column 6). Eventhough this percentage looks small, it is acceptable considering the nature of our research. This is because the respondents from a particular village/community will almost give the same or similar answers to a particular water problem. Therefore, there is no need for unnecessary duplications since we are interested in knowing the water supply situation in many villages/communities. As a result of these reasons, we accept the sampled population as been representative of the entire rural area under study.

Data were collected concerning the sources of water in the area, the estimated distance travelled in search of water and the time spent, the quantity of water supplied and used, the estimated quantity demanded, the deficiency in supply and the causes of such deficiency. Respondents estimated the amount of water demanded and consumed by

TABLE 5: Number of households sampled in the different communities and their 1987 projectd population

Communities	No. of sampled households	Mean No. of Persons per household	Total Pop. sampled	Pop. of the area (1987)	% of Sampled pop.
Amaise	32	8	256	5,049	5.0
Amaise-Ahaba	26	9	234	8,099	3.0
Mbutu	35	9	315	25,929	1.0
Ngwaobi	29	9	261	5,966	4.0
Ngwaukwu	48	9	432	29,589	2.0
Nsulu	66	8	528	80,059	1.0
Ntigha	29	9	261	29,843	1.0
Nvosi	56	9	504	46,209	1.0
Okporo-Ahaba	42	8	336	11,242	3.0
Omoba	23	8	184	17,931	1.0
Ovungwu	43	9	387	17,966	2.0
Ovuokwu	35	9	315	15,080	2.0
Umuoha	37	8	295	17,565	2.0
Total	501	9	4309	310,245	2.15

their households in units of standard buckets (Standard organisation of Nigeria, size 30) of water per day. These bucket units were then converted to litres by the researcher. A standard bucket of size 30 has a capacity of 12 litres. Data were also collected on the problems associated with water shortage, the effects on the people and the suggestions made by them to solve these problems, and possible measures already taken to combat the problem of water supply in the area.

For the questionnaire survey, the family was the basic unit of inquiry. The head of the household or spouse (or the person who is incharge of the household activities) was always the respondent. Eventhough we made attempts to explain to the respondents what the research was intended to achieve, there are some individual subjectivities since some of the information was estimated. The subjective components of the questionnaire are thus representative of the individual's response while the overall total information obtained is representative of the household, and so in a sense may be regarded as objective. Therefore, the questionnaire response is a sample of households and not individuals.

Also used were interview schedules (Appendix B) answered by the Zonal Leader, Imo State Water Board, Isiala-Ngwa zone. The general activities of the Water Board were thus got from the Zonal Leader. Maps showing the distribution networks and other vital documents necessary for the work were also provided by the Board.

Other information and data for analysis were obtained from fieldwork and official records both published and unpublished sources. The fieldwork involved both oral interviews and field observation. Oral interviews were used to complement the answers got from the questionnaires. The oral interviews were used to find the way people use their household water, who fetches the water, and to estimate the time spent in water fetching, in order to find the proportion of time spent for other productive activities in a day. Field observations were used to check/visualize the answers extrapolated from the questionnaires on the distances travelled by people from a village to the water source as well as the time spent in fetching water from the water source. The representativeness of the locations of public standpipes in the areas where they occur were also observed. We also took an inventory of the public standpipes (both functional and non-functional) in the area (Appendix C).

The major techniques of analysis include the homogenization of the data. After the homogenization, patterns and relationships were deduced with the use of totals, means, standard deviations, percentages, pie charts, bar graphs and maps, as the major analytical tool. Principal components analysis (PCA) is used to collapse the variables into significant components explaining the underlying dimensions of the water deficiency in the area. All the statistical analysis for the PCA are performed with the aid of the statistical package for the social sciences (SPSS) (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975).

programme run on the University of Nigeria's I.B.M. 4361/4 computer (Appendix D). Minor computations are carried out on a National Panasonic 8431 electronic calculator.

1.7 Thesis Plan:

The study is divided into six chapters. It is planned in such a way as to display a sequential progression of thought and development from the introduction to the final conclusion.

The first chapter is devoted to the introduction which is subdivided into six sections. The first section deals with the statement of the problem. Here, the problems that motivated this research are advanced, while the aims we hope to achieve in this work are spelt out in section two. The third section deals with the study area as it relates to the subject matter and is subdivided into growth and development, climate, relief and drainage, pattern of settlement/residential structure, and the economy of the area. The remaining sections in this chapter deals with literature review, theoretical framework and research methodology.

Chapter two follows suit with an assessment of water demand in Isiala-Ngwa. First, attention is directed to the understanding of demand for water in rural areas of the developed and developing countries. The relationship between water demand and water consumption are discussed.

The demand for water in Isiala-Ngwa is divided into the domestic and the non-domestic components. Also, the consumption of water is divided into the domestic and the non-domestic components. The total household water demand and consumption are found for the area and compared with the Federal Government of Nigeria's standard minimum of 115 litres per capita per day. Tables, pie charts and bar graphs are used to deduce patterns and relationships.

Chapter three deals with the sources of water supply in Isiala-Ngwa. The sources of water supply in the area is divided into three, namely public, from water works; private, from wells, private boreholes, streams, springs, ponds and raincatch; and commercial, from the water vendors. The sources of water supply as well as their methods of distribution are treated. Lastly in this chapter, a summary of the pattern of sources of water supplies in the area is made.

The analysis of the deficiency of water supply follows in chapter four. This chapter starts by enumerating the spatial representation of the available water sources in the area. This is a form of water inventory. The deficiency of supply relative to demand is also treated. The factors responsible for water deficiency in the area are examined. The multivariate statistical technique used to find the factors responsible for water deficiency-principal components analysis - is explained here. Results of its application are equally analysed here during which definite conclusions are reached. The eff cts of water deficiency and their implications for the development of the area are also examined. A spatial delineation of zones of relative deficiency (priority zones) of water supply in the area are also developed.

Chapter five concerns the strategies for meeting the water needs of the area. In this chapter, the existing strategies for water development in the area are analysed. The suitability or otherwise, of these existing water development strategies are evaluated. The need for alternative strategies for water development are advanced. The case studies of the water development strategies adopted in other developing countries with similar water resource problems are also examined. This is followed by the analysis of alternative strategies for water development in Isiala-Ngwa. Some suggested new water development strategies for Isiala-Ngwa are also put forward together with the most desirable locations of water development sites in the area.

The various results obtained from our analysis are summarized in chapter six which is our last chapter.

Summaries of the major findings and recommendations are made. The conclusion of the work follows immediately after the nine recommendations. The problems encountered by this researcher in the process of this work are also contained here.

CHAPTER 2

ASSESSMENT OF WATER DEMAND IN ISIALA-NGWA

2.1. The Demand for water in Rural Areas:

The demand for water in rural areas is related to the level of development of the country in which the rural areas are situated. Because countries are of different levels of economic development, the demand for water in the rural areas will differ for developed and developing countries.

The demand for water in the rural areas of the developed countries is high, with the domestic components almost similar to their urban areas. In Western Europe, it varies between 100 and 250 litres per person per day, while the higher official forecasts, such as that for Southern England (Water Resources Board, 1966; Rees, 1973) predict 300 litres per day for 1980 and 360 litres for 2000A.D. Current domestic use in the U.S.A. already averages some 400 litres per day and official forecasts predict 660 litres per day by 1980 and 1000 litres per day by 2000 A.D. (US Senate committee, 1960; Kuiper, 1965; and Murray and Reeves, 1972).

In the developing countries, the demand for rural water is very low and the domestic component differs markedly from their urban areas. The volume of water used in the developing countries ranges from a daily mean consumption per person of a little over one litre to about 25 litres for rural areas with tap connections or standpipes (White et al, 1972; Feachem, 1973). For village dwellers who use public standpipes, the consumption is about 10-50 litres per person per day, and 15-90 litres for those with only a single tap in the household (Teller, 1963; Feachem, 1973; Frankel and Shouvanavirakul, 1973; Roure, 1973; and White, 1977). An investigation carried out by Cembrowicz (1982) in rural Togo showed that consumption from standpipes, under certain conditions, could be as high as 50-60 litres per person per day.

The demand for water for different uses and for different units of the population is varied, so also are the rates of consumption by these strata of use and units of the population. This demand depends on a number of factors such as the distribution system of the public water supply network; the accessibility and distance of the water source to the households; the number of persons in a household; the number of domestic animals kept and the type of crops grown especially by irrigation, the number of shops, hotels, schools, and hospitals in the rural areas; and the size and climate of the rural areas (Kuiper, 1965; Gin, Corey and Middlebrooks, 1966; Donaldson, 1972; Feachem, 1977; and Katzman, 1977).

The terms water demand and water consumption have been used interchangeably by several workers (Frankel and Shouvanavirakul, 1973; Rees, 1973; Katzman, 1977; Akintola and Areola, 1980; Obeng, 1980; and Hanke and DeMare, 1982). This is because the consumption of water in any geographical area determines the demand and in most cases, the factors that affect water demand also affect the consumption pattern. This may justify their interchangeable use. However, the major difference between demand and consumption is that, water consumption is usually less than the demand. Because of this, most workers (Frankel and Shouvanavirakul, 1973; Rees, 1973; Katzman, 1977; and Hanke and DeMare, 1982) have used present water consumption patters to predict and forecast future water demands for domestic and other uses. However, in this work, water demand is taken to mean the anticipated amount of water required by the rural people for their domestic and non-domestic activities. While consumption is the actual amount of water fetched and consumed by the people.

2.2 Domestic Water demand in Isiala-Ngwa:

The mean household domestic water demand for the various household activities for Isiala-Ngwa obtained from the questionnaire samples was found to be 199 litres per household per day (lpd). While the mean daily domestic per capita demand of water was found to be 23 litres per person per day (lpd) with a standard deviation of 21pd. The respondents estimated their household domestic water demand in standard buckets (standard organisation of Nigeria (SON) size 30). Since one standard bucket (SON size 30) had a capacity of 12 litres, we then converted the number of buckets demanded to litres as presented in Table 6.

TABLE 6: The Mean household domestic water demand in Isiala-Ngwa

Communities	Mean demand per household (litres)	Mean demand per person (litres)
Amaise	192	24
Amaise-Ahaba	186	21
Mbutu	180	20
Ngwaobi	188	21
Ngwaukwu	210	23
Nsulu	215	27
Ntigha	188	21
Nvosi	202	22
Okporo-Ahaba	198	25
Omoba	218	27
Ovungwu	213	24
Ovuokwu	212	24
Umuoha	184	23
Mean	199	23
Standard deviation	13	2

From Table 6, the mean domestic water demand for Omoba was seen to be the highest with 218 litres per household per day (lpd), while that of Mbutu with a mean per household water demand of 190 lhd is the least. From here, the range of the mean domestic water demand for Isiala-Ngwa is 38 litres, while the standard deviation is 13 lhd. As can be seen from Table 6, it does appear as if the mean domestic demand per household is similar from one community to another. The reason for this is that the people of Isiala-Ngwa have one culture and tradition, and therefore have similar habits and similar water needs for their domestic activities.

We obtained figures of the mean daily domestic per capita water demand to the nearest litre in each community in Isiala-Ngwa (third column of Table 6), by dividing the mean demand per household by the mean number of persons per household. From this column, Nsulu and Omoba have the highest relative mean daily domestic per capita water demand with 27 lpd each, while Mbutu has the lowest with 20lpd. From Table 6, it can be seen that the per capita water demand is generally low in all the communities. This trend can be explained by the inherent problem of water supply shortages in the area which has tended to lower the quantity of water demanded by the people. This is because, the people believe that there is little or no need to demand much water for domestic activities since there are water supply shortages.

2.2.1 The domestic water consumption pattern:

In most rural areas with particular reference to Isiala-Ngwa, the amount of domestic water consumed per household per day corresponds with the total amount of water fetched for that day by the members of the household for domestic purposes. In otherwords, the amount of water consumed in the area is a correlate of the amount of water actually fetched in the household per day. This phenomenon is due to lack of adequate water storage facilities and the long distance to the water sources, so people fetch the amount they will consume per day.

The mean household domestic water consumption for the various household activities for Isiala-Ngwa obtained from the questionnaire samples was found to be 80 litres. The mean consumption per household is found by dividing the actual mean amount of water consumed in a household in each sampled village by the member of villages sampled in each community. As discussed in section 2.2, the people also estimated their domestic water consumption in standard buckets (SON, size 30) and we converted the number of buckets of water consumed to litres as presented in Table 7.

TABLE 7: The mean daily domestic household water consumption pattern in Isiala-Ngwa

Communities	Mean No. of persons in a household	Mean consumption per household (litres)	Mean consumption per person (litres)
Amaise	8	85	11
Amaise-Ahaba	9	62	7
Mbutu	9	92	10
Ngwaobi	9	74	8
Ngwaukwu	9	77	9
Nsulu	8	110	14
Ntigha	9	96	11
Nvosi	9	95	11
Okporo-Ahaba	8	65	8
Omoba	8	86	11
Ovungwu	9	70	8
Ovuokwu	9	68	8
Umuoha	8	63	8
Mean	9 (a)	80	10
Standard devation	1	15	2

Note: (a) mean number of persons in a household is found by dividing the average number (No.) of people in a household in each sampled village by the number of villages sampled in each community.

From Table 7, the mean per household water consumption for Nsulu (110 litres), Ntigha (96 litres) and Nvosi (95 litres) are the highest, while Amaise-Ahaba (62 litres), Umuoha (63 litres), and Okporo-Ahaba (65 litres) are the lowest.

By dividing the mean consumption per household by the mean number of persons per household, we obtain figures of the mean daily domestic per capita consumption of water to the nearest litre in each community in Isiala-Ngwa (fourth column of Table 7). From this column, it can be seen that the mean daily domestic per capita consumption of water is generally very low in all the communities. The highest consumption (even though very low comparatively) is 14 litres per person per day (lpd) in Nsulu, other areas with similar per capita consumption are Ntigha, Nvosi and Omoba with 11lpd each. The smallest mean daily domestic per capita consumption of 7 lpd is recorded in Amaise-Ahaba. These areas with relatively high mean per capita consumption correspond with the areas having or lying near surface streams/springs except Omoba. In the case of Omoba community, the relatively high mean per capita consumption is due to the influence of Omoba urban centre, which is more regularly supplied with water from the public supply than in most other areas. So most people from nearby villages in Omoba community come to Omoba urban centre to fetch water as well as produce consumption goods to sell to people in the Omoba railway station, schools, hospitals, and to other businessmen. This accounts for the relatively high mean per capita consumption of 11 lpd. On the other hand, Amaise-Ahaba with the least mean per capita consumption of 7 lpd, do not have any form of surface water as well as functional standpipes. These discrepances in the mean per capita consumption of water in the area result to the high range of 7 lpd (that is, highest lpd minus the lowest) with a standard deviation of 2 lpd as shown in Table 7. From the analysis so far, the domestic water consumption patterns in Isiala-Ngwa Local Government Area are therefore extremely low.

2.2.2 The pattern of the mean domestic water use for different household activities.

The pattern of the mean domestic water use for the different household activities show that the bulk of household water is used for drinking, washing (plates/clothes), cooking and bathing. Other less important uses include water for fermenting cassava and for washing of tapioca. Table 8 and Figure 5 show the pattern of the mean domestic water use for the different household activities.

From Table 8, it can be seen that water for drinking, washing (plates/clothes), cooking and bathing (second column) have the highest mean percentage (%) of 64. This is followed by water used for scrubbing (11%), water for washing toilets (10%), water for washing cars/motor cycles/ bicycles (9%), and lastly water for fermenting cassava and washing of tapioca (6%).

Figure 5 clearly depicts the consumption pattern of the mean domestic water use for the different household activities shown in Table 8. Water for drinking, washing (plates/clothes), cooking and bathing is the highest in all the communities while that for fermenting cassava and washing of tapioca is the smallest with 6%.

It can also be seen from Fig.5 that the lowest mean percentages of household water used for drinking, washing (plates/clothes), cooking and bathing occur in Nsulu, Ntigha Nvosi and Omoba with 46%, 50% 51% and 42% respectively. This trend is explained by the fact that these areas with the exception of Nvosi and Omoba, have surface streams/springs where people go to wash their clothes and at times bathe before returning home. Conversely, these four areas have the highest household water used for washing cars/motor cycles/bicycles with Nsulu (20%), Ntigha (17%) Nvosi (10%) and Omoba (17%). Nsulu and Omoba use the highest mean household water percentages

TABLE 8: The pattern of the mean domestic water use for the different household activities in Isiala-Ngwa (in percentages).

Communities	Drinking, washing (clothes/plates) cooking, bathing (%)	Scrubbing floors (%)	Washing cars/bicycles (%)	Fermenting cassava/washing of tapioca (%)	Washing toilets (%)
Amaise	74	8	4	4	10
Amaise-Ahaba	73	9	3	5	10
Mbutu	65	13	8	6	8
Ngwaobi	69	13	6	6	6
Ngwaukwu	69	11	5	6	9
Nsulu	46	15	20	6	13
Ntigha	50	13	17	8	12
Nvosi	51	18	10	12	9
Okporo-Ahaba	67	10	8	3	12
Omoba	42	8	17	7	26
Ovungwu	73	7	5	6	9
Ovuokwu	77	8	4	6	5
Umuoha	75	9	4	7	5
Mean	64	11	9	6	10
Standard deviation	12	13	6	2	5

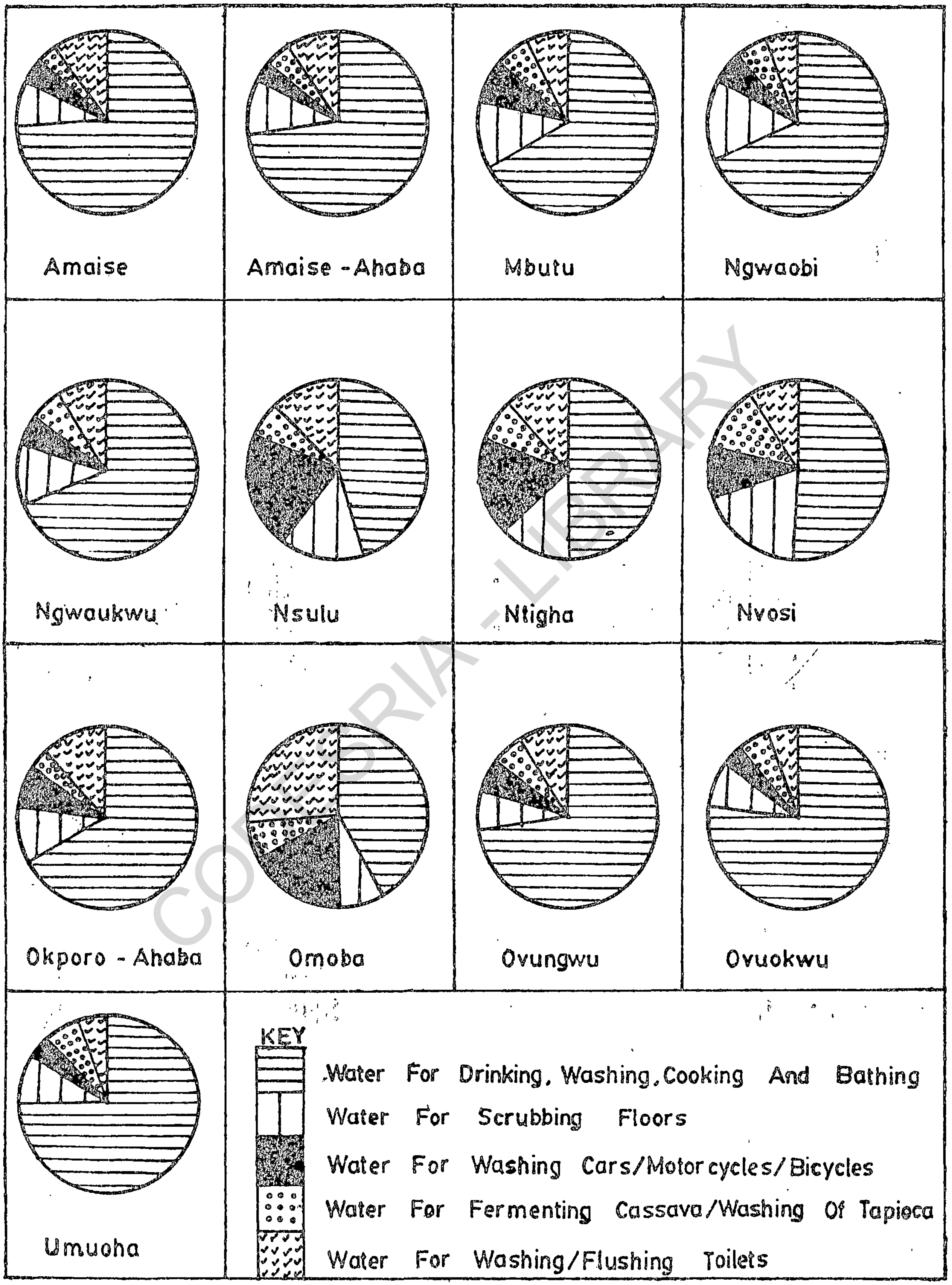


FIG. 5 : THE PATTERN OF DOMESTIC WATER CONSUMPTION FOR DIFFERENT HOUSEHOLD ACTIVITIES IN ISIALA - NGWA.

for washing/flushing of toilets, with 13% and 26% respectively. This pattern is also explained by the fact that these two communities have urban centres at Nbawsi (Nsulu Community) and Omoba (Omoba community) with modern water systems. They thus consume much more water in washing and flushing their toilets compared with other communities that mainly make use of pit latrines. The generally low percentages of water used in fermenting cassava and washing of tapioca are due to the fact that people have started to move away from eating fofoo ("Akpo") to eating garri. Also at times people carry their cassava to the streams (where they exists) to ferment. Also many people do not engage in preparing tapioca due to the large amount of time involved. This also helps to account for the relatively small standard deviation of 2%, as shown in Table 8.

2.3 <u>Non-domestic water demand in Isiala-Ngwa</u>:

This includes all the water utilized in the household for purposes outside those of general sanitation, drinking and other domestic purposes outlined in section 2.2.2. Non-domestic water demand therefore includes all household water used for production (or the creation of utility goods) such as oil palm processing and house building.

The mean household non-domestic water demand for the various non-domestic activities for Isiala-Ngwa obtained from the questionnaire samples was found to be 909 lhd. While the mean non-domestic per capita water demand was found to be 106 lpd with standard deviation of 12 lpd. As in section 2.2, the same respondents estimated their household non-domestic water demand in standard buckets (SON, size 30), jerry cans (SON size 50) and in drums (SON medium size). The capacities of the water containers were found to be 12 litres for size 30 bucket, 35 litres for size 50 jerry can, and 110 litres for medium size drum. With these capacities known, we therefore did the conversion as presented in Table 9.

From Table 9, it can be seen that Omoba and Ovungwu have the highest mean non-domestic demand with 1067 and 1034 litres per household respectively. While Amaise has the smallest with 766 litres per household. The range of mean non-domestic water demand in Isiala-Ngwa is thus 301 litres, while the standard deviation is 101 litres per household. This high range coupled with the high standard deviation signifies that there are marked variations in the amount of water required for the non-domestic activities in the different communities of Isiala-Ngwa.

TABLE 9 : The mean household non-domestic water demand in Isiala-Ngwa

Communities	Mean non-domestic demand per household. (litres)	Mean non-domestic demand per person (litres)
Amaise	766	96
Amaise-Ahaba	836	93
Mbutu	967	107
Ngwaobi	776	86
Ngwaukwu	972	108
Nsulu	846	106
Ntigha	891	99
Nvosi	995	111
Okporo-Ahaba	788	99
Omoba	1067	133
Ovungwu	1034	115
Ovuokwu	972	108
Umuoha	904	113
Mean	909	106
Standard deviation	101	12

2.3.1 The non-domestic water consumption pattern:

The mean household non-domestic water consumption for the area was found to be 275 litres per household. This figure clearly shows that more water is used for non-domestic activities than the domestic household counterparts discussed in section 2.2.1. The per capita non-domestic water consumption obtained as discussed in section 2.2.1, was also found to be 32 lpd. As discussed in section 2.3, the people estimated their household non-domestic water consumption in standard buckets (Son size 30), jerry cans (SON size 50) and drums (SON medium size), and we converted the number of water containers consumed to litres as presented in Table 10.

From Table 10, Omoba and Nsulu have the highest non-domestic water consumption with 430 litres and 395 litres per household respectively. While Okporo-Ahaba and Amaise-Ahaba have the smallest with 175 litres and 180 litres per household respectively. The range of mean non-domestic water consumption in Isiala-Ngwa was found to be 255 litres, while the standard deviation is 86 litres per household. This high range suggests the amount of variation in non-domestic water using activities. This trend is explained by the fact that Omoba and Nsulu communities have two urban centres at Omoba and Nbawsi respectively, and people in and around these urban centres use large amounts of water in building construction. While Okporo-Ahaba and (Amaise-Ahaba are dominated by old traditional thatched houses that require lesser amounts of water. Most of the non-domestic water are used for

TABLE 10: The mean household non-domestic water consumption pattern in Isiala-Ngwa

Communities	Mean consumption per household (litres)	Mean consumption per person (litres)
Amaise	261	33
Amaise-Ahaba	180	20
Mbutu	334	37
Ngwaobi	196	22
Ngwaukwu	326	36
Nsulu	395	49
Ntigha	350	39
Nvosi	280	31
Okporo-Ahaba	175	22
Omoba	430	54
Ovungwu	248	28
Ovuokwu	215	24
Umuoha	185	23
Mean	275	32
Standard deviation	86	11

oil palm processing and palm wine mixing.

Also from Table 10 (third column), the mean per capita non-domestic water consumption for Omoba (54 lpd), Nsulu (49 lpd), Ntigha (39 lpd), Mbutu (37 lpd), and Ngwaukwu (36 lpd) are the highest. While Amaise-Ahaba

(22 lpd), and Umuoha (23 lpd) are the lowest. This gives a range of per capita non-domestic water consumption of 34 lpd, with a standard deviation of 11 lpd for Isiala-Ngwa. Generally, the per capita water consumption for non-domestic activities is greater than those of the domestic activities. Nevertheless, the pattern of the per capita non-domestic water consumption for Isiala-Ngwa is still very low comparatively. The areas with relatively high per capita non-domestic water consumption correspond with the areas having surface streams and springs except Omoba. Whereas Amaise-Ahaba, Ngwaobi and Okporo-Ahaba with the least per capita do not have any form of surface water. So there is a relationship between the physical availability of surface water and the amount consumed for non-domestic activities.

2.3.2 The pattern of non-domestic water use for different activities:

Table 11 and Fig. 6 show the percentage distribution of household non-domestic water consumption for different activities in the communities of Isiala-Ngwa. The pattern shows that oil palm processing uses the highest amount of water with 34%, closely followed by water for building houses which has 33%. While water required for plants has the lowest with 8%

TABLE 11: The consumption pattern of different non-domestic household water activities (in percentages)

Communities	Water for building (%)	oil Palm processing (%)	Watering plants (%)	Feeding animals (%)	Mixing palm-wine (%)
Amaise	36	29	5	14	16
Amaise-Ahaba	36	35	4	10	15
Mbutu	29	37	8	12	14
Ngwaobi	33	31	5	7	24
Ngwaukwu	35	39	8	6	12
Nsulu	29	29	10	18	14
Ntigha	33	34	16	7	10
Nvosi	31	36	5	12	16
Okporo-Ahaba	36	35	5	10	14
Omoba	41	24	9	15	11
Ovungwu	34	41	8	4	13
Ovuokwu	28	34	7	5	26
Umuoha	33	39	8	7	13
Mean	33	34	8	10	15
Standard deviation	4	5	3	4	5

Overall, the highest percentage of non-domestic water consumption allocated for building structures is used by Omoba (41%). While that for oil palm processing is used by

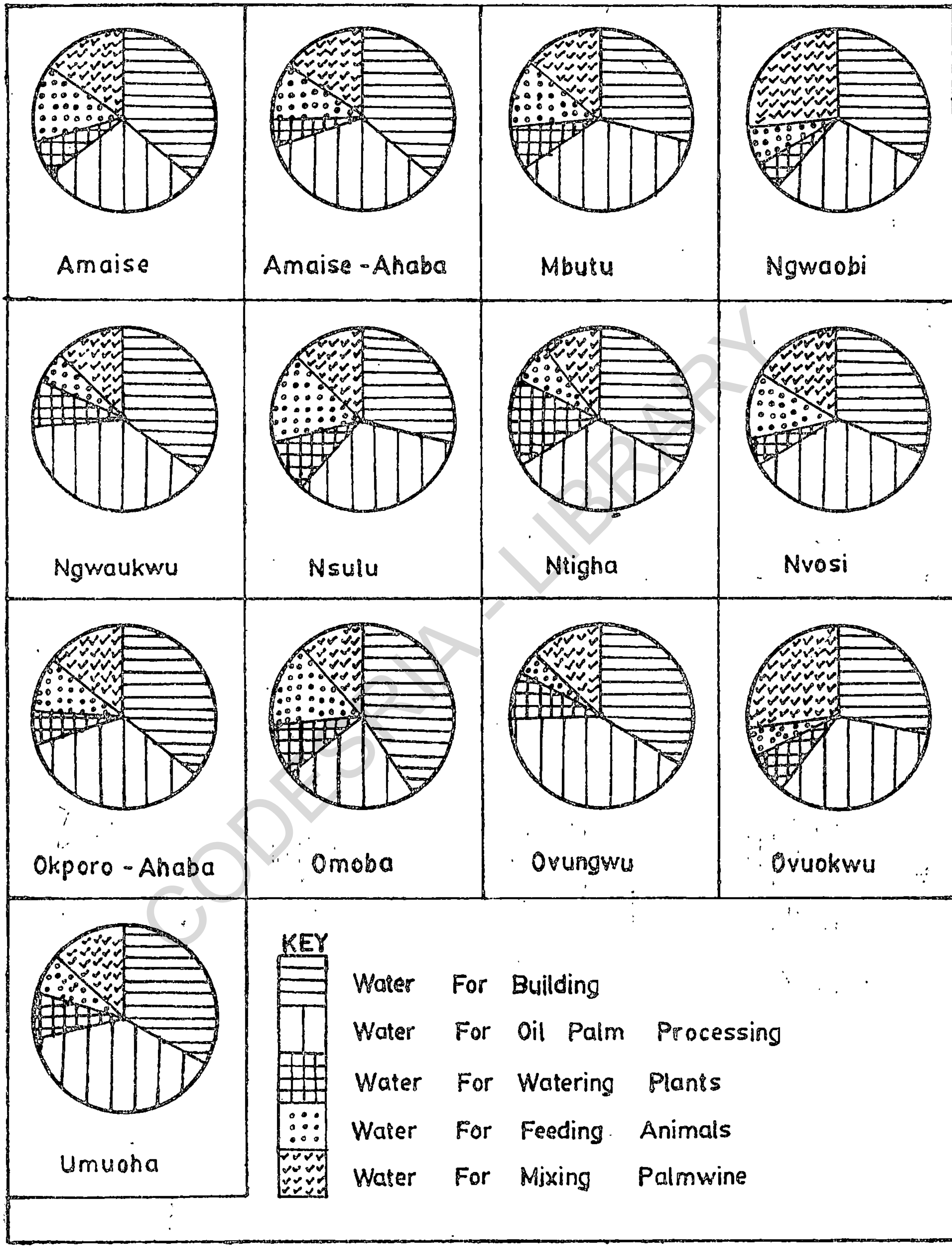


FIG. 6 : THE PATTERN OF THE NON-DOMESTIC WATER CONSUMPTION FOR DIFFERENT ACTIVITIES IN THE COMMUNITIES OF ISIALA-NGWA.

Ovungwu (41%), and that for watering of plants is used by Ntigha (16%). The water for feeding of animals is used by Nsulu (18%), while that for mixing of palm wine is used by Ovuokwu (26%). Generally, the amount of water used for building and oil palm processing is high in all the communities. In the case of non-domestic water used for building, there is a range of 13% with a standard deviation of 4%. While the water used for oil palm processing has a range of 17% with a standard deviation of 5. It is only in Omoba that a small percentage of water is used for oil palm processing. This pattern may be due to the fact that most people in Omoba community are immigrants who engage in one business or the other and thus leaving oil palm processing to very few people, mainly the indigenes. Ovuokwu on the other hand, has the least percentage of water used for building structures. This may be due to the fact that the people of the area have not fully diffused the influence of modernisation as most of their buildings are still dominated by the old traditional thatched buildings.

Table 11 and Fig.6 also show that the percentage of water used for watering of plants and feeding of animals is the least.

The percentage range of water used for watering plants is 11% with a standard deviation of 3%, while the range of water used for feeding animals is 14% with a standard deviation of 4%. The percentage distribution of water used for both watering of plants and feeding of animals is very small in all the communities. This may be due to the fact that the people have not yet recognised the importance of watering their plants and feeding of their animals with adequate amount of water in order to increase the productivity. On the other hand, the low percentage may be due to the fact that the people use the small amount of available water for the other non-domestic activities such as building constructions and oil palm processing.

2.4 The Total household water demand and consumption pattern in Isiala-Ngwa:

2.4.1 The total household water demand pattern:

The mean household water demand for Isiala-Ngwa was found to be 1108 lhd with a standard deviation of 108 lhd. The range of household water demand is 327 lhd varying from 958 lhd for Amaise to 1285 lhd for Omoba. This large variation signifies that different communities in Isiala-Ngwa require different amounts of water for their domestic and non-domestic activities as discussed in sections 2.2. and 2.3. The mean household water demand was found by summing up the mean household domestic water demand and the mean household non-domestic water demand as shown in Table 12. The mean per capita water demand for all the communities of Isiala-Ngwa was also found to be 129 lpd with a standard deviation of 13 lpd.

From Table 12 and Fig.7, the mean household water demand for both domestic and non-domestic activities in Omoba (1285 lhd), Ovungwu (1247 lhd), and Nvosi (1197 lhd) are the highest. While that of Amaise (958 lhd), Ngwaobi (964 lhd), and Okporo-Ahaba (986 lhd) are the least. The reasons for this have been discussed in sections 2.2 and 2.3. What is most evident from Table 12 is that all the communities in Isiala-Ngwa, except Amaise-Ahaba and Ngwaobi, have a per capita water demand above the Federal Government of Nigeria's minimal standard of 115 lpd.

2.4.2 <u>The total household water consumption pattern</u>:

The mean household water consumption for Isiala-Ngwa was found to be 355 lhd. There is however a great

TABLE 12: The mean household water demand pattern in Isiala-Ngwa :

Communities	Domestic demand (Litres)	Non-domestic demand (litres	Total demand (litres)	Per capita demand (litres
Amaise	192	766	958	120
Amaise-Ahaba	186	836	1022	114
Mbutu	180	967	1147	127
Ngwaukwu	210	972	1182	131
Ngwaobi	188	776	964	107
Nsulu	215	846	1061	133
Ntigha	188	891	1079	120
Nvosi	202	995	1197	133
Okporo-Ahaba	198	788	986	123
Omoba	218	1067	1285	161
Ovungwu	213	1034	1247	139
Ovuokwu	212	972	1184	132
Umuoha	184	904	1088	136
Mean	199	909	1108	129
Standard deviation	13	101	108	13

variation in the amount of water consumed in the various communities. There is thus a range of 276 lhd with a standard deviation of 98 litres. The mean household water consumption was found by summing up the mean household

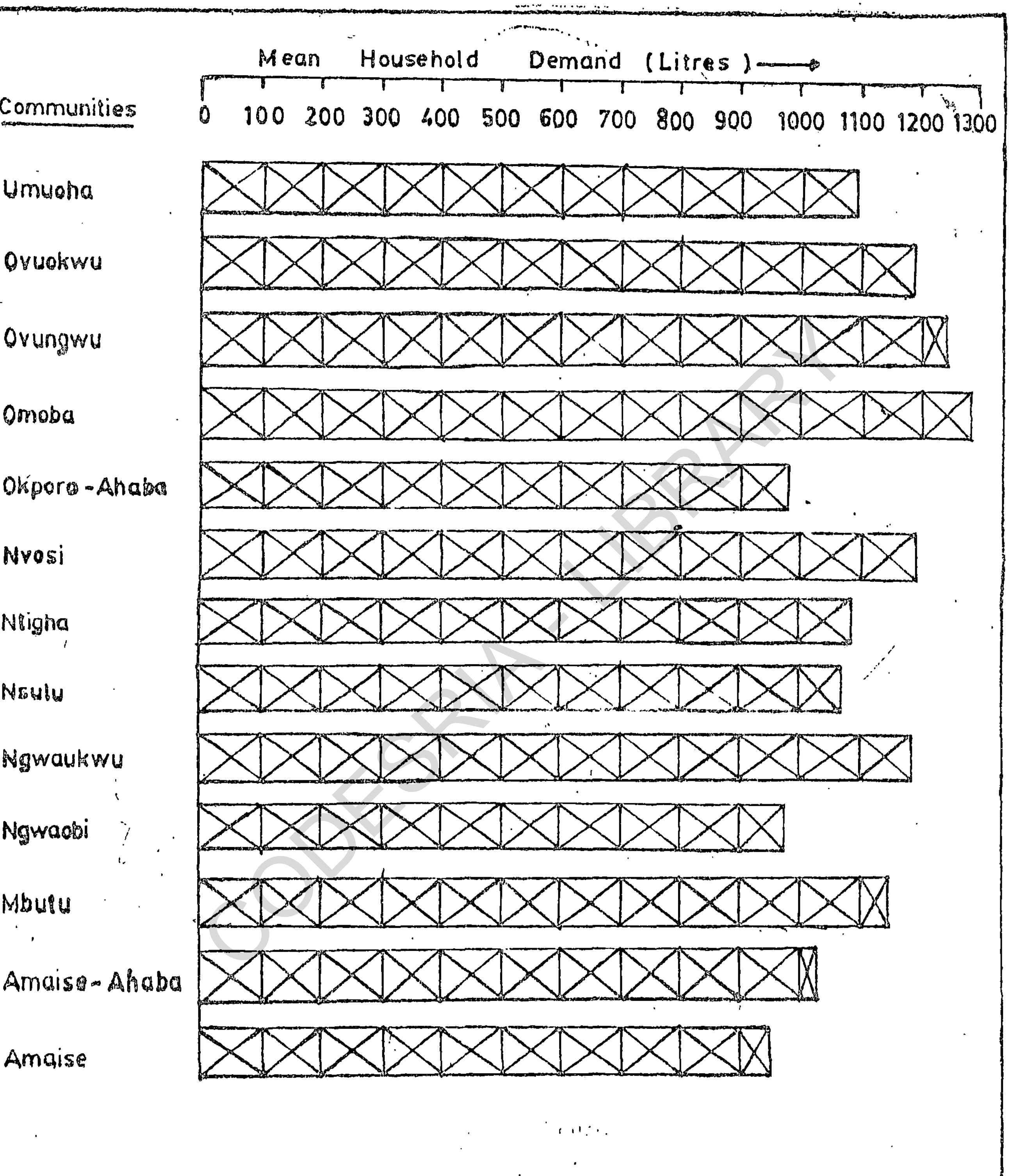


FIG. 7 : MEAN HOUSEHOLD WATER DEMAND PATTERN IN ISIALA-NGWA.

domestic water consumption and the mean household non-domestic water consumption as discussed in sections 2.2.1 and 2.3.1. The mean per capita water consumption for all the communities of Isiala-Ngwa was also found to be 42 lpd. The per capita water consumption in Isiala-Ngwa ranges from 27 lpd to 65 lpd. This gives a range of 38 lpd and a standard deviation of 13 lpd as shown in Table 13. The per capita water consumption was calculated by dividing the mean household water consumption by the mean number of persons per household in the communities of Isiala-Ngwa, and this is shown in Table 13.

From Table 13 and Fig.8, the mean household water consumption for both domestic and non-domestic activities in Omoba (516 lhd), Nsulu (505 lhd), Ntigha (446 lhd) and Mbutu (426 lhd) are the highest. While that of Okporo-Ahaba (240 lhd), Amaise-Ahaba (242 lhd), Umuoha (248 lhd) and Ngwaobi (270 lhd) are the least. The reasons for this type of pattern have been discussed in sections 2.2.1 and 2.3.1. What is most evident from Table 13 is that there is a relationship between the amount of water consumed for the domestic activities and that of the non-domestic activities. Thus, areas

TABLE 13: The mean household water consumption pattern in Isiala-Ngwa

	Domestic consumption (litres)	Non-dome domestic consumption (litres)	Total consumption (litres)	Per capita consumption (litres)
Amaise	85	261	346	43
Amaise-Ahaba	62	180	242	27
Mbutu	92	334	426	47
Ngwaobi	74	196	270	30
Ngwaukwu	77	326	403	45
Nsulu	110	395	505	63
Ntigha	96	350	446	50
Nvosi	95	280	375	42
Okporo-Ahaba	65	175	240	30
Omoba	86	430	516	65
Ovungwu	70	248	318	35
Ovuokwu	68	215	285	31
Umuoha	63	185	248	31
Mean	80	275	355	42
Standard deviation	15	86	98	13

with high domestic consumption also have high non-domestic values. It is only in Omoba that the non-domestic components far exceeded the domestic components. This can be explained by the fact that Omoba

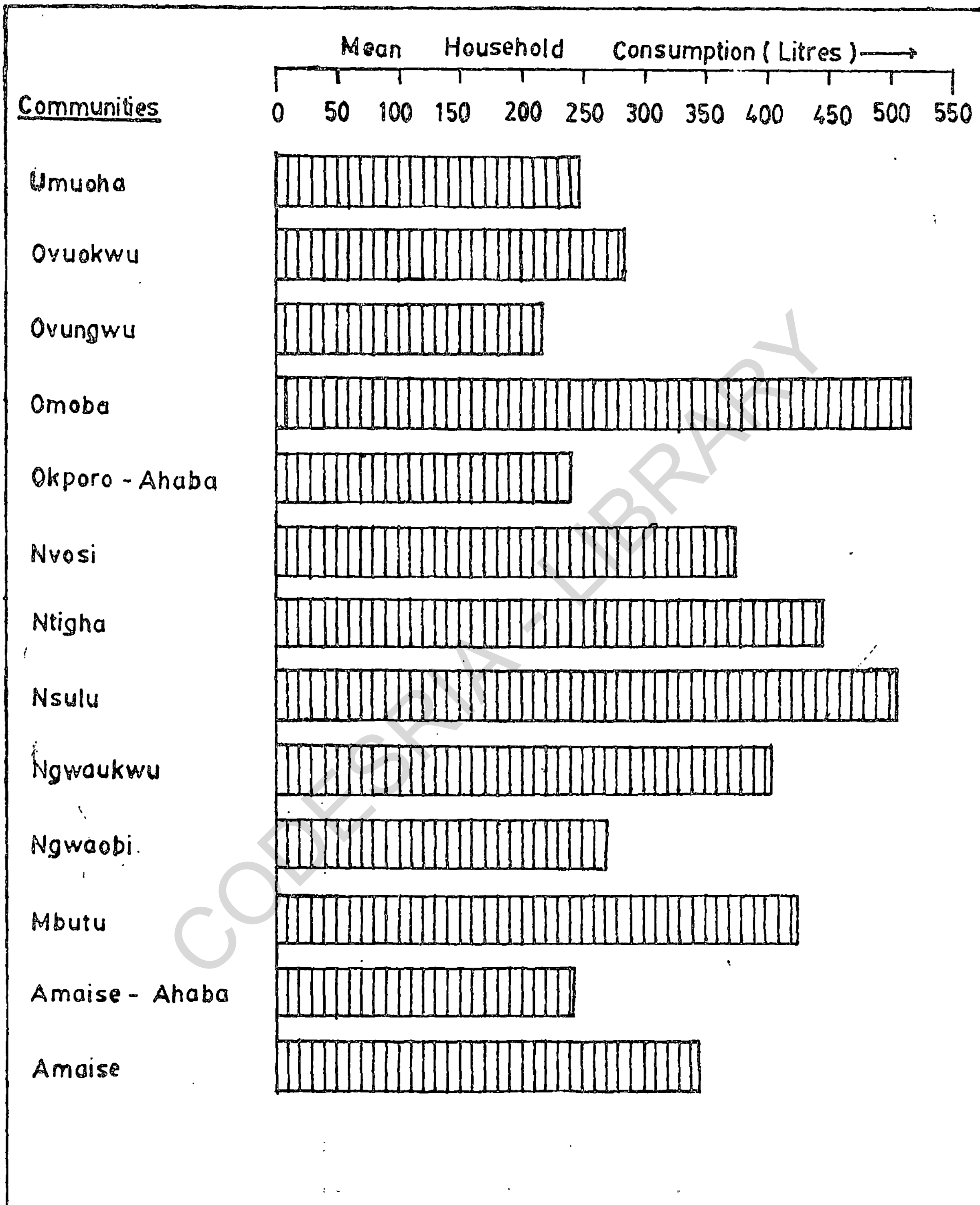


FIG- 8 : MEAN HOUSEHOLD WATER CONSUMPTION PATTARN IN ISIALA - NGWA.

has a growing urban centre and therefore requires large amounts of water for building constructions as found in Table 11 of section 2.3.2.

The per capita water consumption shown in Table 13 indicates that Omoba, Nsulu, Ntigha and Mbutu have the highest per capita consumption with 65 lpd, 63 lpd, 50 lpd, and 47 lpd respectively. While Amaise-Ahaba, Ngwaobi and Okporo-Ahaba have the least with 27 lpd, and 30 lpd each, respectively. The reasons for this pattern have been explained in sections 2.2.1 and 2.3.1. However, these communities with relatively high per capita water consumption also correspond with the more developed parts of Isiala-Ngwa. In the communities with high per capita consumption, there are railway stations (in Nbawsi (Nsulu) and Omoba (Omoba)), hospitals, schools, markets and many building constructions that require large amounts of water.

As can be seen from this analysis, what is most evident from column 5 of Table 13 is the fact that non of the communities consume up to the per capita quantity of 115 lpd recommended by the Federal Government of Nigeria for the Third National Development Plan of 1975-1980. The mean per capita water consumption for the area is 42 lpd. This is only some 36.5% of the recommended minimum. The summation of this therefore, is that water consumption patterns in Isiala-Ngwa Local Government Area are extremely low.

CHAPTER 3

SOURCES OF WATER SUPPLY IN ISIALA-NGWA

Water demand in the rural areas of developed countries is met by water works run by state organs, private companies or rural cooperatives as the case may be. In the more remote areas, these sources may be supplemented or complemented by private supplies from boreholes or wells. In the developing countries however, public water supplies to rural areas is very limited, both in amount and areal coverage. This is largely because states concentrate on supplying water to the urban areas.

Isiala-Ngwa obtains its water supplies from three sources, namely public, from the water works operated by the Imo State Water Board; private, from wells, private boreholes, streams, springs, ponds and raincatch; and commercial, from water vendors.

3.1 Public Water Supply:

By public water supply, we mean water supplied to the area by governmental agencies. In this case, the supply agency is the Imo State Water Board. The Isiala-Ngwa Zone of this Board maintains and is responsible for six water supply systems, namely:

(i) Ngwaukwu rural water works
(ii) Nbawsi rural water works
(iii) Mbutu rural water works
(iv) Ovungwu/Ovuokwu rural water works
(v) Eziama rural water works
(vi) Amaiyi rural water works.

The areal coverage of these water works systems is illustrated in Fig.9.

These systems were formerly under the Imo State Water works, Aba zone until October 1980, when they were carved out to form the present Isiala-Ngwa zone of the water board. According to the Zonal Leader of the Imo State Water Board, Isiala-Ngwa zone, the cost of these water works systems is estimated to be about ₦5 million. The infrastructure involved in these water works systems are boreholes, pumping plants, pump houses, overhead tanks, pipelines and taps.

The Imo State Water Board has its headquarters at Owerri (the capital of Imo State). The water board has zonal offices in all the 21 Local Government Areas of the state, each zonal office is headed by a zonal leader. However, the recruitment, placement and transfer of staff

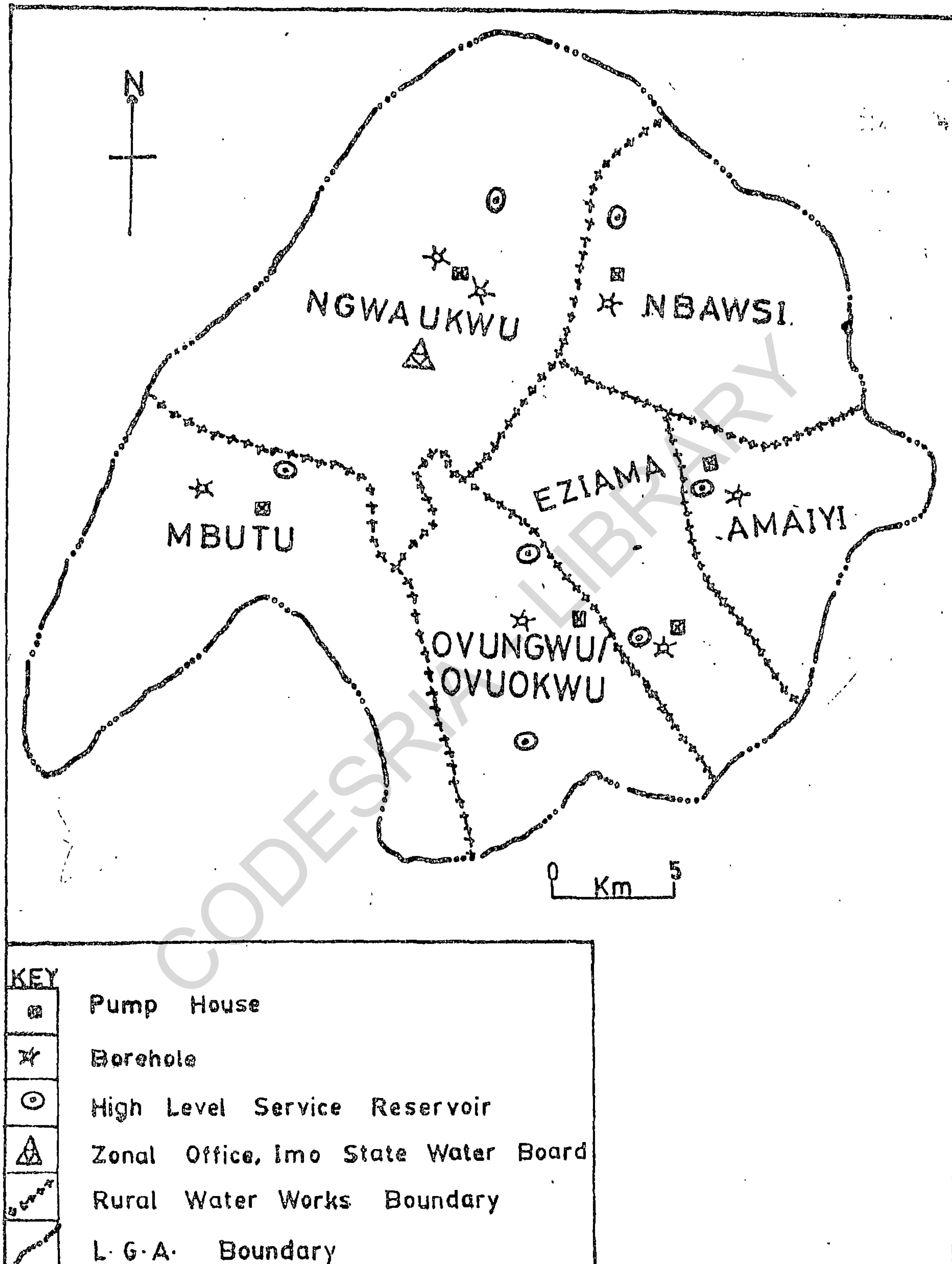


FIG. 9 : RURAL WATER WORKS IN ISIALA-NGWA.
(Source : Imo State Water Board, Isiala-Ngwa Zone, 1985)

of the zonal offices is done by the Imo State Water Board, Owerri. Also the administrative, managerial, financial and technical functions of the zonal water boards are determined and controlled from the headquarters at Owerri under the headship of the General Manager.

The Isiala-Ngwa zone of the board is headed by the zonal leader who oversees the general administration of the technical and administrative officers and workers of the zone. The Isiala-Ngwa zonal headquarters is at Okpuala-Ngwa (the Local Government Area capital). The Isiala-Ngwa zonal headquarters oversees the activities and performances of the workers of the six rural water works systems in the zone. The zonal headquarters is responsible for general administration in the form of correspondences, reports, requisition of materials and stores, transport (lorries and vans), tracing of plans, drawings and charts, and statistics (water consumption and other records including finances).

For easy administration and performance of the six water works systems, they are divided into groups called teams. Each group is headed by a Team Leader. The Team Leaders are responsible to their chief officers incharge of their water works. The Team Leaders supervise the workers and make sure that mapped out plans are properly executed. The chief officers send progress reports on the activities of their water works to the Zonal Leader at Okpuala-Ngwa for proper action. Generally, the activities of the rural water works are grouped into the following:

(i) Those responsible for the construction of supply works, pumping stations, booster stations, trunk mains and pipelines.

(ii) Those responsible for distribution and supply.

These include workers responsible for plumbing (laying and maintenance of service pipes, fittings, plumbing repairs, and testing of fittings); extensions and maintenance of mains, transport (lorries and vans), main repairs (restoration of trenches, temporary and permanent plasters) and general maintenance of properties and works.

3.1.1. <u>The distribution of Public Water Supplies:</u>

3.1.1.1. <u>Public water supply sources</u>:

The sources of water for the rural water supply works mentioned in section 3.1, come solely from boreholes. In otherwords, the Imo State Water Board, Isiala-Ngwa zone, uses a strategy based on the tapping of groundwater resources in the development of her water supplies.

The Imo State Water Board, Isiala-Ngwa Zone uses seven boreholes water works in the area (Table 14 and Fig.9). The mean depth of the boreholes used by the six rural water works in Isiala-Ngwa is about 49 metres with a standard deviation of about 5 metres below groundsurface, and this is shown in Table 14.

TABLE 14: Locations and depths of boreholes in the water works of Isiala-Ngwa
(Source: Fieldwork, 1987)

Rural water works	No. of boreholes	village located	community	Depth (metres)
Ameiyi	1	Amaiyi	Nvosi	42
Eziama	1	Eziama	Nvosi	44
Mbutu	1	Uhum	Mbutu	51
Nbawsi	1	Umunkpe kpeyi-Nbawsi	Nsulu	46
Ngwaukwu	2	Amaoji	Ngwa-ukwu	(i) 52 (ii) 53
Ovungwu/ Ovuokwu	1	Umuapu	Ovungwu	52
	Total= 7			Mean = 48.6
				Std. dev. = 4.5

The mean value of about 49 metres is some 3 metres deeper than the average depth of the water table for areas within the undulating lowland coastal plains of Eastern Nigeria (Ofomata, 1975). As can be seen in Table 14, it is only the Ngwaukwu rural water works that has two (2) boreholes.

The rural water works equip their boreholes with submersible centrifugal borehole pumps (Sumo pumps) which have a capacity of over 1 million litres per day (I.m.l.d). The boreholes are protected from outside interferences with concrete slabs which can be opened as the need arises (Plate 4). Also, each rural water works has one pumping plant of 159 kilo volt amperes (KVA) (Plate 5). The pumping plants are installed firmly on the ground in the pump house (Plate 5). The pump houses are moderately small modern cement block buildings carefully planned and protected to prevent any possible burglary of the pumping plants (or some of the parts) plates 6A and 6B). These pumping plants use diesel as the fuel.

The pumped water is stored in high level service reservoirs made of concrete (Plate 7). Their numbers, locations, and capacities are presented in Table 15, and Figs. 10-15.

PLATE 4: The Nbawsi rural water works borehole at **Umunkpeyi-Nbawsi.** **The** borehole is protected with concrete slabs.

PLATE 5: A pumping plant of 159 kilo volt amperes (KVA). Every rural water works in the area has one of this type of pumping plant.

PLATE 6A: Eziama rural water works pump house at Eziama village in Nvosi community.

PLATE 6B: Nbawsi rural water works pump house at Umunkpeyi-Nbawsi in Nsulu community.

PLATE 7: Nbawsi rural water works high level service reservoir (147,000 litres) at Agburuke Nsulu.

TABLE 15: Locations and capacities of high level service reservoirs in Isiala-Ngwa water zone (Source: Fieldwork, 1987)

Rural water works	How many	Village located	community	capacities (litres)
Amaiyi	1	Amaiyi	Nvosi	220,800
Eziama	1	Eziama	Nvosi	220,800
Mbutu	1	Egbelu-Mbutu	Mbutu	220,800
Nbawsi	1	Agburuke	Nsulu	147,200
Ngwaukwu	1	Amapu	Ntigha	690,000
Ovungwu/ Ovuokwu	2	(i) Umuhu (ii) Omoba	Nvosi	(i) 220,800 (ii) 220,800

From Table 15, it is seen that all the rural water works have one service reservoir, with the exception of Ovungwu/Ovuokwu (Ov/Ov) rural water works that has two service reservoirs. It can also be observed that Ngwaukwu rural water works has the largest service reservoir (690,000 litres) in the area, while the Nbawsi rural water works has the smallest (147,200 litres).

3.1.1.2 The volume of water supplied 1987:

As has been discussed in section 3.1, the public water supply in Isiala-Ngwa, comes from the six rural water works. Water is supplied to the public through public standpipes. However, most of the standpipes in the area are non-functional as a result of disuse and road construction. Our fieldwork determined a total of 783 standpipes in the area. Out of this number 564 are non-functional while 219 are functional (Table 16).

<u>TABLE 16:</u> <u>Details of the Standpipes in Isiala-Ngwa water zone (Source: Fieldwork, 1987)</u>

Rural water works	Total number of stand-pipes	No. of functional standpipes	No of non-functional standpipes.
Amaiyi	95	42	53
Eziama	49	9	40
Mbutu	190	30	160
Nbawsi	114	15	99
Ngwaukwu	175	87	88
Ov/Ov	160	36	124
Total	783	219	564

From Table 16, Ngwaukwu rural water works has the highest number of functional standpipes with 87, while Eziama has the least with 9. The 219 functional standpipes do not supply water for more than 24 hours per week.

In some cases, they supply water once a month (Appendix C). Generally, the functional standpipes run for an average of 2 times per week, giving a total period of 6 hours per week (that is, 3 hours per day) (Table 39). The water is usually rationed to different villages at different times and days of the week.

According to Nwokonko (1987), 118,680 litres of water are pumped out from each borehole per hour, and the period of pumping may last between 2-6 hours per day in every water works in the area. The total volume of water thus supplied to Isiala-Ngwa for the year 1987, is shown in Tables 17 and 18. As indicated in the Table, the mean quantity of water supplied for the year (1987) is 474631 cubic metres (475 million litres) with a standard deviation of 100387 cubic metres (100 million litres). This gives a daily mean supply of 7786 cubic metres (8 million litres) and a daily supply standard deviation of 1674 cubic metres (2 million litres). Note that 1 cubic metre is equal to 1000 litres. The average daily supply is computed by dividing the total quantity of water supplied for the months by the total number of days contained in these months. Also, the average daily per capita supply for the year (1987) was found to be 25 lpd with a daily

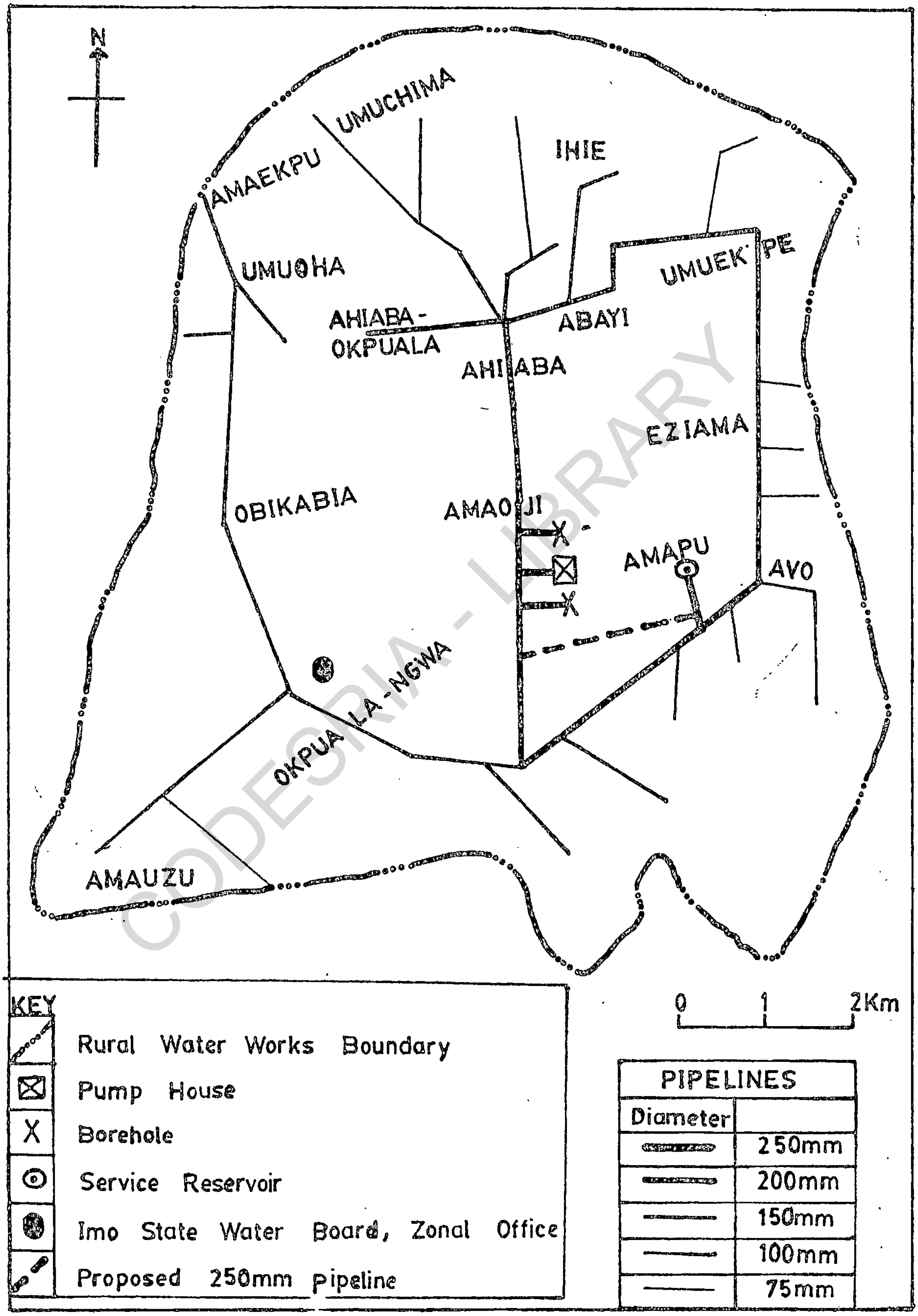


FIG- 10 : NGWAUKWU RURAL WATER SUPPLY NETWORK ·

per capita supply standard deviation of about 6 lpd. The per capita daily supplies are computed by expressing the average daily supplies in litres and dividing by the 1987 estimated population.

As can be seen from Table 17, the highest quantity of water is supplied in Ngwaukwu and Ov/Ov rural water works throughout the year. While the least is supplied in Eziama and Nbawsi rural water works. The reason for this type of pattern can be explained by the fact that the Ngwaukwu and Ov/Ov. rural water works supply water to Okpuala-Ngwa (the Local Government Area capital) and Omoba respectively, which are both young urban centres. Also, the Ngwaukwu rural water works supply water to the highest number of people in Isiala-Ngwa. The small quantity of water supplied in Eziama and Nbawsi water works can be explained by the fact that these water works supply relatively smaller number of people with water. The Nbawsi rural water works which is supposed to supply water to the villages of Nsulu community, only concentrates on supplying water to Nbawsi urban centre. As will be observed in section 3.1.1.3, Eziama and Nbawsi water works have smaller diameter pipelines which result in constant pipe burst as a result of high hydraulic pressures. As a result of this, smaller amounts of water is pumped out to the

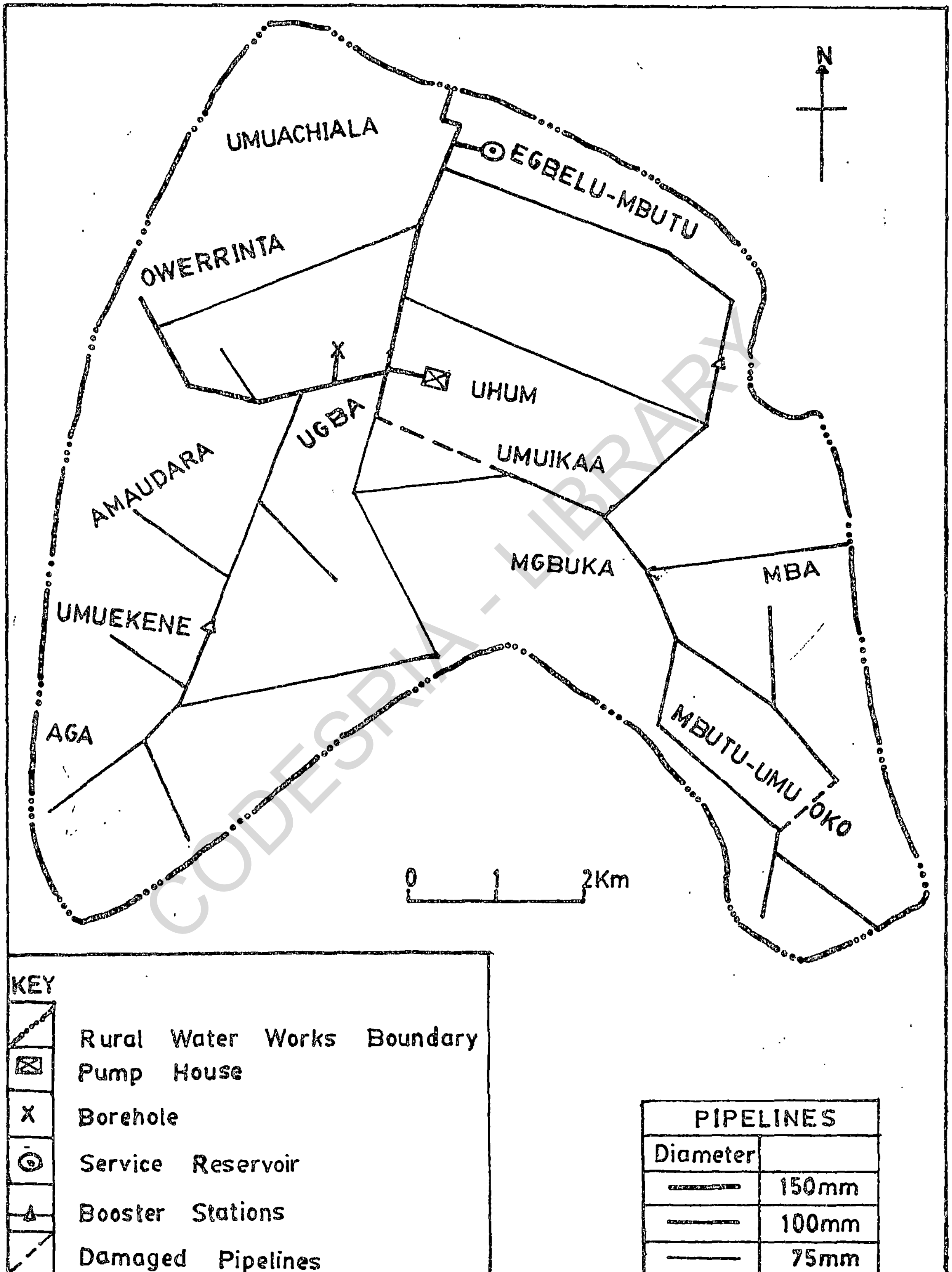


FIG. 11 : MBUTU RURAL WATER SUPPLY NETWORK.

TABLE 17: Volume of Water Supplied to Isiala-Ngwa 1987 (Source: Field work, 1988)

Months	Supply	Amaiyi	Eziama	Mbutu	Nbawsi	Ngwaukwu	Ov/ov	Totals
	Type of amount supplied in the Rural Water Works							
Jan/ Feb.	Qs	83,257	75,405	96,570	82,640	115,048	102,500	555420
	Ad	1388	1257	1610	1377	1917	1708	9257
	Pc	25	20	32	28	40	36	30
March/ April	Qs	84864	69208	87880	71875	105546	101872	521245
	Ad	1391	1135	1441	1178	1730	1670	8545
	Pc	26	20	30	25	36	30	28
May/ June	Qs	37045	20942	48061	36955	74680	64686	282369
	Ad	607	343	788	606	1224	1061	4629
	Pc	12	7	16	10	25	21	15
July/ August	Qs	72856	50796	80996	70889	104996	87443	467976
	Ad	1175	819	1306	1144	1694	1410	7548
	Pc	23	15	27	19	34	28	24
Sept./ Oct.	Qs	70680	62051	81616	77654	97222	88590	477813
	Ad	1159	1017	1338	1273	1594	1452	7833
	Pc	22	18	28	23	30	29	25
Nov./ Dec.	Qs	89442	80225	90493	88566	100761	93474	542961
	Ad	1466	1315	1484	1452	1652	1532	8901
	Pc	27	23	29	29	35	32	29

Note: Qs = Quantity supplied in cubic metres
Ad = Average daily supply in cubic metres
Pc = Mean daily per capita supply in litres.

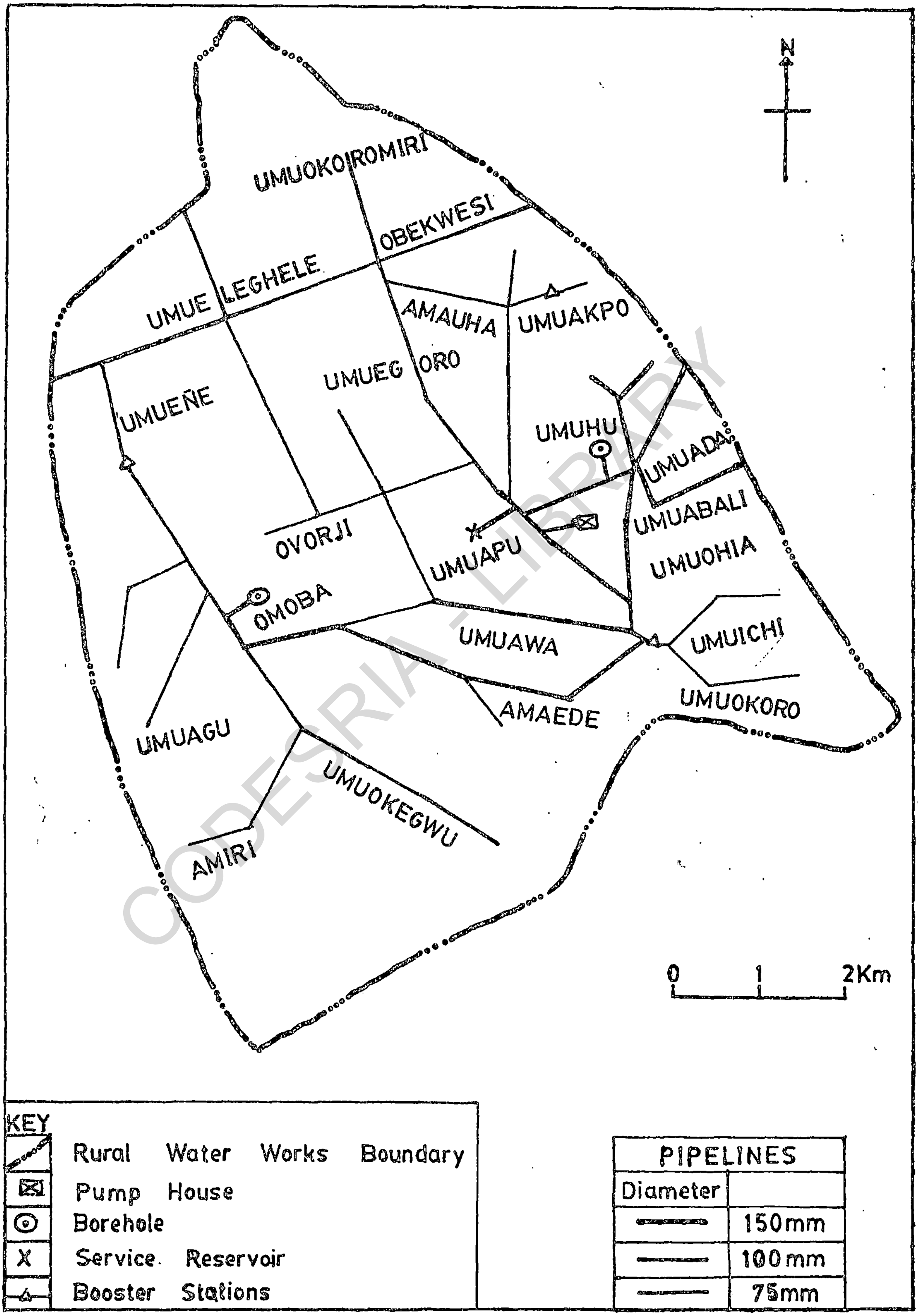


FIG. 12 : OVUNGWU/OVUOKWU RURAL WATER SUPPLY NETWORK.

consumers. Another factor that can explain for the higher quantity of water supplied in Ngwaukwu and Ov/Ov water works, is that the Ngwaukwu water works has two boreholes while the Ov/Ov has two service reservoirs as discussed in Tables 14 and 15.

What is most evident from Tables 16 and 17 is the fact that water works with greater number of functional stand-pipes supply more water than those with more non-functional standpipes. In other words, there is high relationship between the amount of water supplied and the number of functional standpipes existing in the rural water works in the area.

For clearer interpretation of Table 17, the volume of water supplied in Isiala-Ngwa is further discussed in Table 18.

TABLE 18: Summary of volume of water supplied to Isiala-Ngwa 1987 (Source: Fieldwork, 1988)

Months	Quantity supplied (cubic metres)	Average daily supply (cubic metres)	Average daily per capita supply (litres)
January-February	555420	9257	30
March-April	521245	8545	28
May-June	282369	4629	15
July-August	467976	7548	24
September-Oct.	477813	7833	25
November/December	542961	8901	29
Mean	474631	7786	25
Standard deviation	100387	1674	6

(Note: I cubic metre = 1000 litres)

From Table 18, it can be seen that the quantity of water supplied to Isiala-Ngwa by the Isiala-Ngwa water zone fluctuates throughout the year. The largest quantity of water supplied for the year 1987 (555,420 cubic metres) was supplied for the months of January and February hence giving a mean of 277,710 cubic metres per month. The least was for the months of May and June, with a mean of 141,185 cubic metres per month. The quantity of water supplied kept decreasing over the months from a total of 555420 cubic metres (January to February) to 282, 369 cubic metres (May to June), a difference of 273,051 cubic metres.

On no two different monthly periods were the quantity of water supplied noted to be constant, either a decrease or increase in the quantity supplied occurred.

The highest average daily water supply was for the months of January to February (9257 cubic metres per day), while the least average daily water supply was for the months of May to June (4629 cubic metres per day). Also the per capita daily supply values range from 30 lpd in January/February, to 15 lpd in May/June, with an overall mean of 25 lpd for the year. The differences in the average daily water supply could be explained in terms of rainfall regimes which create high water demand in the dry months of January and February, and relatively low demand in May and June when human physiology does not demand so much water and households supplement water needs with rain-catch, thus reducing demand from the public water utility source.

From the above overall mean per capita supply of 25 lpd, it can easily be observed that the supply is too low since it is not enough to bridge the 115 lpd recommended by the Federal Government of Nigeria for the Third National Development Plan of 1975-1980. When the mean per capita supply of 25 lpd is compared with the mean per capita consumption of 42 lpd (section 2.4), there is a deficit of 17 lpd. Therefore, the people make up this deficit from private and commercial water supply sources.

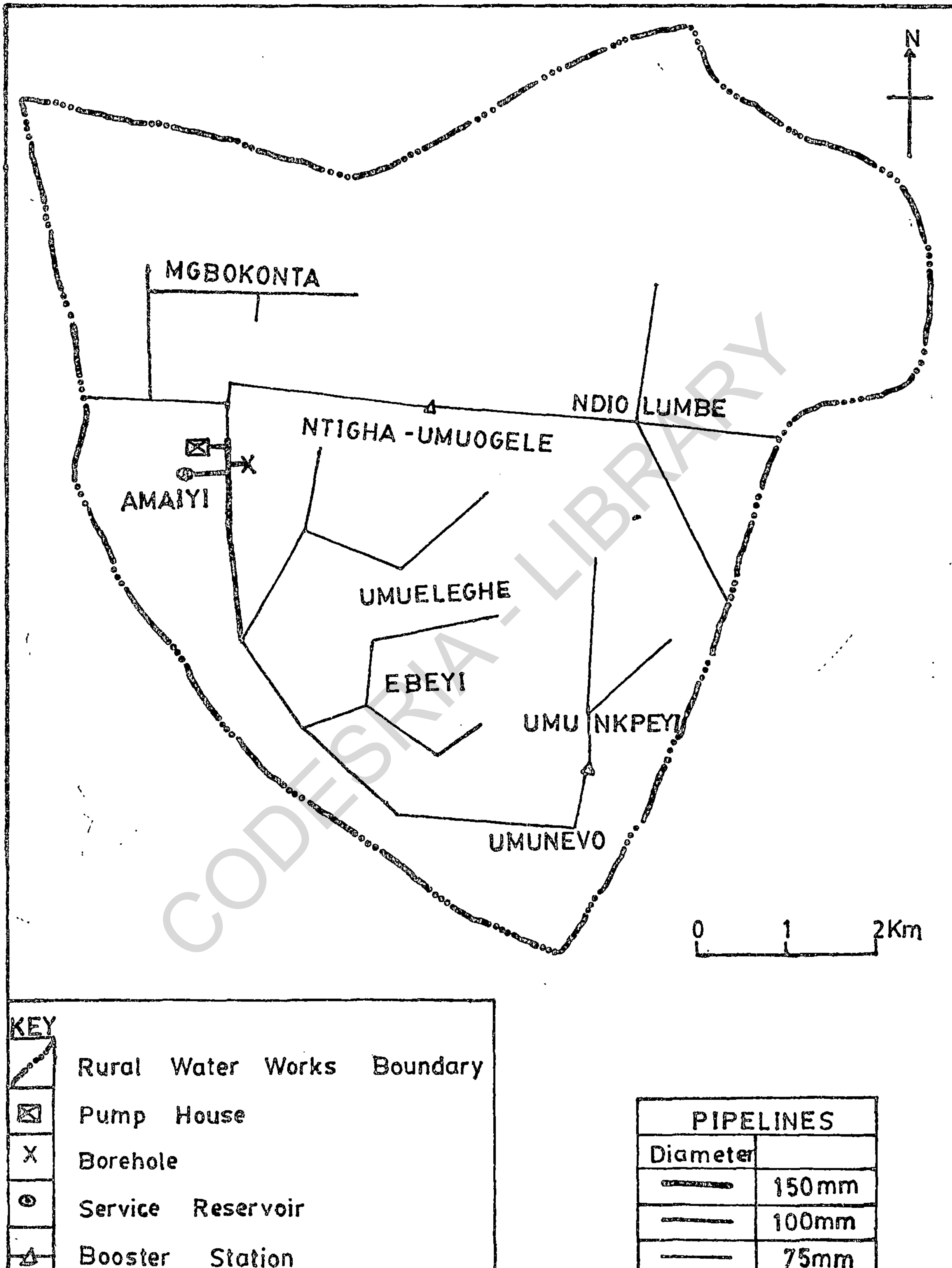


FIG. 13 : AMAIYI RURAL WATER SUPPLY NETWORK.

3.1.1.3 The Public Water Supply Network:

A water distribution system has been defined as all water works components for the distribution of finished or potable water by means of gravity storage or pumps, through piping networks to the consumers or other users (DeMoyer and Horwitz, 1954), including distribution equalising storage (Mcpherson and Prasad, 1966). In otherwords, it is a system of conduits or pipes (Fair and Geyer, 1970) that conveys water to the points of use from the terminus of the central supply conduit. Water, according to DeMoyer and Horwitz (1954) is distributed to consumers through pipes varying in size of several metres in diameter to consumer service pipes of the order of 25mm.

The water distribution system in Isiala-Ngwa is poorly developed with many villages not connected with pipe networks at all, especially in many parts of Umuoha, Ovungwu, Okporo-Ahaba, and Nsulu communities (Fig.16). The distribution pipes found in the area varies in diameter ranging from 50mm to 250mm as illustrated in Table 19 and Fig.16. The arteries of the distribution are:

(i) The 250mm diameter pipeline which connects the Ngwaukwu pumping house (where there are two boreholes) at Amaoji to the 690,000 litres high level concrete reservoir at Umualanta in Amapu

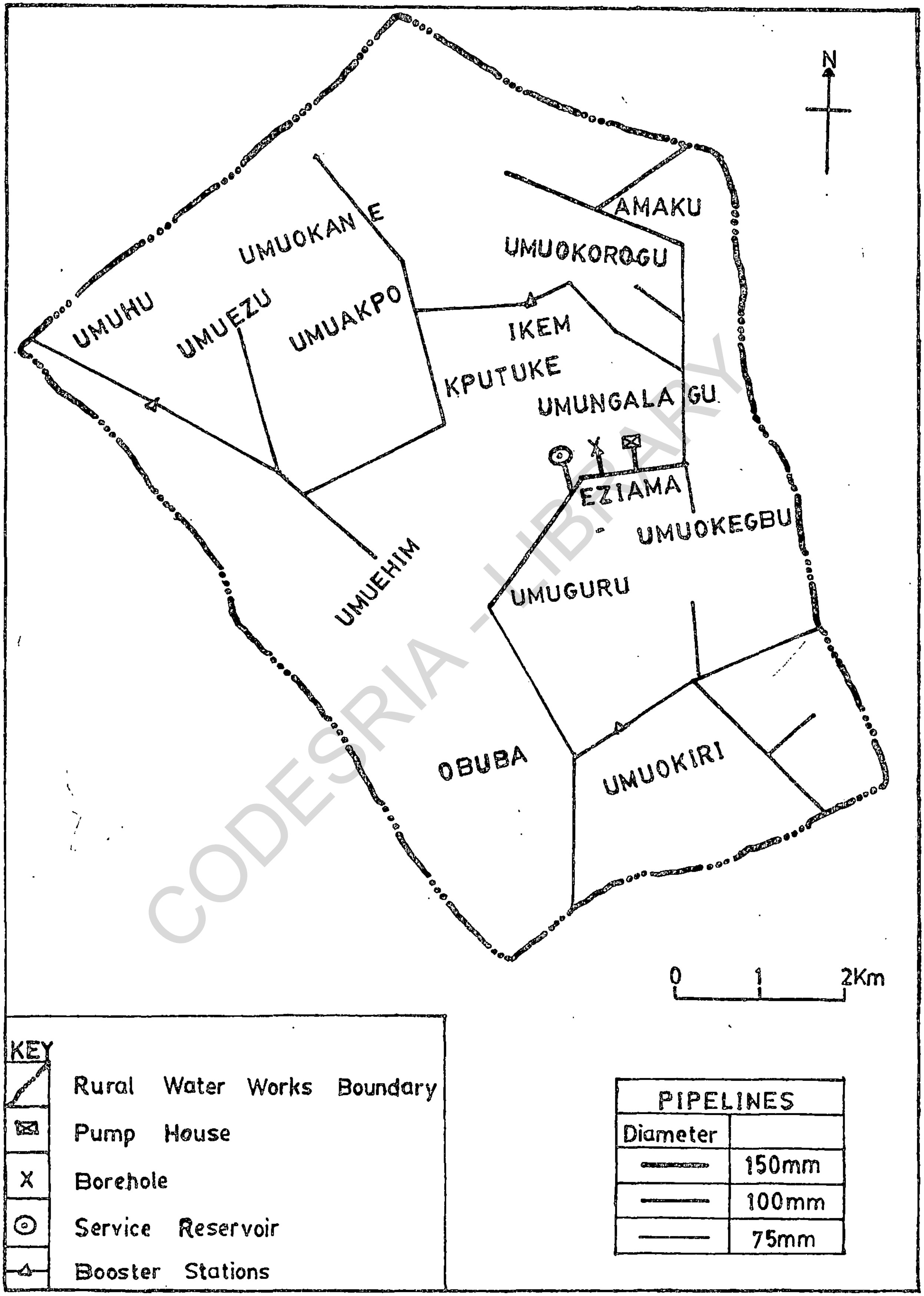


FIG. 14 : EZIAMA RURAL WATER SUPPLY NETWORK.

village in Ntigha community (Fig.10). Here, this 250mm diameter pipeline acts as the "rising main" (main pipeline) connecting water from the two boreholes at Amaoji to the 690,000 litres service reservoir (The largest in the whole Isiala-Ngwa) at Ntigha. At Amapu village in Ntigha community, where the reservoir is situated, the 250mm diameter pipeline is joined by the 200mm diameter pipeline which serves the villages of Avo, Eziama, Umuekpe-Ntigha, Abayi, Ihie, Ahiaba Ubi, and Ahiaba-Okpuala (Fig.10). The total length of the 250mm and 200mm diameter pipelines is about 18 kilometres (Table 19).

(ii) The 150mm diameter pipeline which acts as the "rising main" and thus connects the pump houses of Amaiyi, Eziama, Mbutu, Nbawsi, and Ov/Ov; with their respective service reservoirs (Fig.16). The 150mm diameter pipeline is also used in distributing water to the villages. A good example is the 150mm diameter pipeline running from Mbutu via Umuoha to Ngwaukwu (Fig.16), distributing water to Owerrinta, Umunvo (Ugba junction), Egbelu-Mbutu (Fig.11), and to Amaekpu (Umuoha), Obikabia (Ngwaukwu), and Okpuala-Ngwa (Fig.10). Another 150mm diameter pipeline runs from Ovungwu to Ovuokwu and to

Omoba, distributing water to Umuokoromiri, Umuegoro, Umuapu, Umuabali, Umuhu, Umuawa and Omoba (Fig.12). The total length of all the 150mm diameter pipeline is about 53 kilometres (km), representing 21.9% of the total pipeline sizes laid in Isiala-Ngwa.

(iii) The pipelines which range between 75mm and 100mm in diameter which supply water to all the communities except Umuoha (Fig.16). They are used purely for distributing water to the consumers. Good examples are found in Amaiyi and Eziama rural water works (Figures 13 and 14). The 75mm and 100mm diameter pipelines are the most numerous and have a total length of about 114km and 58km respectively, this represents a mean percentage of 46.7% and 23.9% respectively (Table 19).

(iv) The small 50mm diameter pipeline found only in Nbawsi along the road leading to the railway station and along the road to Umuati village in Nsulu community (Fig.15). It has the shortest distance of about 0.4km representing about 0.2% of the total pipeline sizes laid in Isiala-Ngwa.

As can be seen from Fig.16 and Table 19, Isiala-Ngwa is dominated by small pipe sizes of the order from 50mm to 100mm in diameter. This contributes 70.8% of the overall pipelines laid in the area, while the fairly medium 150mm and 250mm diameter pipes contribute 29.2%. Table 19 shows the water pipeline sizes and their respective distances and percentages in Isiala-Ngwa.

From Table 19, the total length of all the pipelines laid in Isiala-Ngwa is about 243km. The 75mm diameter pipeline has the largest distance (length) of about 114km representing 46.7%. This is followed by the 100mm diameter pipeline with the distance of about 58km representing 23.9%. and the 150mm diameter pipelines with the distance of about 53km representing 21.9%. The smallest pipe sizes are the 50mm diameter pipeline with the distance of about 0.4km representing 0.2%; and the 250mm and 200mm diameter pipelines with the distance of about 9km each representing 3.6% and 3.7% respectively.

From Table 19, it can also be seen that the fairly medium sized 200mm and 250mm diameter pipelines are only found in Ngwaukwu rural water works. This is explained by the fact that Ngwaukwu water works has two boreholes together with the largest service reservoir (690,000 litres) in Isiala-Ngwa. It is the Ngwaukwu water works that serves Okpuala-Ngwa (the Local Government Area capital), and in fact, this water works supplies water

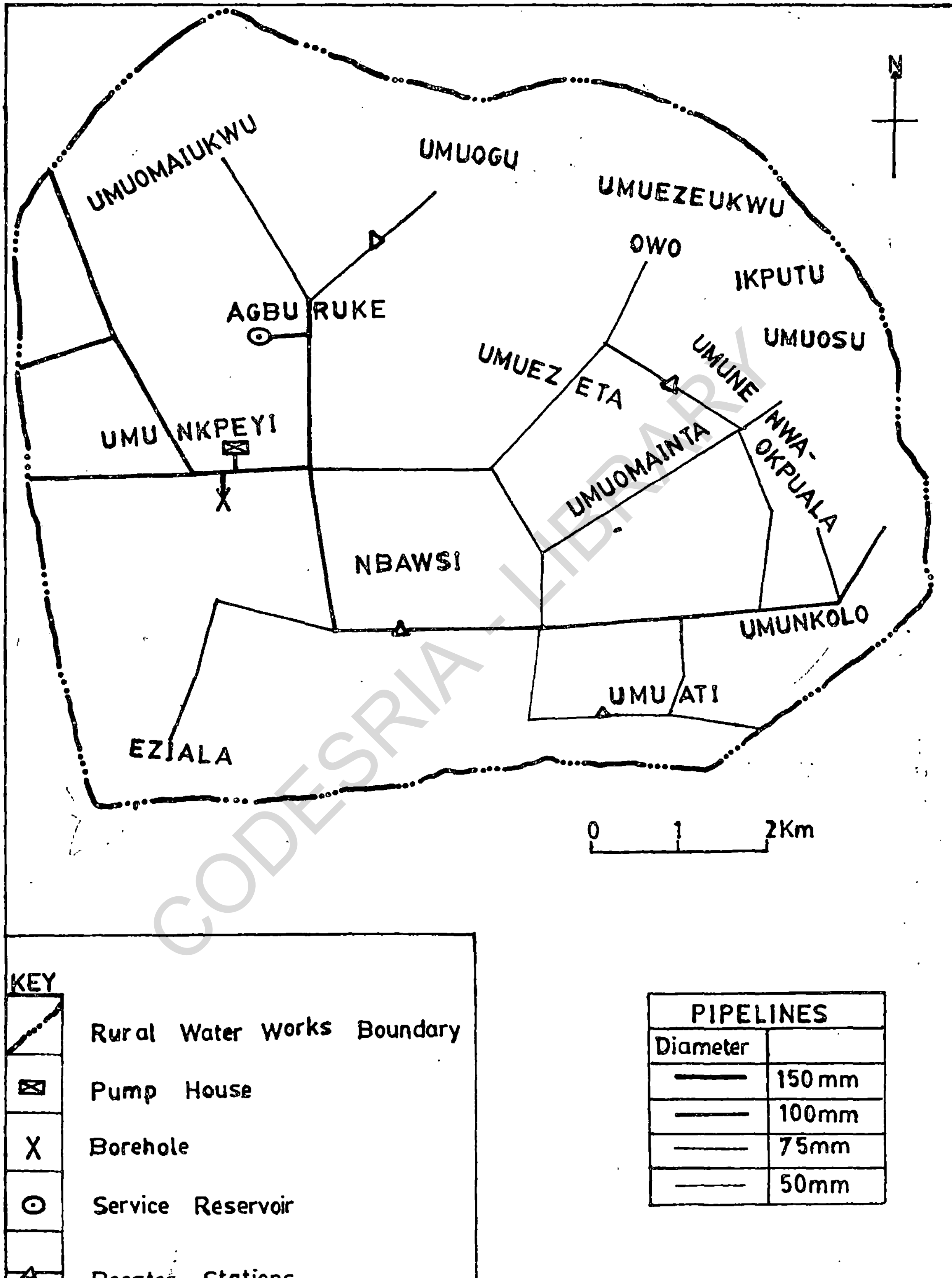


FIG. 15 : NBAWSI RURAL WATER SUPPLY NETWORK

TABLE 19: Network sizes and their distances (km) in Isiala-Ngwa (Source: Fieldwork, 1987)

Distances in the water works (km)

Diameter (mm)	'Amoiyi	'Eziama	'Mbutu	'Nbawsi	'Ngwa ukwu	Ov/ Ov	Total	% Total
250	-	-	-	-	8.7	-	8.7	3.6
200	-	-	-	-	9.0	-	9.0	3.7
150	0.5	4.1	12.8	6.4	11.7	17.6	53.1	21.9
100	0.5	17.1	20.3	3.1	8.4	8.6	58.0	23.9
75	26.0	8.6	14.5	17.8	0.9	45.7	113.5	46.7
50	-	-	-	0.4	-	-	0.4	0.2
Total	27.0	29.8	47.6	27.7	38.7	71.9	242.7	100

to the greatest number of people compared with other rural water works in Isiala-Ngwa. While Nbawsi is the only water works that has the 50mm diameter pipeline. The 50mm diameter was used to complete the line when the 75mm and 100mm diameter pipelines finished during the pipe layering work (Nwokonko, 1987).

3.2. The Private Water Supplies:

From the discussion in section 3.1.1.2, it was seen that the mean daily per capita public water supply of about 25 lpd, when compared with the mean per capita

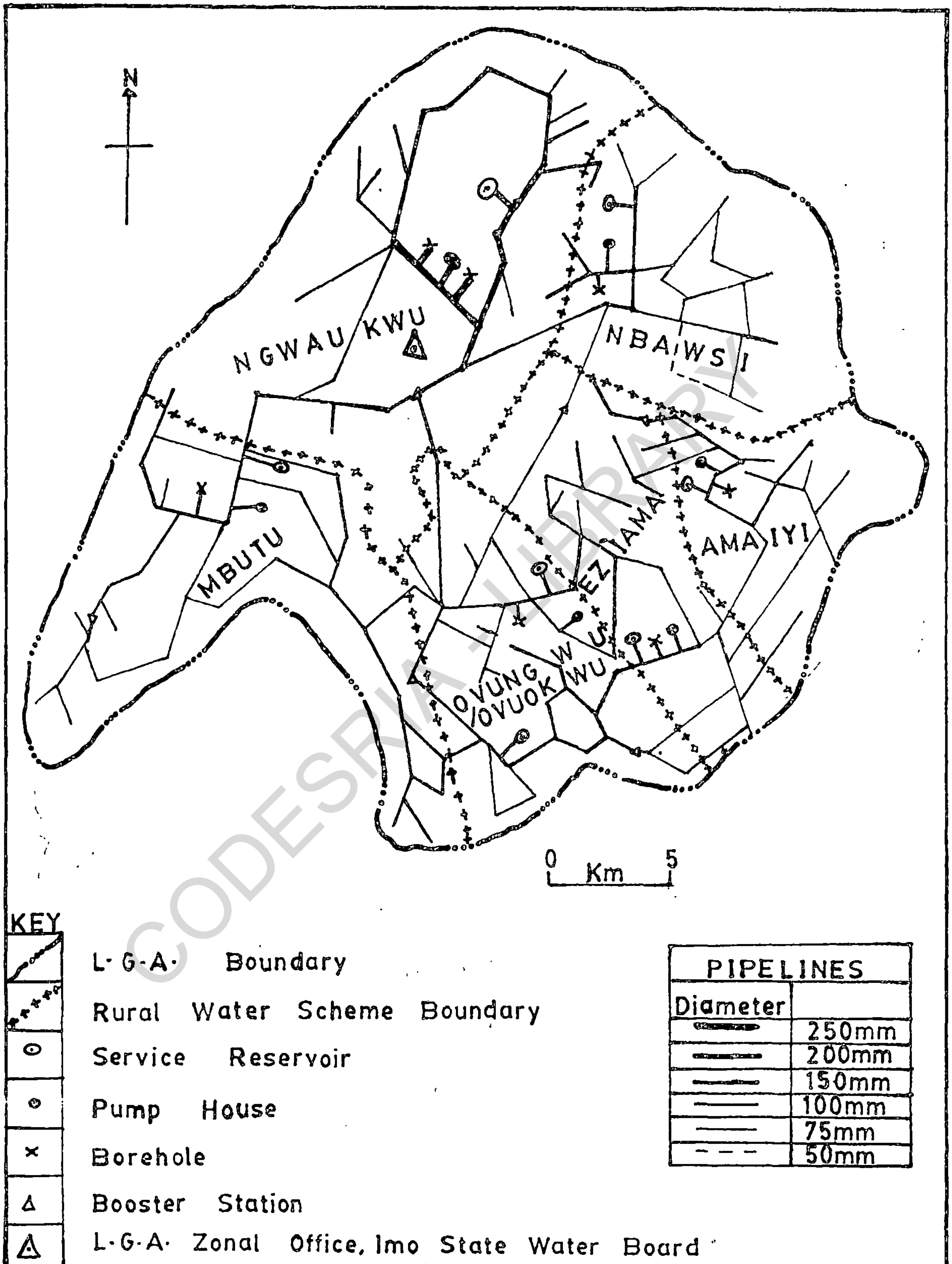


FIG · 16 : ISIALA-NGWA WATER SUPPLY NETWORK·

(Source : Imo State Water Board, Isiala - Ngwa Zone .)

consumption of 42 lpd, showed a deficit in supply. To cope with this inadequate public supply, private sources of supply are utilized by the people of Isiala-Ngwa. The various sources of private water supply in the area include:

(i) Wells and private boreholes
(ii) Streams, springs and ponds; and
(iii) raincatch.

3.2.1 The distribution of private water supplies:

Water is collected or abstracted from the streams, springs and ponds mainly by unit abstraction. People go to these sources with their buckets, jerry cans, pots and gourds to collect water which they carry to their homes. The journey to fetch water may be by trekking, cycling (mainly by bicycles) or driving if the route to the water source is motorable. People go to the water sources as many times as possible according to when the need arises. But the majority of the people go to fetch their water in the morning and evening hours of the day.

Domestic water meant for drinking is stored inside the houses in pots (clay and plastic types), gourds and at times, in jerry cans. This water storing process enables the water to be cool for drinking. Drinking water storage containers are well covered to prevent mosquitoes from breeding in them as to prevent animal pests such as rats, lizards, geckoes, cockroaches and ants from entering the storage containers.

3.2.2 Wells and Private boreholes:

Village wells are found in almost all communities of Isiala-Ngwa where there is acute scarcity of water especially in Amaise-Ahaba, Okporo-Ahaba, Ovungwu, Ovuokwu and Umuoha. The wells in the area were dug during the late 1950s and early 1960s. The wells are located near central place areas/centres so as to be able to serve all the members of the village.

The wells were excavated by hand and have diameters of about 2 metres (plate 8). Local well diggers provided the labour and they may range from 6-10 in number. Pick axes and shovels are the basic implements used for digging of these wells. Loose materials is hauled to the surface in a container (metal buckets) by means of suitable pulleys and strong ropes. For safety and to prevent caving, lining

PLATE 8: An open hand-dug well (42 metres deep) in Umuosu Nsulu. Note the concrete casings and the two longitudinal iron bars where the cut bamboos with circular grooves are fitted. This well has dried up.

(or cribbing) of wood or sheet piling were usually placed in the hole to brace the walls. Excavation is continued until water flows in more rapidly than it can be bailed out. The wells are permanently lined with casings of brick or concrete (Plate 8).

There are iron bars positioned longitudinally across the wells very close to the ends and fitted with cut bamboos with circular grooves. The bamboos with circular grooves (where the ropes stay) facilitate the winching mechanism. The bamboos enable large amounts of water (with heavy weights) to be carried with relatively little effort. The effort now is the pulling of the rope which turns the grooved bamboo when the water is lifted with small metal buckets from the well. The wells are not covered to protect them from environmental pollution (Plate 8). At times, children haul in stones into these wells in order to hear the sound it produces. Most of these wells have dried up. The few wells with water as at December 1987 are found in Amaise-Ahaba, Ntigha and Okporo-Ahaba communities.

The average depth of these wells is about 37 metres below ground surface and with a standard deviation of about 7 metres (Table 20). The drying up of the wells in

TABLE 20: Location of some wells and their depths (metres) in Isiala-Ngwu(Source: Fieldwork, 1987

Location (village)	Community	year of completion	Depth (metres)
Amaputa	Umuoha	1959	39
Ichi	Umuoha	1958	39
Umuosu	Nsulu	1961	42
Umuogu	Nsulu	1961	12
Mba	Okporo-Ahaba	1960	35
Mgbedeala	Amaise-Ahaba	1962	41
Amuke	Okporo-Ahaba	1962	45
Umuacha	Amaise-Ahaba	1960	40
Agbaragwu	Ovangwu	1961	40
Agburuke	Nsulu	1962	32
Agburuke	Nsulu	1962	34
Agburuke	Nsulu	1961	33
Umuomai-ukwu	Nsulu	1963	36
Amapu	Ntigha	1964	36
Umuele-ghele	Ovuokwu	1961	40
Umuopia	Ovuokwu	1960	39
Egbelu-Nbutu	Mbutu	1958	42
Uratta	Umuoha	1960	38
Obiekwe-nsu	Ovuokwu	1962	39
Ikem	Nvosi	1961	41
			Mean = 37
			Std. dev. = 7

the area may be due to insufficient groundwater to necessitate all season flow of water. This is because, when we compare the depths of the boreholes (about 49 metres deep) as discussed in section 3.1.1.1, with that of the wells (about 37 metres deep), there is a mean difference of 12 metres. This difference shows that the permanent water table was not struck during well excavation. This phenomenon may be due to inadequate knowledge of the hydro-geological dynamics of the area, or, as a result of lack of adequate engineering technology as the wells were dug manually.

Another aspect of groundwater tapping to provide private water supply in the area is by the use of boreholes. Recently, many private boreholes have been drilled by some well-to-do members of the area to provide water for private use. The areas where private boreholes are found in Isiala-Ngwa include Umuezegu village (in Nsulu), Umuosu (Nsulu), Obiekwensu (Ovuokwu) and Omoba, which are 45m, 47m, 51m and 49m deep respectively.

Private borehole drilling however, is a recent innovation to curb the problem of water shortage in the area. On several occasions, many members of the village go to these people that have boreholes to beg for water.

3.2.2. Streams, Springs and Ponds:

Surface water forms an accessible source of water supply in Isiala-Ngwa. The main streams, springs and ponds in Isiala-Ngwa have been noted in section 1.3.3. The main streams are Imo, Ahii and Otamiri ("iyi Ubaha"), while the springs are "iyi Nkpokoro", "Onumiri", and "iyi Olugele". These streams and springs drain the western and north eastern parts of Isiala-Ngwa as illustrated in Fig. 3.

The Imo River flows southwards along the western boundary of Isiala-Ngwa. Its tributaries are Oji stream and Etu Amapu stream. The Imo River is well developed in Umuchima village in Ngwaukwu community and in Owerrinta in Mbutu community.

The Ahii which rises near Umuahia drains the north eastern parts of the area. Its main tributaries are "Iyi Umuosidim", "iyi Ubi", "Ihu iyi", and "iyi ulo". The Otamiri rises near Umuomainta village in Nsulu community and flows in a south easterly direction through the villages of Umuosu, Umuala, Ubaha and Umuakwu, until it joins the Ahii.

The "Nkpokoro" rises in the north eastern part of Umuosu village (in Nsulu)and flows in an easterly direction until it joins "iyi ubi, "Iyi Nkpokoro" is about 6 metres below sealevel and has a stepped entrance. The "Onumiri" spring rises in Umuode village (Nsulu) and flows in a north eastern direction until it joins the "Ihu iyi". While the "Olugele" spring rises in Mbubo village (Nsulu) and flows in a northeasterly direction until it joins the "iyi ulo".

These streams and springs are perennial and have an almost constant flow all year round, depending on the rainfall regime. They are at their lowest stage in March, just before the beginning of the rainy season and they rise as the months progress. This gradual rise lasts until the beginning of September. The peak is however reached in the end of October. A sharp drop in the water level occurs during the end of the rainy season in November and the low water period begins in December.

The streams and springs provide a good drainage system for the people living in the northern parts of Nsulu (Mbubo, Ohuhu-Nsulu, Ubaha, Umuakwu, Umuala, Umuode, Umuomainta, and Umuosu villages). While the streams flowing in the western part of Isiala-Ngwa provide good drainage for people living in the western parts of Mbutu, Ngwaukwu, Ntigha and Umuoha communities. The streams and springs are utilized in these areas for domestic and non-domestic water activities through direct unit abstraction. Many water vendors also go to Imo River (at Owerrinta in Mbutu community) and Otamiri stream (at Ubaha in Nsulu community) to pump water from the streams to their tankers (Plate 9).

Another source of surface water is the natural ponds. These are found mainly in the central parts of Isiala-Ngwa notably Nnemeh and Nkara (in Ngwaukwu community), Uju (Ovungwu community), Ngwu (Ovuokwu community), Ife (Nvosi community) Ifanim (Umuoha community), Iyiala and Iyi achara (Nsulu community) (Fig.3). These natural ponds are seasonal and only rise during the rainy season. The ponds dry during the dry season and holes are dug on the ground in search of water (see plate 2). Cups and bowls are used in collecting water from the dug holes (Plate 2). During the busy hours of the day especially early in the morning, in the afternoon immediately after school hours (around 2.30 p.m.), and evening periods, many hours are wasted in trying to fetch water from these dug wells.

3.2.3 Raincatch:

Raincatch is the process of collecting rain water during rainfalls. As illustrated in section 1.3.2,

PLATE 9: Water vendors pumping water to their lorry tankers from the Otamiri stream.

Isiala-Ngwa has 8 months of rainfall with annual total ranges between 1875mm to 2500mm. During the rainy season, raincatch is one of the major sources of water supply for domestic purposes.

For the collection of the rainwater, the 'roof catch' method is utilized. In the 'roof catch' method, about 4-7 minutes are allowed for the rain to wash away dust particules from the roofs (especially when it has not rained for a long time normally during the on-set of the rainy season) before water collection starts. There are two main methods of 'roof catch' in the area. These are:

(i) Direct collection from roofs to containers, and

(ii) Channelling to ground level/sunken storage tanks.

In direct collection from roofs, the containers are positioned where rain drops can easily enter the water containers (Plate 10A). The containers used for collecting water directly from the roofs include aluminium and plastic buckets, pots, aluminium and plastic basins, gourds and drums (Plate 10A). In some cases, corrugated iron eaves are put on some parts of the edges of the corrugated iron roofs to channel water to the water containers (Plate 10B).

In the case of channeling water to ground level/sunken storage tanks, the edges of the corrugated iron roofs are eaved round (or part of it) with corrugated metals to collect and channel the rainwater to the storage tanks (Plate 10B). These storage tanks may be made of concrete or metal. The stored water is later drawn for use or into drums for direct use when there are water shortages. At times, some people pipe the stored water from the storage tanks to their houses to provide modern piped water systems with taps, shower taps and basins, and water closets. It is important however, to point out that presently (1988), direct rainwater collection into pots, gourds buckets, basins, and drums in more common than collection and channelling of rainwater into surface or underground storage tanks.

People also dig pits ('catchment pits') to collect flood water (runoff water) (See Plate 3). These 'catchment pits' may be constructed individually or by members of one kindred, or the village as the case may be. People go to these 'catchment pits' to fetch water with their buckets and gourds. They use the water for many domestic and non-domestic activities such as washing, building and for oil palm processing.

However, there is a limit to which the people of Isiala-Ngwa can depend on rainwater for their domestic and other activities since rainfall is seasonal, occuring between mid-march and early November. A further limit to rainfall utilization in the area is the fact that rain does not fall everyday, even during the rainy season.

PLATE 10A: Some of the containers used for direct collection of rainwater from roofs.

PLATE 10B: Corrugated iron eaves used to channel rainwater from the corrugated iron roofs to the storage tanks.

3.3 Commercial water supplies:

As a result of uneven distribution of the streams, springs and ponds, and the shaky and fluctuating supplies from wells and private boreholes, coupled with the inadequate and unreliable water supplies from the Imo State Water Board, Isiala-Ngwa zone, private individuals have undertaken the supply of water on commercial basis. There are thus, many water vendors and hawkers in Isiala-Ngwa to take the advantage of the water scarcity. The water vendors and hawkers make use of lorry tankers and Motor cycles/ bicycles as the case may be.

The water vendors travel with their lorry tankers to the streams mainly the Otamiri (between the villages of Ubaha and Umuala along the Aba - Umuahia road), and the Imo River at Owerrinta to pump water to their tankers through flexible suction method (see plate 9). Most of the water vendors carry their pumping plants to the streams or they keep the plants at the water source, normally during the dry season. There are people who stay and work at these water sources (streams) to maintain order and cleanliness. They make sure that people wash, bathe and fetch water at the appropriate places as well as looking after the pumping plants. These people collect money from the water vendors before pumping water to them. The sum of ₦10.00 is charged per tanker trip of water. The total amount of money realised from the sales of water from the streams is used in paying those that work at the streams. The remaining amount is shared among the villages that own the stream. This is a form of riparian right enforcement. However, recently (1988), the Isiala-Ngwa Local Government Council has taken over the control of the streams. They now pay the workers and control the remaining revenue from the water sellings.

Also, some people in the area drill boreholes specifically for commercial purposes. They therefore sell water to the water vendors (Plate 11A). One lorry tanker filled with water cost ₦15.00 as at December, 1987. A good example of commercial motivated private borehole is found in Ovungwu village in Ovungwu community. This borehole is about 52 metres deep.

The water vendors carry the water from one village to the other with their lorries to serve their customers (Plate 11B). The water is usually in constant demand as exemplified by the numerous buckets, jerry cans and

PLATE 11A: A water vendor collecting water from a private borehole at Ovungwu village in Ovungwu community. The cost of filling that tank with water is ₦15.00.

PLATE 11B: Water vendor serving their customers in Umueleghele village in Ovuokwu community. The cost of filling one large (75 litres) plastic container with water is ₦1.50k during the dry season in 1987.

drums one normally see along the roads when travelling in the area. In fact, water selling is becoming a very lucrative business and people have reacted positively to this by turning their lorries over to this water business during the dry season (Plates 11A and 11B). Some water hawkers also exist. They go to the streams to fetch water with their bicycles or motor cycles on demand.

Generally, the cost of water in the rainy season differs from the cost in the dry season. The cost of one standard bucket of water (SON size 30 of 12 litres) is 20 kobo in the rainy season, while it is 30 kobo in the dry season. For one jerry can of water (SON size 40 of 30 litres), it is 40 kobo (rainy season) and 50 kobo (dry season). The cost of one drum of water (SON medium size of 110 litres) is ₦1.50k in the rainy season and ₦2.00 in the dry season. While the cost of one tank full of water (with capacity of 2300 litres) is ₦20.00 in the rainy season and ₦25.00 in the dry season.

3.4 Summary of sources of water supplies in Isiala-Ngwa:

The general pattern of the sources of water in Isiala-Ngwa show that the major source of water supply in the area comes from rainfall while the least important source is from private boreholes. Information on the

TABLE 21: The pattern of sources of water supplies in Isiala-Ngwa (Source: Fieldwork, 1987)

Communities	Streams	Springs	ponds	wells	public taps	Rain water	private bore-holes
Amaise	22	-	11	-	9	31	-
Amaise-Ahaba	6	-	20	8	6	26	-
Mbutu	7	-	35	-	28	35	-
Ngwaukwu	10	-	43	-	39	48	-
Ngwaobi	-	-	29	-	-	29	-
Nsulu	42	18	18	-	9	66	6
Ntigha	18	-	11	14	29	29	-
Nvosi	9	-	41	-	51	56	-
Okporo-Ahaba	-	-	42	12	-	42	-
Omoba	-	-	2	-	23	23	4
Ovungwu	-	-	43	-	23	43	3
Ovuokwu	-	-	36	-	-	36	3
Umuoha	8	-	31	-	2	37	-
Total	122	18	362	34	219	501	16
Percentage	9.6	1.4	28.5	2.7	17.2	39.4	1.3

pattern of the water supply sources were got from the questionnaire samples and respondents were asked to indicate the source(s) where they get their water for their household activities. The result of the sources where people get their household water is shown in Table 21.

From Table 21, the greatest number of respondents get their water from rainwater (39.4%) followed by water from ponds (28.5%). While water from boreholes is the least (1.3%), closely followed by water from springs (1.4%). From Table 21, it is evident that every person in the area makes use of water from rainfall. This is because the value of 501 corresponds with the total number of respondents as against water from private boreholes (with the value of 16) which occur in only four communities (Nsulu, Omoba, Ovungwu and Ovuokwu). Springs with the value of 16 occur in only Nsulu community and contributes about 11% of all the water supply in Nsulu.

CHAPTER 4

ANALYSIS OF THE DEFICIENCY OF WATER SUPPLY

In this chapter, we analyse the margin of deficiency between water demand and supply in Isiala-Ngwa and determine the causes of this deficiency. Also examined, are the effects of this water deficiency on the people and its implication for rural development.

4.1 The spatial representation of available water in the area:

In this section, we present all the available sources of water in Isiala-Ngwa. This is a sort of water inventory, eventhough it will concentrate mainly on surface water sources (streams, springs and ponds) together with the available functional boreholes/handpumps/wells as shown in Table 22.

From Table 22, it can be observed that the spatial distribution of these water sources varies from place to place. Boreholes have the highest occurrence with 20, while springs have the least with 3. These boreholes include those utilized by the rural water works and the newly drilled mono-handpumps/boreholes distributed in all the communities except in Amaise and Amaise-Ahaba.

It is only in Nsulu community that springs occur. This may however be due to the fact that the Nsulu area where these springs occur are transitional zones to another geologic formation - Bende - Ameki series, with a relatively impervious layer which can breate springs given a proper topographic setting. Functional wells occur in three communities of Amaise-Ahaba, Ntigha and Okoro-Ahaba.

As can be seen from the Table also, Amaise-Ahaba, Ngwaobi Okporo-Ahaba and Omoba do not have any form of surface water, while Nsulu has all forms of surface water (streams, springs and ponds). Thus, this spatial pattern in the number and degree of occurrence of these water sources may have repercu-ssions in the water need of the people.

4.2 The deficiency of supply relative to demand:

As was pointed out in section 2.2.1, the total amount of household water consumption is a correlate of the actual amount of household water fetched. In otherwords, household water consuption equals household water supply. This is because in most rural areas with particular reference to Isiala-Ngwa, there are no house-to-house supply of water from the public water works, so people travel to fetch (or buy the quantity they required from water vendors) whatever amount they need for household water activities. Even in areas with functional standpipes,

TABLE 22: The spatial representation of the available water sources in Isiala-Ngwa (Source: Fieldwork, 1987)

Coomunities	Streams	Springs	ponds	Boreholes	Wells
Amaise	1	0	0	0	0
Amaise-Ahaba	0	0	0	0	1
Mbutu	1	0	1	2	0
Ngwa-obi	0	0	0	1	0
Ngwa-ukwu	2	0	2	3	0
Nsulu	7	3	2	4	0
Ntigha	1	0	1	1	2
Nvosi	0	0	1	3	0
Okporo-Ahaba	0	0	0	1	1
Omoba	0	0	0	1	0
Ovungwu	0	0	1	2	0
Ovuokwu	0	0	1	1	0
Umuoha	1	0	2	1	0
Total	13	3	11	20	4

people also travel to fetch the household water. From this therefore, the total household water consumption will be taken to mean the total household water supply provided by the members of the household.

Also, as was established in section 2.4, the mean household water demand for Isiala-Ngwa was found to be about 1108 lhd as against the mean household water consumption of 355 lhd. This therefore shows a deficiency of water supply relative to demand of about 753 lhd representing about 68% of the demand. In otherwords, this means that the mean consumption (taken in this work as the mean water supply to the household) of 355 lhd, represents only about 32% of the demand as illustrated in Table 23.

From Table 23, Ovungwu has the highest water deficiency of 929 lhd, while Nsulu has the least with 556 lhd. This shows a deficiency range of about 373 lhd among the communities. This high deficiency range is an indication of the spatial variation of water sources/supply over the area as illustrated in section 4.1.

Also, Table 23 shows a mean household water deficiency margin of about 68% with standard deviation of about 8%. The highest mean percentages of water deficiency are found in Umuoha (77%), Amaise-Ahaba, Okporo-Ahaba, and Ovuokwu with 76% each, while Nsulu (52%) and Ntigha (59%) have the least. The relatively low mean percentage of water deficiency for Nsulu and Ntigha communities may be due to the fact that these two areas have more water sources

TABLE 23: The margin of deficiency of household water supply relative to demand in Isiala-Ngwa.

Communities	Mean household water demand (litres)	Mean household water consumption/ supply (litres)	Deficiency	% deficiency
Amaise	958	346	612	64
Amaise-Ahaba	1022	242	780	76
Mbutu	1147	426	721	63
Ngwaobi	964	270	694	72
Ngwaukwu	1182	403	779	66
Nsulu	1061	505	556	52
Ntigha	1079	446	533	59
Nvosi	1197	375	822	69
Okporo-Ahaba	986	240	746	76
Omoba	1285	516	769	60
Ovungwu	1247	318	929	75
Ovuokwu	1184	285	899	76
Umuoha	1088	248	840	77
Mean	1108	355	753	68
Standard deviation	108	98	110	8

than Umuoha, Amaise-Ahaba, Okporo-Ahaba and Ovuokwu communities as shown in Table 22.

4.3 Factors responsible for the water deficiency:

One of the main attributes of any geographical investigation is its ability to answer "why" questions. In this case, why has the water deficiency persisted over time despite many attempts by the people to remedy the situation? To answer this question, it is necessary to find out the root factors responsible for water deficiency in the area. This is necessary since the solution to any geographical problem requires the elucidation of its root causes/factors.

In this section, we attempt to verify our first assumption which says that the causes of water shortage/ deficiency in the area of study are influenced by physical, socio-economic and political factors. We therefore use principal components analysis to test the physical, socio-economic and political variables listed in Table 24.

Principal components analysis (PCA) is chosen because it leads to a much more deterministic approach to a problem as opposed to the use of factor analysis (FA) which leads to a much more flexible experimental approach. Also, the nature of our data was such that FA could not be performed. This is because, when we tried to analyse the data with FA as a tentative comparative tool, the determinant of correlation coefficient could not be found. This made it impossible to find the squared multiple correlations needed for the analysis. Also, it was found that the initial estimate of communalities is maximum off-diagonal element of correlation matrix. After first iteration, communality of one or more variable exceeded 1.0. Therefore, FA cannot be done.

4.3.1 The principal components model:

It is a basic characteristic of social science that isomorphism or the existence of simple, one-to- one causal relationships, is rare. An attempt to understand a phenomenon such as, say, "urban growth" thus typically involves an investigation of a series of causally-related variables. Such an examination may be made more rigorous and less time-consuming if our explanatory variables can be considered simultaneously, rather than in a stepwise "One-after-another" manner (Goddard and Kirby, 1976).

Principal components Analysis (PCA) is a technique derived from analysis of variance and analysis of correlation.

It was first introduced and further developed by Hotelling (1933, 1936). The technique allows the replacement of an original set of variables by a new set of orthogonal (uncorrelated) variables called principal components (PC). If for a series of sites, or objects, or persons, a number of variables is measured, then each variable will have a variance (a measure of the dispersion of values around the mean), and usually the variables will be associated with each other. That is, there will be covariance between pairs of variables. The data set as a whole will have a total variance which is the sum of the individual variances.

PCA is based on the assumption that each variable (strictly, its variation) can be sub-divided into several independent parts in terms of its association with other variables. In addition, that each correlation coefficient similarly is made up of different segments. According to general assumption, these segments are entirely independent of each other so that we can identify the groups or variables between which the correlations are high and those segments and relevant variables where the correlations are near zero.

TABLE 24: The 19 predictor variables

Label	Variable description
FS	Few streams within the area
POWS	Pollution of water sources
CNAT	Shortage of water as a result of seasonality of rainfall, slope and geological differences, and low water table.
DIST	Long distance to the streams, ponds and standpipes.
DAM	Damages to pipes/standpipes during road construction/grading.
AGOV	No governmental support
STP	Insufficient functional standpipes in the areas having pipeborne water.
PIPE	Lack/insufficient pipes to extend the distribution system.
ATT	Careless attitude of the people in handling the public standpipes.
WLK	Water leakage from pipes
BORE	Insufficient boreholes
DRY	The drying of village wells
FUEL	Inadequate fuelling and repairs of pumping plants.
CORP	Misappropriation of community funds for water projects.
PPWL	Lack of any form of pipeborne water in some villages.
COL	Lack of co-operation from members of the water board to listen to water complaints from members of the public.
TAPs	Infrequent running of the taps (both public and private).
TANK	Lack of personal/village storage tanks.
POLIT	Political differences in the area.

These segments are not observable in reality and not directly measured. They are the principal components.

PCA also assumes that the variation of each original variable is defined entirely by the correlation between it and all the other remaining variables. Simply put, it means that the variation of each variable is not affected by the unique variance (that is, the error or residual segment of each variable). Thus, PCA is often defined as a closed model of components analysis. Because the variation of each variable in PCA is defined by variations included in the segments, the number of principal components equals the number of the original variables. In otherwords, PCA treats all variables as of equal weight.

PCA has been utilized in various geographical studies such as that by Wong (1963), used in the study and prediction of mean annual floods in New England. Abiodun (1967) used the technique in the study of the factors responsible for 'urban hierarchy in a developing country'; while Doornkamp and King (1971) use it in the study and analysis of geomorphological factors. Also, Rice (1973) used PCA to analyse the factors that influence basin physiography; while Ebisemiju (1979) and phil-Eze (1986) used the technique to determine the factors that influence drainage basin morphology, and the major parameters influencing runoff in the basins in south eastern Nigeria, respectively.

4.3.2. Extraction and Analysis of the components:

In order to verify the causes of water shortage deficiency in the area of study, data on the people's responses on what they feel are the causes of water deficiency in their area were collected. 19 variables were thus got from the questionnaires as presented in Table 24. These variables incorporate physical, socio-economic and political factors. The data on the 19-predictor variables were thus homogenized and transformed into a square of correlation coefficients between the variables. The lower diagonal of the correlation matrix is presented in Table 25.

The correlation matrix in Table 25 shows that some of the independent variables are highly correlated with each other while others show very small or no correlation. For instance, variables DIST (long distance to the streams, ponds and standpipes) is strongly correlated with variables FS (Few streams within the area), POWS

(Pollution of water sources), and CNAT (shortage of water as a result of seasonality of rainfall, slope and geological differences, and low water table). In other-words, long distance to the streams, ponds and standpipes (DIST) is strongly related to few streams within the area (FS), pollution of water sources (POWS), and shortage of water as a result of seasonality of rainfall, slope and geological differences, and low water table (CNAT).

These strong intercorrelations between the supposed independent variables would account for some of the redundancies observed in Table 25. To remove the effect of these intercorrelations, as well as include the contribution of the "redundant" variables, we transform our 19 predictor variables into orthogonal values by principal components analysis. The correlation matrix was then subjected to PCA, and the components are derived from the latent vectors of the matrix. The correlation matrix was transformed by means of matrix algebra into a components matrix as shown in Tables 25 (unrotated components matrix) and 27 (varimax rotated components matrix), each component being defined by eigenvectors. The vertical sum of squared loadings indicate the total variance accounted for by each

TABLE 25: The Correlation Matrix of the Variables

	FS	POWS	CNAT	DIST	DAM	AGOV	STP	PIPE	ATT	NLK	BORE	DRY	FUEL	CORP	PPWL	COL	TAPs	TANK	POLIT
FS	1.00																		
POWS	0.53	1.00																	
CNAT	*0.83	*0.87	1.00																
DIST	*0.86	*0.84	0.99	1.00															
DAM	0.10	-0.07	0.07	0.11	1.00														
AGOV	*0.72	0.38	0.58	0.63	-0.07	1.00													
STP	-0.00	-0.52	-0.31	-0.26	0.15	-0.04	1.00												
PIPE	0.46	0.51	0.44	0.46	-0.22	0.68	-0.49	1.00											
ATT	0.64	0.42	0.58	0.59	0.43	0.31	0.10	0.23	1.00										
WLK	-0.31	-0.54	-0.49	-0.46	0.22	-0.57	*0.85	-0.40	-0.08	1.00									
BORE	*0.80	*0.78	*0.92	*0.94	0.10	0.56	-0.17	0.30	0.63	-0.42	1.00								
DRY	0.27	0.28	0.23	0.27	0.33	0.41	-0.23	0.66	0.06	0.01	0.13	1.00							
FUEL	-0.37	-0.50	-0.49	-0.47	0.24	-0.62	*0.82	-0.47	-0.14	*0.95	-0.42	0.03	1.00						
CORP	0.48	0.42	0.48	0.52	-0.11	*0.89	-0.59	0.80	0.05	-0.55	0.42	0.61	-0.60	1.00					
PPWL	0.46	*0.81	*0.78	*0.77	0.09	0.57	-*0.71	0.58	0.28	-*0.71	0.66	0.38	-*0.71	0.66	1.00				
COL	0.38	0.17	0.19	0.24	-0.02	0.08	0.51	0.34	0.37	0.46	0.20	0.33	0.46	0.02	-0.20	1.00			
TAPs	0.12	0.03	0.15	0.15	0.13	-0.41	*0.75	-0.33	0.18	0.63	0.17	-0.10	0.69	-0.48	-0.23	0.55	1.00		
TANK	0.49	*0.92	*0.81	*0.79	-0.23	0.48	-0.53	0.62	0.31	-0.48	*0.75	0.31	-0.51	0.60	*0.81	0.14	-0.04	1.00	
POLIT	*0.70	0.53	*0.75	*0.73	-0.26	0.48	-0.01	0.05	0.27	-0.38	*0.72	-0.19	-0.32	0.23	0.36	0.13	0.26	0.48	1.00

(* Significant relationship at 0.05 level of confidence) component, and this is known as the eigenvalue. The total variance is equal to the number of original variables, because the matrix is made up of correlations among the variables, each of which has a variance of 1.00.

The major components in the component matrix are identified on the basis of Kaiser (1959), and King's (1969) criteria. Kaiser (1959), assumes that the most important components have eigenvalues above unity and this is the most frequently used. King (1969) is of the view that the most important eigenvalues should explain over 5 percent of the total variance. In the views of Daultrey (1973), it does not really matter where the cut-off point is, provided the hetereogeneity of the eigenvalues/components can be demonstrated.

To determine the significance of the variables related to each components, we will regard only those variables with loadings from 0.70 and above as important. This cut-off value is an arbitrary decision rule based on the size of the loadings.

In keeping with Kaiser's (1959) rule, Tables 26 and 27 show five and six components respectively which account for most of the variance. The importance of a component may be weighed by looking at the proportion of the total variance accounted for by the components.

Usually, for purposes of analysis, eigenvalues are expressed as a percentage of the total number of variables explained. Most components analysts rotate their components via varimax method so that the loadings on some variables are either increased or decreased. This enables clearer interpretation of the components. For instance, five components were obtained for the unrotated components matrix but six components were obtained (Table 27) after varimax orthogonalization and the results presented in Table 27.

The Kaiser's varimax orthogonal rotation aims at maximising variance. The closer the loadings all are to ±1.0, the greater the potential contribution of each loading to the total variance accounted for. However, the issue of rotation as applied to PCA has received several criticisms such as that by Davies (1971) and Mather (1972). Daultrey (1978) while criticising the issue of components rotation asserts that varimax rotation among distorting reality does not maximise the variance explained.

A comparison of both the unrotated (Table 26) and the rotated (Table 27) component matrices show marked differences both in number of significant components and the percentage of the total variance explained by each.

TABLE 26: The unrotated principal components matrix for 13 communities in Isiala-Ngwa

Variables	Components				
	I	II	III	IV	V
FS	(0.76)	0.46	0.02	-0.02	-0.40
POWS	(0.85)	0.15	-0.12	0.00	0.45
CNAT	(0.91)	0.35	-0.17	0.06	0.08
DIST	(0.91)	0.38	-0.11	0.08	0.03
DAM	-0.05	0.28	0.26	(0.89)	-0.06
AGOV	(0.79)	-0.12	0.24	-0.12	-0.50
STP	-0.59	(0.74)	0.02	-0.12	-0.24
PIPE	0.68	-0.17	0.59	-026	0.03
ATT	0.46	0.54	-0.00	0.42	-0.22
WLK	(-0.71)	0.56	0.30	-0.06	0.08
BORE	(0.83)	0.42	-0.23	0.10	-0.02
DRY	0.36	0.02	(0.85)	0.11	0.17
FUEL	(-0.73)	0.57	0.26	-0.05	0.17
CORP	(0.76)	-0.31	0.44	-0.15	-0.17
PPWL	(0.88)	-0.18	-0.01	0.22	0.29
COL	0.07	(0.72)	0.46	-0.36	0.01
TAPS	-0.23	(0.87)	-0.12	-0.11	0.28
TANK	(0.86)	0. 06	-0.02	-0.17	0.42
POLIT	0.60	0.37	-0.51	-0.30	-0.20
EIGEN-VALUE	8.93	3.88	2.14	1.45	1.20
% OF VARIANCE	47.00	20.16	11.26	7.63	6.32
CUMULA-TIVE %	47.00	67.16	78.42	86.05	92.37

(Significant Loadings are in parenthesis)

For example, while the unrotated component matrix has five significant components that explains 92.37% of the total variance, the rotated component matrix has six significant components explaining 96.99% of the total variance. This therefore leaves a total variance of 7.63% unexplained for the unrotated component matrix, while that of the total unexplained variance for the rotated components matrix is 3.01%. From Tables 26 and 27, it is evident that the varimax rotation has failed in maximising the variance explained by the unrotated components matrix. This therefore, validates Daultrey's (1978) assertion. However, the unrotated components matrix appears incoherent for analytical interpretation since the 5th component which has eigenvalue of 1.20 and percentage variance of 6.32% (thus obeying Kaiser's (1959) and King's (1969) rule), does not have any significant loading above 0.60. For this reason, we are leaving the unrotated components matrix to concentrate our analysis on the varimax rotated components matrix (Table 27).

4.3.3. The Interpretation of Derived principal components:

From Table 27, the first component has high positive loadings on POWS (pollution of water sources), TANK (lack of storage tanks), PPWL (lack of pipeborne water),

TABLE 27: Varimax rotated components matrix for 13 communities in Isiala-Ngwa

Variables	Components					
	I	II	III	IV	V	VI
FS	0.25	0.02	(0.82)	0.29	0.06	0.36
POWS	(0.92)	-0.14	0.25	0.15	-0.06	0.16
CNAT	(0.72)	-0.08	0.64	0.14	0.08	0.18
DIST	0.68	-0.06	0.67	0.20	0.12	0.19
DAM	-0.03	0.11	-0.03	0.03	(0.97)	0.17
AGOV	0.05	-0.41	0.66	0.60	-0.05	0.13
STP	-0.43	(0.83)	0.14	-0.25	0.05	0.11
PIPE	0.32	-0.23	0.06	(0.82)	-0.25	0.26
ATT	0.27	0.08	0.34	-0.01	0.31	(0.82)
WLK	-0.35	(0.85)	-0.27	-0.05	0.12	-0.01
BORE	0.62	-0.04	0.68	0.05	0.11	0.24
DRY	0.21	0.11	-0.07	(0.89)	0.32	-0.09
FUEL	-0.30	(0.87)	-0.29	-0.10	0.15	-0.11
CORP	0.20	-0.43	0.35	(0.77)	-0.06	-0.09
PPWL	(0.74)	-0.46	0.26	0.29	0.18	-0.04
COL	0.09	(0.73)	0.13	0.39	-0.21	0.41
TAPS	0.21	(0.89)	0.16	-0.27	0.06	-0.04
TANK	(0.85)	-0.16	0.25	0.30	-0.20	0.06
POLIT	0.35	-0.02	(0.87)	-0.18	-0.23	-0.07
EIGEN-VALUE	4.38	4.37	3.81	3.08	1.46	1.33
% Of VARI-ANCE	23.05	23.00	20.05	16.21	7.68	7.00
CUMULATIVE %	23.05	46.05	66.10	82.31	89.99	96.99

and CNAT (shortage of water as a result of seasonality of rainfall, slope and geological differences, and low water table). What component I is describing is the general trend of correlation resulting from limitation of available sources, water storage facilities, improved sources, and index of natural influences to water shortage. The positive signs here means that there is positive correlation between the component and the variables. This also means that the areas with the highest increases in the above mentioned variables score highly on component I. Component I which has an eigenvalue of 4.38, accounts for 23.05% of the total explained variance reflects the general pattern of the limitation of available water sources in Isiala-Ngwa. It has therefore been identified as an indication of water deficiency. The simple correlation between areas having pollution of water sources (POWS) with variables TANK, PPWL and CNAT are 0.92, 0.81, and 0.87 respectively (Table 25). This further shows the influence of area and suggests that component I represents the pattern of the limitation of available sources index.

Component II has the highest number of positive loadings on variables TAPS (infrequent running of taps), FUEL (inadequate fuelling and repairs of pumping plants), WLK (pipe water leakage), STP (insufficient functional standpipes), and COL (lack of co-operation from members of the water board). What component II is describing is the problem of public water operation and distribution. Component II which has eigenvalue of 4.37 accounts for 23% of the total explained variance reflects the inherent problem of public water operation and distribution in Isiala-Ngwa. The problem of operation and distribution of public water supply has therefore been identified as one of the causes of water deficiency in Isiala-Ngwa.

Component III has an eigenvalue of 3.81 which accounts for 20.5% of the total variance. It has two positive loadings which score highly for variables POLIT (political differences in the area), and FS (few streams within the area). What component III is describing is the trend of correlation resulting from areas with different political inclinations and few surface water sources. The high simple correlation value of 0.70 (Table 25) confirms this fact. Component III is an indication of the influence of locational factors to water deficiency in the area.

In component IV, the variables with high loadings as shown in Table 28 are DRY (the drying of village wells), PIPE (lack of pipes for water connection) and CORP (misappropriation of community fund). The drying of the village wells is an indication of poor drilling methods

TABLE 28: Variables with highest loadings on the components

VARIABLES	COMPONENT I	LOADING
POWS	-	0.92
TANK	-	0.85
PPWL	-	0.74
CNAT	-	0.72
	COMPONENT II	
TAPS	-	0.89
FUEL	-	0.87
WLK	-	0.85
STP	-	0.83
COL	-	0.73
	COMPONENT III	
POLIT	-	0.87
FS	-	0.82
	COMPONENT IV	
DRY	-	0.89
PIPE	-	0.82
CORP	-	0.72
	COMPONENT V	
DAM	-	0.97
	COMPONENT VI	
ATT	-	0.82

or lack of hydrogeological expertise due to lack of fund to employ experienced engineers. Lack of pipes for water connection may be due to lack of fund to purchase the pipes or that the pipes are not available due to inadequate technological know-how. While misappropriation of community fund is an indication of corruption as a result of the desire to acquire more money. Generally, component IV is an indication of technological/financial inadequacies. Thus, this component IV which has eigenvalue of 3.08 and accounts for 16.21% of the total variance has been identified to be the influence of technological/financial inadequacies to rural water deficiency in Isiala-Ngwa.

Component V with eigenvalue of 1.46 accounts for 7.68% of the total variance. It has only one significant positive loading on variable DAM (damages to standpipes during road construction/grading). This component could be interpreted as constructional index particularly on the new express roads running from Umuahia to Aba. Therefore, component V has been identified as an indication of the influence of constructional problems to water deficiency in Isiala-Ngwa.

Component VI has the least eigenvalue of 1.33 and explains 7% of the total variance. It also has one significant positive loading on variable ATT (careless attitude of the people in handling the public standpipes). This component indicates a general lack of policy against any person found tampering with the standpipes or a lack of management strategies in the form of supervision of the standpipes in the part of members of the water Board. Thus, component VI is an indication of management/policy inadequacies to water deficiency in Isiala-Ngwa.

From the above analysis and interpretation of the principal components, it can be adduced that all the significant loadings in the components are positive. This therefore signifies that there is positive correlation between the components and the variables. Accordingly, the following underlisted components have been identified as the indices/components responsible for water deficiency in Isiala-Ngwa.

1. The general limitation of the available water sources.
2. The problem of public water operation/distribution.
3. The influence of locational factors.
4. The influence of technological/financial inadequacies.
5. The problem of road construction/grading.
6. The influence of management/policy inadequacies.

The use of principal components analysis has made it possible to reduce our 19 predictor variables into 6 major components responsible for water deficiency in Isiala-Ngwa. Thus, the 6 major components responsible for water deficiency in the area incorporates both physical, social, economic and political problems, and hence validates our first assumption that the causes of water deficiency in Isiala-Ngwa is influenced by physical, socio-economic and political factors. Some of the 6 major components responsible for water deficiency in Isiala-Ngwa correspond with the findings elsewhere, such as that by Emezie (1980), and Obot (1984).

4.4 The effects of water deficiency and their implications for the development of Isiala-Ngwa:

As has been established that there is water deficiency in Isiala-Ngwa, and the root causes also enumerated. What then are the effects of this water deficiency in the area to warrant the energy being expended to rectify the causes. To fully examine the effects of water deficiency and their implications for the development of the area, some topical issues catalogued during the course of fieldwork need to be elucidated.

4.4.1. The effects of the water deficiency in Isiala-Ngwa:

This section will analyse the direct effect of the water deficiency on the people of the area. In otherwords, this section will devote attention on the problems people encounter (on individual basis) as a result of water shortages. This will be discussed under the following subsections. Thus:

4.4.1.1. The water collection journey/Time spent in water collection:

The mean distance travelled in search of water in Isiala-Ngwa was found to be about 5km with standard deviation of about 2km. The average time spent in water collection was also found to be about 2 hours. When the percentage average daytime was calculated to find the proportion of the day spent for water fetching, we discovered that water fetching occupied about 18% of the daytime with standard deviation of about 5% (Table 29). We assumed here that the daytime actually used for productive activities is 12 hours.

TABLE 29: Distances and Time spent in water collection in Isiala-Ngwa:

Communities	Estimate of average distance travelled (km)	Average Time spent (hrs)	% of average day time spent in water collection
Amaise	5	1.98	16.5
Amaise-Ahaba	7	3.15	26.25
Mbutu	4	1.72	14.33
Ngwaobi	5	2.25	18.75
Ngwaukwu	5	2.10	17.5
Nsulu	3	1.23	10.25
Ntigha	3	1.07	8.92
Nvosi	6	2.32	19.33
Okporo-Ahaba	7	2.62	21.83
Omoba	2	2.42	20.14
Ovungwu	6	2.36	19.67
Ovuokwu	5	2.18	18.17
Umuoha	5	2.00	16.67
Mean	4.85	2.12	17.56
Std. deviation	1.5	0.55	4.57

From Table 29, the average estimated distance travelled for water collection ranges from 2km for Omoba to 7km for Amaise-Ahaba and Okporo-Ahaba. While the average time spent for water collection ranges from 1.07hrs in Ntigha to 3.15hrs in Amaise-Ahaba. Similarly, the percentage of average daytime spent in water collection also ranges from 8.92% in Ntigha to 26.25% in Amaise-Ahaba. These trends are explained by the fact that Amaise-Ahaba does not have any form of surface water at all or boreholes. So the people travel long distances in search of water as opposed to Ntigha that has streams and boreholes with some functional standpipes.

From the table, one would have expected Omoba that has the least distance to have the least time but here, Omoba inhabitants spend 2.42hrs for water collection. This is because Omoba depends solely on public water supply and so have to spend much time in queuing and struggling for water.

As has been established, the water collection journey of about 5km contradicts the West African Studies figure of 13km for the Ngwa of Southeastern Nigeria as quoted by Chisholm (1968). The West African Studies figure is therefore over-generalised particularly for Isiala-Ngwa. But our average figure of about 5km agrees with their generalisation for Eastern Nigeria.

As can be seen from Table 29, the people of Isiala-Ngwa spend an average percentage of about 18% of the day in water collection. This thus leaves about 82% of the daytime for other productive activities. For 18% of the daytime to be devoted to water collection alone, creates a lag for other productive activities as shown in Table 30. Table 30 shows the frequency of losses encountered by the people of the area as a result of water shortage/long water collection journey as recorded from the questionnaire samples.

From Table 30, losses due to water shortage/long distance to the sources, not specifically mentioned in the questionnaire account for the highest with 274 representing about 25%, while injuries/major accidents is the least with 148 representing about 13%. Other losses due to water shortage/long distance to the sources include missing of belongings at the water source, pots and other water containers broken, children not participating in moonlight plays, and business drawbacks (undefined). Table 30 shows that children miss/go to school late as a result of shortage of water/long distance to the water source, this represents about 24% of the overall losses.

TABLE 30 : Frequency of loss(es) due to shortage of water/ long water collection distance in Isiala-Ngwa

Communities	Missing/ going to farm late	Not going to hawk	Missing/ going to school late	Injuries/ major accidents	Others
Amaise	13	9	14	8	16
Amaise-Ahaba	15	13	18	10	16
Mbutu	17	13	18	16	19
Ngwaobi	15	11	14	10	22
Ngwaukwu	18	14	26	10	22
Nsulu	39	29	46	29	27
Ntigha	15	12	17	9	12
Nvosi	28	24	34	19	42
Okporo-Ahaba	15	11	20	9	18
Omoba	7	18	12	7	23
Ovungwu	16	14	23	12	19
Ovuokwu	18	12	20	9	18
Umuoha	19	12	27	12	20
Total	253	192	271	148	274
% Total	21	17	24	13	25

From Table 30, it can also be seen that as a result water shortage and the search for water, some economic activities are affected such as going to farm late which represents about 21%, and not going to hawk which represents about 17% of the overall losses. This therefore hampers or prolongs the time for farming and also militates hawking activities. It is also important to note that most of the rural people get their income from these economic activities which seem to suffer due to the search for water. Also, the people use the money from these economic activities to buy water which seems to marginalise the people's income. This is illustrated in Table 31 which shows how the people of the area get their revenue for buying water during the period of water shortage.

From Table 31, it can be seen that the people get the revenue for buying water during the periods of water shortage mainly from selling of their agricultural products which account for about 61%, and cutting down of other expenses which account for about 30%. Some people borrow money to buy water which accounts for about 5%, while other sources not specified in the questionnaire account for about 4%. These other sources include doing outside labours such as hawking and trading.

What can be adduced from Table 31, is that water shortage in the area has placed the people in marginal income. This is because the little they get which could have been utilized for other productive activities such as hawking and trading, is used in purchasing water.

TABLE 31: Frequency of sources of revenue to buy water in Isiala-Ngwa:

Communities	Cutting down other expenses	Selling of agric. products	Borrowing	Others
Amaise	8	18	2	0
Amaise-Ahaba	8	16	3	0
Mbutu	10	18	1	3
Ngwaobi	6	12	2	3
Ngwaukwu	7	17	0	4
Nsulu	19	39	3	0
Ntigha	7	14	0	0
Nvosi	10	18	1	3
Okporo-Ahaba	9	19	2	0
Omoba	5	6	0	0
Ovungwu	10	21	1	0
Ovuokwu	10	15	1	2
Umuoha	9	22	3	0
Total	118	235	19	15
% Total	30	61	5	4

4.4.1.2 Social/household problems:

Many social/household problems have been catalogued as a result of shortage of water in the area as shown in Tables 32 and 33.

TABLE 32 : Frequency of household problems encountered during water shortage in the area:

	Clothes not washed	Cooking delayed	Cannot bathe when wanted	No water for drinking	Others
Amaise	13	17	14	10	16
Amaise-Ahaba	16	18	24	18	15
Mbutu	19	19	20	17	24
Ngwaobi	13	17	14	11	22
Ngwaukwu	18	22	34	15	24
Nsulu	45	53	59	50	38
Ntigha	15	14	24	10	13
Nvosi	37	38	42	32	24
Okporo-Ahaba	17	11	19	12	18
Omoba	10	11	17	8	23
Ovungwu	20	18	17	13	23
Ovuokwu	19	21	22	17	19
Umuoha	23	15	29	16	18
Total	265	274	335	229	277
% Total	19	20	24	17	20

From Table 32, some household problems manifested as a result of water shortage include people not bathing when wanted, cooking delayed, clothes not washed, lack of drinking water and others which include toilets not washed, buildings stopped, palm oil processing stopped, and death

TABLE 33: Frequency of social problems encountered during water shortage in the area

Communities	Struggling	Fighting	Quarreling	Others
Amaise	19	10	11	7
Amaise-Ahaba	22	12	15	6
Mbutu	21	16	14	9
Ngwaobi	20	6	9	9
Ngwaukwu	29	15	16	12
Nsulu	45	35	31	18
Ntigha	16	8	14	10
Nvosi	34	25	24	21
Okporo-Ahaba	24	16	16	8
Omoba	17	11	7	11
Ovungwu	25	16	16	11
Ovuokwu	23	12	11	7
Umuoha	28	15	17	9
Total	323	197	201	138
% Total	38	23	23	16

of crops. The most important problem encountered during water shortage is that of not finding water to bath when wanted, and this represents about 24%, while the least problem is lack of water for drinking which represents about 17%. The generally almost equal percentage of these household water problems indicate that they exert almost equal weight.

From Table 33, some social problems encountered during the course of water fetching are struggling, fighting, quarrelling, and others such as insults and abuses from juniors. The most pressing social problem is struggling which represents 38%, while the least is others with 16%.

4.4.1.3. Health Problems:

One of the major repercussions of water deficiency in any geographical area is its inherent health problems. The health problems encountered as a result of water fetching and problems of water inadequacy have been shown in Tables 34 and 35.

From Table 34, health problems encountered as a result of water fetching include headache due to constant carrying of water, tiredness, from climbing hilly slopes painful and stiff joints due to trekking, malaria due to exposure to malarial parasites, and others which include snake/scorpion bites, early morning cold and hynia. The problem of headache is the highest with 28% while tiredness due to climbing hilly slopes is the least with 10%. These health problems help to make the people easily susceptible to diseases which invariably affect their productive capacities. Because of this, the people easily fall victims of water-related diseases such as shown in Table 35.

TABLE 34: Incidence of health problems encountered as a result of water fetching in Isiala-Ngwa

Communities	Head-ache	Tiredness from climbing hilly slopes	Painful and stiff joints	Malaria	Others
Amaise	18	6	16	13	15
Amaise-Ahaba	20	8	17	16	13
Mbutu	18	7	22	18	16
Ngwaobi	18	3	16	12	13
Ngwaukwu	22	3	22	22	14
Nsulu	41	38	34	33	4
Ntigha	20	5	11	17	15
Nvosi	38	23	37	30	20
Okporo-Ahaba	20	4	26	13	10
Omoba	18	0	16	9	7
Ovungwu	26	0	18	18	12
Ovuokwu	20	2	20	13	19
Umuoha	26	4	20	13	19
Total	281	103	216	230	175
% Total	28	10	22	23	17

TABLE 35: Incidence of water-related disease in Isiala-Ngwa

Communities	Diarrhoea	Scabbies	Cholera	Dysentery	Others
Amaise	15	7	3	7	3
Amaise-Ahaba	19	8	8	9	10
Mbutu	17	10	5	12	9
Ngwaobi	13	8	3	7	9
Ngwaukwu	16	10	4	12	7
Nsulu	15	11	5	17	10
Ntigha	11	8	2	6	7
Nvosi	22	10	8	17	11
Okporo-Ahaba	24	21	5	12	13
Omoba	8	3	0	4	2
Ovungwu	22	18	5	12	8
Ovuokwu	15	10	5	14	8
Umuoha	16	10	4	10	11
Total	213	134	57	139	108
% Total	33	20	9	21	17

From Table 35, the water-related diseases suffered by the people are diarrhoea scabbies, cholera, dysentary, and others such as rheomatism, Diarrhoea affects the people most and this represents 33%, while cholera is the least with 9%. The spatial distribution of these water-related diseases show that Okporo-Ahaba has the highest occurrence with 75, while Omoba has the least with 17. This trend is explained by the fact that Okporo-Ahaba does not have either surface water or functional stand-pipes except the newly drilled United Nations International Children Emergency Fund (UNICEF) mono-hand pump which is yet to start functioning, unlike Omoba which gets its water solely from the public water supply. This phenomenon shows that the establishment of improved water supply through pipeborne water could go a long way to improving the rural health of the people.

4.4.2. The Implication of Water deficiency for the development of Isiala-Ngwa:

This section tries to show the effect of water deficiency on the development of Isiala-Ngwa. The sectors where deficiency of water have played prominent roles in militating against rural development are grouped into three, namely, agricultural production, rural industrialisation; and tertiary activities.

4.4.2.1 Agricultural production:

Many agricultural activities in the area have stopped as a result of lack of adequate water supply. For instance, in Ikputu village in Nsulu community, the attempt to cultivate rice on a commercial level has failed due partly to lack of adequate water supply and inadequate soil properties/minerals. Also, during the dry season, many heaps of palm oil nuts are wasted in many communities notably in Amaise-Ahaba, Nvosi, Okporo-Ahaba, Ovungwu and Umuoha due to lack of water. During this period, some people most of whom get their mains of sustenance from oil palm processing are rendered unemployed.

On several occassions, women leave their farm work to fetch water for one community development project or the other. To these women, the opportunity cost of going to fetch water for community development projects is the farm work left undone. But the women have no choice since they cannot afford to pay the penalty accruing to any defaulter. Also, during the rare occassions when the public standpipes run, many farmers leave their farm work to struggle and possibly fight for water. All these help to limit the agricultural productivity. There are many cases when the crops planted close to the compounds wither during the dry season. These crops could have been watered (irrigated) if there were available water.

4.4.2.2. <u>Rural Industrialisation:</u>

Many rural industries have folded up in Isiala-Ngwa as a result of water shortage. For instance, in 1986, the

Onyeama's block industry at Umuala Nsulu folded up when their tanker lorry that supplies them with water from the Otamiri stream ("iyi ubaha") spoilt. The corn mill food processing limited at Umuosu Nsulu folded up during the early 1970's due partly as a result of water shortage. They were spending large amounts of money in buying water from the local hawkers. The local soap industry in Ovungwu which makes use of the fibres from oil palm head folded up in 1984 partly as a result of lack of water. Presently (1988), one of the major problems facing the Adapalm Nigerian Limited at Nbawsi, which processes and markets oil palm products is that of inadequate water supply (Njoku, 1987). All these show the impact of water deficiency on the establishment and growth of rural industries which is a sine-qua-non to rural development.

4.4.2.3. Tertiary activities:

As a corollary to the shortage of water supply in the area, many tertiary activities are affected. For instance, many building constructions such as schools, churches, civic/kindred halls are stopped during the periods of acute water shortage. The plastering of Ichi Civic hall in Umuoha community was abruptly stopped during the months of November to March 1987/88 as a result of shortage of water.

Also, many villages have lost their bid to have secondary schools established in their area as a result of lack of any form of water supply. For example, the present Umunna comprehensive Secondary School at Umuosu Nsulu would have been sited at Umuezeukwu Nsulu except that they do not have any reliable water supply. Also, the present Umuoha Secondary School at Uratta village would have been sited at Ichi village except that they do not have any reliable source of water.

There are occasions when the pupils and teachers posted to Ngwaukwu technical secondary school, Okporo-Ahaba secondary school, and Ovungwu secondary school refuse going there mainly because they do not have either water supply or electricity. All these show the importance of water supply to rural development in the area.

4.5 Spatial delineation of zones of relative deficiency of water supply:

From the analysis done so far in the previous sections, we now present the areas according to their level of water deficiency in a way to delineate spatial areas of rural water priority zones. This is done by evaluating the problems each community encounters in its water needs as presented in Table 36.

Table 36 shows the parameters used in delineating the spatial rural water priority zones in Isiala-Ngwa. The values of the variables in the communities are shown in columns A-H, while the mean of the variables are used as the yardstick for evaluating the contributions of the variables in the communities as shown in Table 37.

On how the ranking in Table 37 was derived, the figures in Table 36 were scaled from 1 to 5 representing very high; high; medium; low; and very low water problem/priority accordingly. If for instance, in Column A (in Table 36), the mean value is 2 which automatically represents medium, and below the mean will be high water problem assigned with either 1 for very high priority or 2 for high priority, while above the mean will be low water problem assigned with either 4 for low priority or 5 for very low priority. For example, using Table 36 to derive Table 37, zero (0) in column A of Table 36 represents absence of surface water sources

TABLE 36: The rural water priority zones (see key below the table for interpretation)

Communities	A	B	C	D	E	F	G	H
Amaise	1	0	0	5	17	56	43	35
Amaise-Ahaba	0	1	0	7	26	67	27	54
Mbutu	2	2	30	4	14	49	47	53
Ngwaobi	0	1	0	5	19	61	30	40
Ngwaukwu	4	3	49	5	18	63	45	49
Nsulu	12	4	30	3	10	49	63	58
Ntigha	2	3	35	3	9	50	50	34
Nvosi	1	3	36	6	19	53	42	68
Okporo-Ahaba	0	2	0	7	22	67	30	75
Omoba	0	1	8	2	20	61	65	17
Ovungwu	1	2	27	6	20	67	35	66
Ovuokwu	1	1	1	5	18	68	31	53
Umuoha	3	1	3	5	17	66	31	51
Mean	2	2	17	5	18	60	42	50
Standard deviation	3	1	18	2	5	7	13	16

Key

A = The number of surface water sources

B = The number of boreholes/wells

C = Number of functional standpipes

D = The distance travelled to the water sources (km)

E = The percentage of average daytime spent in water collection.

F = The percentage margin of water deficiency

G = The mean water consumption per person (litres)

H = Cases of water-related diseases.

such as streams, springs and ponds, and so is assigned with the value of 1 which means very high water priority while 12 which is the highest value for column A is assigned with 5 which represents very low water priority/problem. This process is used for columns A,B,C,D and G.

In the case of columns E,F and H of Table 37, the reverse of the first process is the case. For instance, in column E of Table 36 which shows the percentage of average daytime spent in water collection, the highest value of 26 is assigned with 1 representing very high water problem, while the lowest value of 9 is assigned with 5 which means a very low water problem. This is so because the higher the daytime spent in water collection is an indication of water problem and vice versa.

TABLE 37 : Ranking of rural water priority zones in Isiala-Ngwa

Communities	A	B	C	D	E	F	G	H	Total
Amaise	2	1	1	3	4	4	3	4	22
Amaise-Ahaba	1	2	2	1	1	1	1	2	11
Mbutu	3	3	4	4	4	5	3	2	28
Ngwaobi	1	2	1	3	2	3	2	4	18
Ngwaukwu	4	4	5	3	3	2	3	3	27
Nsulu	5	5	4	4	5	5	5	2	35
Ntigha	3	4	5	4	5	5	4	4	34
Nvosi	2	4	5	2	2	4	3	1	23
Okporo-Ahaba	1	3	1	1	2	1	2	1	12
Omoba	1	2	2	5	2	3	5	5	25
Ovungwu	2	3	4	2	2	1	2	1	17
Ovuokwu	2	2	1	3	3	1	2	4	18
muoha	4	2	1	3	4	2	2	3	21

Key

1 = very high water priority

2 = High water priority

3 = medium priority

4 = Low priority.

5 = very low priority.

The totals of the rankings for the communities shown in Table 37 indicate a variation of 24 ranging from 11 for Amaise-Ahaba to 35 for Nsulu. These ranked totals were used in delineating the whole area into five zones of relative deficiency of water supply shown in Fig.17. From Fig.17, Amaise-Ahaba, Okporo-Ahaba, and Ovungwu have the highest water priority, while Nsulu and Ntigha have the least water priority. Areas with fairly medium rural water need are Amaise, Ngwaukwu, Nvosi, and Omoba.

The lower the total ranked values (Table 37), the more water priority, while the higher the value, the lower the priority. The above analysis has shown that the water deficiency in the area varies spatially. However, as can be seen from Fig.17, there is a northeast to south west water deficiency trend, with areas in the north more favoured than those in the south. The reason for this type of pattern may be explained by the fact that, areas in the north have more surface streams, springs and ponds than those in the south.

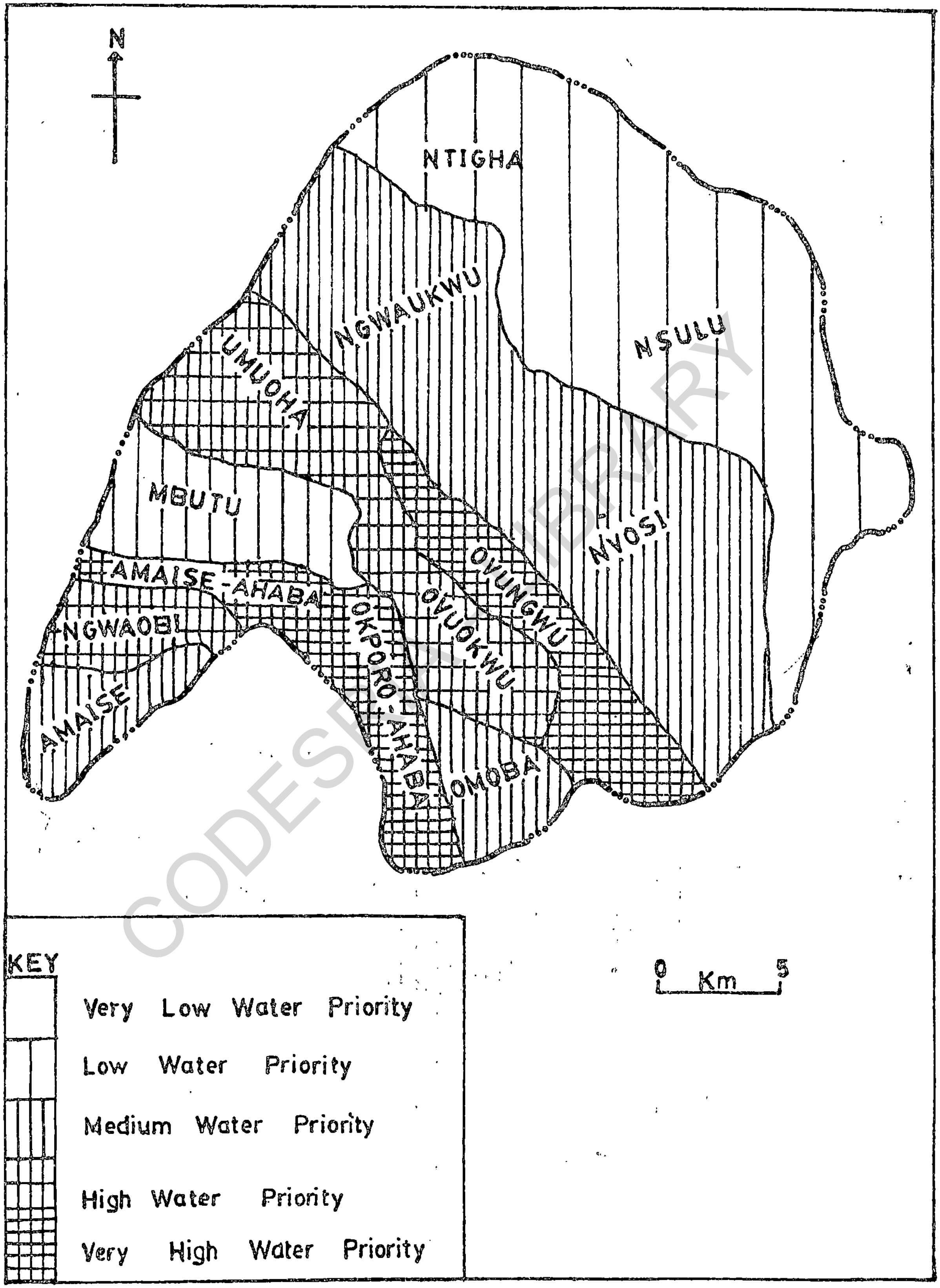


FIG. 17 : DELINEATION OF RURAL WATER PRIORITY ZONES IN ISIALA-NGWA.

CHAPTER 5

STRATEGIES FOR MEETING THE WATER NEEDS OF THE AREA

5.1 Existing strategies for water development in Isiala-Ngwa:

As has been established in the previous chapters, there is water deficiency in Isiala-Ngwa. To cope with this problem, different approaches or strategies are made by the government and people to supply water. Strategy as used in this work implies different approaches or methods which involves many water development facets used or to be adopted in the area to solve the problem of rural water supply. Three strategies are in existence in the Local Government Area, and they are discussed below.

5.1.1. Public participation in rural water development:

The government participates in the development of rural water supply through the setting up of six rural water works controlled by the Imo State Water Board, Isiala-Ngwa zone, as discussed in section 3.1. These rural water works get their water from their respective boreholes. In otherwords, they adopt a strategy based on the tapping of groundwater resources in the development of her water supplies. The water from these boreholes are not treated before they are distributed to the consumers. The water is distributed through public stand-pipes in the communities where the pipelines exist as discussed in section 3.1.1.

An agency that has assisted the government in the development of rural water supply is the United Nations International Children's Emergency Fund (UNICEF). Presently, there are 12 UNICEF handpumps (Table 38) distributed among some of the water priority areas shown in Fig.17. However most of these handpumps have become non-functional (plate 13) due to inadequate feasibility studies of the water table depths. New contracts have been awarded to drill new mono-handpumps to replace the non-functional ones in Mbutu, Ichi, Umueleghele, Umuehim, and Okporo-Ahaba health centre site. All the same, these UNICEF mono-handpumps have helped to minimise the problem of rural water supply in Amaudara (Ngwaobi), Umuejije (Ovungwu), Ahiaba-Okpuala (Ngwaukwu), and Umuomainukwu (Nsulu).

5.1.2 Village/community participation in rural water development:

The villages/communities also engage in water development/supply through community efforts. Many villages in Nsulu community have undertaken annual fund raising ceremonies for water supply. These villages are Agburuke, Amachi, Umuakwu, Umuode and Umuosu. In communities where the villages are essentially too small to undertake water supply through community effort, the community engages in water supply through the combined effort of all the villages forming it. These communities are Mbutu, Ovungwu, Umuoha and Ntigha. In all these villages/communities, every working class male adult, married men and women are levied a fixed sum of money on a pro rata basis. Usually the men pay more than the women. For instance, in Umuode (Nsulu), men were levied ₦10.00 while women paid ₦5.00 in 1987. All working class male adults are usually compelled to pay the levies whether the person is living within the village or not. Defaulters of these levies are penalized accordingly.

Free-will donations are also expected from members of the village/community as well as from invited guests during the fund raising ceremonies. During the fund raising ceremonies, individuals and organisations from different town branches use these occasions as avenues to display wealth and to know who is who in the village/community.

PLATE 12: A non-functional UNICEF mono-handpump in Umuogu village in Nsulu community.

TABLE 38: Location of UNICEF mono-handpumps in Isiala-Ngwa Local Government Area

Location/village	Community
Umuogele Ntigha	Ntigha
Ichi	Umuoha
Ahiaba Okpuala	Ngwaukwu
Mbutu	Mbutu
Amuke	Okporo-Ahaba
Amaudara	Ngwaobi
Umuode	Nsulu
Umuomaiukwu	Nsulu
Umuogu	Nsulu
Umuejije	Ovungwu
Umuehim	Nvosi
Umueleghele	Ovuokwu

Considerably large sums of money are realised during these ceremonies. For instance, Umuode village (Nsulu) realised ₦48,000.00 in 1987, while Agburuke (Nsulu) realised ₦32,000.00 in the same year.

In all these villages/communities, the main choice of water supply strategy has been to tap the groundwater using borehole and then piping the water to different locations in the village(s). In some villages where the construction of the water project have started, like in Agburuke and Umuode villages of Nsulu, the job execution is done by a contractor. On several occasions, the villagers (adult males) are compelled by the village counsellors to supply labour, like in the construction of trenches. Defaulters are penalized appropriately.

It is important to note that most attempts by the people to supply water have remained in the planning stage. This is because of lack of fund, inadequate planning, lack of support from the government and corrupt practices. Many cases abound where the village leaders convert the fund meant for water supply projects to private use. In some villages/communities, like in Umuosu (Nsulu) and Umuoha, the idea of providing water supply by the people have been forgotten, and the already contributed money cannot be retrieved from the village/community leaders. This then has militated against water supply development.

Also, during the 1960s, the villages engaged in the construction of wells. This was subsized by the local government. But, these wells have dried up (see plate 7) except one found in Eziama (Ntigha), Mba (Okporo-Ahaba) and Mgbedeala (Amaise-Ahaba). The water from these wells have been polluted and the people do not drink water from them. These wells dried up mainly as a result of inadequate knowledge of the depths of the permanent water table which is about 49 metres deep as found in this research.

Most of the villages also engage in constructing catchment pits to collect rainwater during the rainy season. (see plate 2) They use the water for non-domestic and at times for domestic activities like washing. The villages that have ponds and springs clean them periodically to guarantee the supply of clean water.

5.1.3. Individual participation in water development:

Individuals also participate in water development through the construction of underground concrete tanks and the buying of metal tanks. Water is then directed to these tanks for storage by channelisation mainly during rainfall (see plate 10B) Other common methods are the use of storage facilities like drums, pots, gourds, buckets and basins.

Recently, many well-to-do members of the area have started drilling boreholes for private use. In many cases, these borehole owners install a standpipe infront of their compounds for public use. This, thus, has helped to reduce the problem of water supply in some villages. Individuals also construct catchment pits to collect rainwater during the rainy season for domestic and non-domestic water activities.

5.2 Evaluation of the existing water development strategies in the area:

As seen from section 5.1, there is a joint participation of the government, village/community, and individuals in water development. Except perhaps in individual participation, there are common features apparent in both the public and village/community participation in water development. These are:

(i) The use of boreholes as the main source of water supply.

(ii) Building of high level storage tanks

(iii) The use of generating plants for powering the pumps.

(iv) The distribution of water to different locations/villages through a pipe network system.

Before a village is selected for water supply, the village/community must show enough enthusiasm by way of agitation, petition, and frequently demanding assistance from the government. Also, the village/community must be financially viable in terms of contributing some portion of the cost of construction of the system, a contribution to be made in terms of money, labour or both. This is like community self financed program and this method has been highly used in Latin America and several Asian countries. When all the necessary construction and installation works have been completed, the pipelines are then connected to the general public water system and the water is rationed among the villages/communities to maximise the hydraulic gradient (that is pressure). This rationing accounts for why taps run for only few hours during the day.

In some villages/communities with pipeborne water, there is no fixed distance for the installation of public standpipes. The standpipes are located haphazardly over the area. This results in some people in many villages/ communities with pipeborne water, travelling more than 2kms to the public standpipes in search of water. According to Nwokonko (1987), the standpipes were located in their present site using a target population of 500-1000 as the yardstick. This strategy accounts for why some public standpipes are sited where there is little or no settlements and people have to trek long distances to this 'meeting point'. For instance, the people of Amuzu village in Ngwaukwu trek about 3kms to Okpuala-Ngwa to fetch water because there is no standpipe in their village. This is due to the fact that they were not up to the expected population then, and Okpuala-Ngwa was chosen as a central point to serve the village.

Also, some villages are selected for pipeborne water on political basis. Political party henchmen provided pipeborne water to their area and areas loyal to their party irrespective of whether they reach the expected population of 500-1000 people. This phenomenon explains why some villages/communities do not have any form of piped water while their neighbouring villages have pipe-borne water. In these areas with pipeborne water, the standpipes are located near or infront of the compounds of the influential members of the village. Other members of the village have to trek there to fetch water. On many occasions, these influential members either personally or by their sons/daughters, control and determine who fetches water as if it is their personal property. Also, this method of locating standpipes accounts for their haphazard spatial positions.

At this junction, it is necessary for us to examine the above working strategies in order to find out whether the strategies are in line with the public water needs of the people of Isiala-Ngwa. Thus verifying our third assumption: whatever water development strategy existing in the area is ineffective. The assumption will be analysed under the following headings:

5.2.1 The number of villages/communities served with pipeborne water:

There are 144 villages/wards in Isiala-Ngwa. Out of these 144 villages, 122 villages have water taps (both functional and non-functional). Out of these 122 villages, 57 villages have functional taps, while 65 villages have non-functional taps. This shows a lag of functional taps over non-functional ones. Table 39 shows the distribution of public standpipes in the communities together with the number of times they run per week and how long the standpipes have stayed without functioning.

From Table 39, Amaise, Amaise-Ahaba, Ngwaobi and Okporo-Ahaba communities have standpipes that have not flowed ranging from a period of 1-18 years, while Ngwaukwu and Umuoha have all its standpipes functional. However, it is important to note that Umuoha community has only one village with pipeborne water (see Appendix C). Other communities have both functional and non-functional standpipes with Nvosi, Mbutu and Ngwaukwu topping the list in having functional standpipes, while Ovuokwu and Umuoha have the least functional standpipes.

TABLE 39: Number of villages with pipeborne water, time of flow per week (hrs), and length of time the standpipes have stayed without water (years) in Isiala-Ngwa (Source: Fieldwork, 1987)

	Total No. of villages	No. of villages with standpipes	No. of villages with functional standpipes	No. of villages with non-functional standpipes	Duration of flow per week (hours)	Length of time the standpipes stopped functioning
Amaise	5	5	0	5	-	4-7yrs
Amaise-Ahaba	5	5	0	5	-	2-10yrs
Mbutu	15	13	10	3	3hrs/3times	3-17yrs
Ngwaobi	6	6	0	6	-	1-4yrs
Ngwaukwu	12	10	10	0	4hrs/3times	-
Nsulu	23	11	5	6	2hrs/2times	1-18yrs
Ntigha	7	7	3	4	3hrs/2times	since 4yrs
Nvosi	24	24	16	8	2hrs/2times	1-16yrs
Okporo-Ahaba	10	10	0	10	-	Over 18yrs
Omoba	7	5	3	2	4hrs/3times	3-8yrs
Ovungwu	11	11	8	3	2hrs/2times	8-18yrs
Ovuokwu	14	14	1	13	2hrs/ 2times	1-9yrs
Umuoha	5	1	1	0	2hrs/2times	-
Total	144	122	57	65	3hrs/2times	1-18yrs
% Total	100	84.7	46.7	53.3		

The general pattern, as shown in Table 39 indicates that the public standpipes run for a duration of 2-4hours in either twice or thrice per week. The silent point about this generalisation is that not all the villages having functional standpipes get this water at the same time. The water is rationed to different villages at different times and days of the week, thus leaving some villages without water for 3 to 4 days. These villages therefore face serious water shortages during the periods without water.

From Table 39, it can also be seen that there are 57 villages with functional standpipes representing 46.7% of the villages with public standpipes. While the villages with non-functional standpipes are 65 and represents 53.3%. The standpipes were made non-functional as a result of disuse and road construction. But these non-functional standpipes can still be made functional, yet, nothing has happened. This is a mark of inefficiency on the part of the water board.

5.2.2. The spatial distribution of public standpipes in the communities of Isiala-Ngwa:

There are 783 public standpipes in Isiala-Ngwa. Out of this number, 564 standpipes are non-functional. While 219 standpipes are functional (see how the standpipes are distributed among the villages in Appendix C). This represents 26% of the functional standpipes as against 74% of non-functional standpipes in the area. Table 40 shows the spatial distribution of public standpipes in Isiala-Ngwa.

From Table 40, Umuoha community has the least number of standpipes, while Nsulu with 135 standpipes has the highest. Ngwaukwu has the highest number of functional standpipes with 49, while four communities do not have any functional standpipes at all. These four communities are Amaise, Amaise-Ahaba, Ngwaobi and Okporo-Ahaba. These communities except Amaise do not have any form of surface water. They therefore suffer from acute shortage of water as illustrated in section 4.2. Hence, the water vendors have started to exploit the situation and large sums of money are spent by the people in buying water.

Table 40 also shows that Nsulu and Nvosi have the highest number of non-functional standpipes with 105 and 87 respectively, while Umuoha has the least with 1. Generally, there are 564 non-functional standpipes out of 783 standpipes in the area. These non-functional standpipes can be made functional by comparatively small repair works. The question is, why has the Imo State

TABLE 40: Distribution of public standpipes in the communities of Isiala-Ngwa (Source: Field work, 1987)

	Total No. of stand-pipes	No. of functional stand-pipes	No. of non-functional stand-pipes	% of functional stand-pipes	% of non-functional standpipes
Amaise	24	0	24	0	100
Amaise-Ahaba	43	0	43	0	100
Mbutu	59	30	29	51	49
Ngwaobi	24	0	24	0	100
Ngwaukwu	103	49	54	48	52
Nsulu	145	30	105	22	78
Ntigha	68	35	33	52	49
Nvosi	123	36	87	29	71
Okporo-Ahaba	40	0	40	0	100
Omoba	49	8	41	16	84
Ovungwu	61	27	34	44	56
Ovuokwu	50	1	49	2	98
Umuoha	4	3	1	75	25
Total	783	219	564	26	74

Water Board, Isiala-Ngwa zone, stayed so long to take appropriate effectual steps to remedy the situation? This delay and neglect is tantamount to inefficiency.

From the analysis so far, we can draw the following conclusions as a result of the adoption of the present/ existing water development strategies. Thus:

(i) The per capita water consumption of 42 lpd is very low as found in section 2.4. This figure only represents 36.5% of the Federal Republic of Nigeria's recommended standard.

(ii) Related to the above is the fact that the average daily water supply of 25 lpd from the public supplies is also too low.

(iii) The average water collection distance of about 5km is too high. For any water development strategy to be effectively felt in any geographical area, the distance travelled to the water source must be at its minimal. That about 18% of the day time is spent in water collection creates a lag for other productive activities. This therefore calls for an immediate reappraisal of the existing water development strategies in order to meet the present water needs of the people of the area.

(iv) Also, that only 57 villages out 144 villages/ wards in the area have functional standpipes signifies a degree of inefficiency in the strategy adopted for rural water development. This then calls for an immediate arrest of the situation through the adoption of new water development strategies.

(v) It is unfortunate that out of 783 public stand-pipes in the area, only 219 are functional. This means that 564 standpipes representing 74% are non-functional.

The above analysis and evaluation of water supply situation in Isiala-Ngwa goes to show that the present/ existing water development strategies adopted by the Imo State water Board, Isiala-Ngwa zone, and the people is inefficient since the water problem still persist. This therefore calls for a reappraisal by way of adopting new alternative water development strategies that will help to meet the people's water needs and thus bring the year 1990 (the International Drinking Water Supply and Sanitation Decade, 1981-1990), which is almost gone, close to reality.

5.3 The need for alternative water development Strategies:

In this section, we examine the strategies adopted in other countries of the world with similar rural water supply problem with a view to determining the possibilities of their adoption in Isiala-Ngwa. This is done taking cognizance of the local environmental conditions of the area and using the people's actual wants/needs and their suggestions (an emic process) on how the problem of rural water supply can be solved. This line of thinking is adopted since we believe that the problem of rural water supply can only be solved by a joint effort of the rural people (emic method) and the government (etic method) of any geographical area.

5.3.1 Case studies:

There is a fast-growing range of simple technologies which may be used to augment and improve water supplies especially in rural areas. The essential factor in these new technologies is to ensure efficiency in collection and extraction methods, as well as in distribution systems. In rural Guatemala, the dominant technology for the introduction of potable water is by gravity flow. Typically, a spring is located which lies at an elevation higher than that of the town.

A concrete or stonework captation tank is constructed at the spring site, and polyvimylchloride (PVC) or steel pipe is used to transport the clean spring water to a distribution tank, located near the population. From the distribution tank, feeder lines constructed of PVC pipe are built to deliver water to either individual household spigots or to public taps shared by three to six families. This gravity-fed technology is particularly appropriate not only because it is relatively inexpensive to build but because it eliminates the need for pumps, hydraulic rams, and other mechanical means of transporting water (Annis and Cox, 1982).

In the Republic of South Korea, which has a very successful rural water programme, the whole village is mobilised to build the supply. The average construction period for a supply from a spring to a population of 500-1000 people was reported to be one week (Schultzberg, 1978). In Malawi, a number of gravity rural schemes serving large areas and supplying up to 80,000 people have been successfully built with community labour and a minimum of ministerial staff. The construction of each scheme is preceded by an extensive period of motivation of the people.

For storage of water, ponds can be dug in small depressions or water catchment tanks can be constructed below ground level using simple hand tools. Water catchment tanks have been introduced in Sudan and Botswana under technical co-operation programmes. During the 1962-1966, FAO mounted a project "Land and water use survey" in Kordofan province in the Republic of Sudan. Several types of "do-it-yourself" catchment tanks had been evolved, combining local materials with small quantities of imported plastic and cement, constructed by local labour. These tanks were primarily for drinking water and only in the latter part of the survey their application for supplementing "micro-irrigation" was considered (Hussain, 1980).

In recent years, the development of shallow tube wells has provided a very useful source of water particularly for small farmers. Currently, such tube wells are being increasingly used in parts of India, Bangladesh and Sri Lanka. Shallow tube wells can be excavated in soft rocks and semi-consolidated formation using the hand-bored or augured method conveniently up to 9m depth and manual percussion methods up to a depth of about 30m.

In the Republics of South Korea and Afghanistan local operators also collect money required for fuel and their own salary from the villagers. In Malawi, local operators look after the schemes, no revenue is collected. The schemes are either gravity fed or based on handpumps which means that operating costs are virtually nil. In Tanzania, no revenue has been collected so far and facilities are frequently not in use due to lack of diesel for the pumps (Schultzberg 1978). In kenya there are considerable operational problems caused by lack of funds and manpower resources and inadequate administrative procedures for reporting and repairing failures. A non-operating supply deteriorates very quickly as people tend to destroy taps and pumps when they do not deliver the desired water.

Many methods have been used by countries in selecting villages for rural water supply. There has, in the past, been a strong tendency to attend to those communities which show greatest potential for growth, are wealthiest and best educated, have the greatest capacity to repay capital loans, have the strongest political influence and most vocal in their demands. A good example is in Peru. In contrast, Tanzania's current development plan places the highest priority on villages of the greatest need. In fostering its co-operative programme, water supplies are being supported first in Ujamaa cooperative villages, in areas of acute scarcity of water, areas of population concentration and where productive activities may be promoted. Thailand's worst-first strategy is similar to Tanzania's greatest need strategy.

Although technical efficiency should not be discounted, the technology selected and the way it is chosen must be suited to the physical and social conditions in which it is placed.

5.3.2. Comparisons with the Isiala-Ngwa (Imo State) Strategy:

From section 5.3.1, it can be adduced that the main centre of focus for the development of rural water supply is either through tapping the groundwater resources or through surface water sources mainly springs. The groundwater is tapped through boreholes/wells/handpumps, while the surface water is tapped by gravity supply. Also, rainwater is tapped in some countries by the use of ponds dug in small depressions or water catchment tanks constructed below ground level.

In Imo State, with particular reference to Isiala-Ngwa, the borehole strategy is used to tap the groundwater by the public water board. According to Nwokonko (1987), the borehole strategy is adopted because it is the purest for drinking at any time since it does not need treatment and therefore saves cost. In Isiala-Ngwa, there has not been any attempt to tap the surface water for public consumption as has been done in other developing countries such as Guatemala and even in some states of Nigeria like in Plateau (For instance, Langtang and Pankshin Local Government Areas). Open dug wells have been tried in the area as a means of supplying water to the people but these wells have dried up. Recently, 12 UNICEF handpumps have been installed in the area as a way of augmenting the efforts of the Imo State Water Board. However, most of these handpumps have become non-functional (Plate 12). This is as a result of inadequate feasibility studies of the water table.

Eventhough Isiala-Ngwa (Imo State) strategy differs from other parts of the world by not making use of the surface water strategy, their emphasis on groundwater (borehole/wells) have been the trend in other parts of the world mainly the developing countries. However, the major difference have been in terms of method and degree of involvement between the people and the government (Water Board). While in some countries like Tanzania, Sudan and Malawi, the rural people are integrated in the decision and implementation of the water projects, in Isiala-Ngwa (Imo State), the decision and implementation is done by the government. This has thus tended to make the rural people, those to enjoy the water, the on-lookers. In some areas, where the people mobilize themselves to provide water for themselves through community effort, they have always failed due to lack of adequate fund and support from the government. This can be shown by the series of fund raising ceremonies for rural water supply and yet, there has not been any village that has successfully completed a water project in Isiala-Ngwa.

Many times, the failure of these water projects stem from the fact that they do not really know exactly what water development strategy/facet to adopt. At times, some villages/communities engage in the construction of storage tanks when they do not have pipes to distribute the water, while some envisage drilling a borehole while they do not consider pipes and storage tanks. This is a big problem which calls for proper elucidation by way of enuciating new alternative strategies/methods that will integrate the people's suggestions/perceptions with that of the government.

5.4 Alternative strategies for Isiala-Ngwa:

It is our belief that the problem of rural water supply in Isiala-Ngwa can only be solved when there is a joint rapport between the people and the government by way of suggestions, contributions both in kind and cash, and the setting up of rural water development committees that will oversee the running and proper implementation and maintenance of water projects. We believe that the setting up of this, rural water development committees can help to raise up interest in community participation through self-financed water programmes. It is because of the high regard we place on the rural people, that their suggestions on how the water problem can be solved, have been sampled and integrated as presented in the alternative strategies/facets shown in Table 41. It is with these sampled people's suggestions on the best way(s) to solve the problem of rural water supply, that we will recommend alternative strategies for the development of rural water supply in the area.

TABLE 41: Frequency of suggestions by the people on the best way(s) to solve the problem of water supply in Isiala-Ngwa (* see key for interpretation of the variables):

Communities	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Amaise	9	6	10	2	4	6	6	2	6	0
Amaise-Ahaba	10	10	6	7	5	8	2	4	2	0
Mbutu	17	8	8	5	7	6	4	1	0	7
Ngwaobi	11	5	0	2	6	10	1	3	0	0
Ngwaukwu	25	8	0	4	16	11	7	4	5	11
Nsulu	42	9	18	16	15	8	13	9	7	0
Ntigha	18	10	10	6	10	15	5	0	5	16
Nvosi	23	11	4	14	16	11	5	4	7	7
Okporo-Ahaba	12	9	0	8	13	20	0	3	3	0
Omoba	14	3	0	5	6	14	0	0	0	10
Ovungwu	10	6	0	4	10	12	5	3	3	7
Ovuokwu	23	12	0	2	9	15	3	3	1	0
Umuoha	28	10	5	6	10	4	6	6	2	0
Total	242	107	61	81	127	140	57	42	41	58

*Key for the interpretation of variables

S1 = provision and maintenance of boreholes/pipeborne water.

S2 = construction of deep village wells

S3 = pumping water from streams

S4 = provision of water tankers.

S5 = Building of large storage tanks.

S6 = Increase in the number of functional standpipes/repairing of spoilt ones.

S7 = Protection of water sources against water pollution

S8 = Village initiation and local/state government's support.

S9 = Grading of the access roads leading to the water sources.

S10 = Provision and maintenance and fuelling of power plants.

From Table 41, the provision and maintenance of boreholes/pipeborne water has the highest value with 242, while grading of the access roads leading to the water sources has the least with 41. This pattern shows that the people equally percieve the provision of boreholes and pipeborne water as a major relief to the problem of water supply. While it is true that the grading of access roads is important for easy collection and transportation of water by the bicycle/motor cycle/car owners, we found out that it has the least value because the majority of those that go to fetch water, trek to the sources. They therefore do not care whether the roads are graded.

From Table 41 also, the people's suggestions/perceptions on the ways to solve the problem of water supply in Isiala-Ngwa have been grouped into two: the highly valued alternative strategies/methods, and the lowly valued alternative strategies/methods. The highly valued alternative strategies/methods range from 100 and above while the lowly valued alternative strategies/ methods are less than 100. This cut-off value is an arbitrary decision to enhance interpretation based on the number of variables.

5.4.1. <u>The highly valued alternative strategies/methods:</u>

The highly valued alternative methods are S1 (provision and maintenance of boreholes/pipeborne water), S6 (increase the number of functional standpipes and repairing those that are non-functional), S5 (Building of large storage tanks), and S2 (Construction of deep village wells) (Table 42). The people place high value on these water development facets/methods and thus believe that their water problem will be solved if the facets/methods are implemented. To the people, the provision and proper maintenance of boreholes and the distribution of this borehole water to different villages via pipes could go a long way to reduce their water problem. To reduce the distance travelled for water collection, the people equally feel that more functional standpipes should be installed and spoilt ones repaired so that many villages will be served with pipeborne water.

To safeguard any possible failures in the maintenance and fuelling of the pumping plants as well as failures in hydraulic pressure, large central storage tanks should be constructed in communities that normally face serious problem during periods of water deficiency especially in the very high and high water priority zones shown in Fig.17. These storage tanks could be connected to the water distribution network with the help of booster pumps to increase the hydraulic energy. With these booster pumps, water could reach many villages in a community which will thus, reduce the distance travelled in search of water.

In some places where the drilling of boreholes and consequent connection to the water network system could not be done, open dug wells should be encouraged. Alternatively, the already dried up wells could be renovated. This however, requires proper feasibility studies of the groundwater dynamics. To safeguard these wells from pollution, they should be covered and laws made prohibiting people from throwing stones into the wells, which should attract some penalties.

5.4.2. The lowly valued alternative strategies/methods:

From Table 42, the lowly valued alternative strategies/methods are S4 (provision of water tankers by the local government), S3 (pumping water from the streams), S10 (provision and maintenance and fuelling of power plants),

TABLE 42: The alternative rural water development strategies/methods in Isiala-Ngwa

Variable	A = Highly valued alternative strategies	
	value	meaning of variables
S1	242	Provision and maintenance of boreholes/ pipeborne water
S6	140	Increase in the number of functional standpipes/repairing of spoilt ones.
S5	127	Building of large storage tanks
S2	107	Construction of deep village wells
	B =	Lowly valued alternative strategies
S4	81	Provision of water tankers
S3	61	pumping water from streams
S10	58	provision and maintenance and fuelling of power plants
S7	57	protection of water sources against water pollution
S8	42	village initiation and local/state government's support
S9	41	Grading of the access roads leading to water sources

S7 (protection of water sources against water pollution), S8 (village initiation and local/state government support), and S9 (Grading of the access roads leading to the water sources). The important thing about these lowly valued alternative strategies/methods is that they are supplements to the highly valued strategies with the exception of S4 (provision of water tankers by the Local Government) and S3 (pumping water from streams). They therefore do not stand out as strategies on their own.

Water is a social resource whose demand is perfectly inelastic. In otherwords, people will always need water so far as they are alive. Because of this, local/state governments can provide water tankers to serve some communities which have been identified as having acute water shortage. People should buy the water at highly subsized rates. This will help to cut/reduce the excesses of the water vendors as well as make the people feel the impact of the government. This is particularly important especially this time, the government of Nigeria pays attention to rural development and its attendant social mobilization. The Directorate of Foods, Roads and Rural Infrastructure (DFRRI) can make their impacts felt by achieving this.

The presence of S3 (pumping water from the streams) as one of the people's recommended strategies/methods for the development of water supply in the area clearly shows that the people equally recognise that the surface water could be developed to make water more available. Related to S3 (pumping water from streams) is S7 (protection of water sources against water pollution) and S9 (grading of the access roads leading to the water sources). If the water sources are protected against water pollution, this will help to make some of the abandoned water sources more useful. Wells, ponds and streams should be protected and laws and penalties made against any possible offender. People should be warned against indiscriminate use of the ponds and streams as sacrificial areas. If possible, sacrificial areas should be demarcated, so that the native doctors can know their zone of operation. Also, the streams should be demarcated between drinking water users and those using the streams for washing or fermenting their cassava. This will help to check water pollution and thus, make more water available for drinking purposes. The access roads leading to the water sources should also be graded to make them possible for bicycles/motorcycles/cars to ply the roads. This will help to reduce the quagmire encountered during water collection.

5.5. A suggested new water development strategy for Isiala-Ngwa:

In this section, we present the water development strategies/methods we feel are appropriate for the development of water supply in Isiala-Ngwa, taking the people's suggestions, the local environmental conditions and the resources available into consideration. Based on this fact therefore and taking cognizance of the analysis done so far, we are of the opinion that the most effective water development strategy for the area is that which will bridge the gap of the long water collection distance of about 5km and increase the total quantity of water supplied. This is because, the wastage of some economic resources such as oil palm products and children going to school late usually during the water shortage periods, is due mainly to the long distance travelled to fetch water. Also, that about 18% of the day time is spent in water collection lends credence to the role of the long water collection distance to the socio-economic development of the area.

This new strategy for the development of water supply will centre on how to solve the water needs of the different rural water priority zones discussed in section 4.5. This strategy will involve a combination of the use of boreholes/wells/handpumps to tap the groundwater, and the pumping of water from surface streams. It is our submission that the problem of water supply will continue to persist in Isiala-Ngwa if attention is concentrated only on the use of boreholes/wells/handpumps to tap the groundwater resource as is the case presently. This problem will persist because of the high rate at which these boreholes/wells/handpumps dry up (that is, become non-functional) as a result of high water draw down. Inadequate feasibility studies of the groundwater dynamics and wrong site selection for the boreholes/wells/handpumps also affect the longevity of these water projects. The fact that these water projects are drilled on contract basis complicates the matter since the contractors are only interested in getting their money. This is exemplified by the inability of most of the UNICEF mono-handpumps, which were completed in 1987, to supply water.

We therefore suggest the development of the surface **streams** as a strategy for water supply development in the area. This strategy is presently the only solution to the problem of water supply in the area. This is because these surface streams like Imo River, Ahii, Otamiri and Oji have high water discharge rates and have been of use by the people of Isiala-Ngwa. The possibility of adopting this strategy is feasible and has been successfully practised in other states of Nigeria like in Plateau State to supply water to the different Local Government Areas. We are not saying that the groundwater strategy should be discarded entirely but the two strategies should complement each other.

For the selection of the villages/communities to be supplied with water first, emphasis should be placed on supplying water to areas that are worst-off. This is a form of worst-first strategy. Since water is one of the essential amenities to be provided by the government, we suggest that water should be supplied free to the people. This is not too much for the government (local/state) since the people pay their taxes and rates, and contribute immensely to the food production (like oil palm produce, cassava, yam, vegetables and oranges) of the country. However, where the government cannot carry the responsibility of supplying water free to the people, the villages/communities could contribute some portion of the cost of the construction of the water system, a contribution to be made in form of money, labour or both, through the process of community participation.

The success of community participation requires that the villagers are motivated and that there has been some involvement on the part of the villagers in the selection of the scheme. This can be done by encouraging village/community water development committees charged with the planning, mobilization and organisation, collection of levies and implementation of water projects. The process of community labour can bring down the construction costs and as a primary benefit introduce a sense of belonging to the people served. When this rapport has been established between the people and the government (local/state), raising of funds for at least the cost of operation at the local level which will help to prevent water supplies going out of service almost at the same rate as they are being constructed.

Eventhough the people will be mobilized to participate in water supply, the method of selecting villages/communities to be supplied with water should be based on the worst-first or extreme-need strategy as used in Thailand or Tanzania. This strategy will enable the areas without water, mainly the very high/high water priority zones, to be supplied with water first. When these high water priority zones have been selected, the people should be asked to provide 20% of the implementation costs if the government is not carrying the full costs. One of the disadvantages of the worst-first strategy is that most of the worst villages in terms of rural water supply also, consist of the poorest villages. To avoid this, the government (local/state) should encourage the people through the rural water development committees to organise fund raising ceremonies for water supplies, and where the targetted amount of 20% is not met, the government should provide these villages/communities with water. Thereafter, the villages will continue with the payment, on annual instalments, until the expected target is reached. The type of water development project to be engaged on will then depend on the local conditions and the amount of financial resources available.

Also, on individual village-to-village perspective, it is our suggestion that those villages that have initiated moves to supply water through village effort to re-orient their choice of the water supply strategy already chosen. This is necessary in order not to waste the scarce financial resources in adopting a wrong water supply strategy that will not last the tune of time. For instance, it is wrong for some villages like Umuode, Umuosu and Mbubo (all in Nsulu) to adopt a borehole strategy of groundwater tapping, while they have reliable surface streams, and springs. If these streams and springs are developed to supply water to different parts of the village via pipes, the supply will be more constant and reliable than the borehole water. This is why there is need for the setting up of water development committees in the different villages/communities of Isiala-Ngwa to enlighten the people on the suitable water development strategies to adopt. We equally suggest that people should provide more water storage facilities in their houses to store more water during the rainy season.

5.5.1. The desirable locations of water development sites in Isiala-Ngwa:

The rural water priority zones shown in Fig.17 indicate a five-strata hierarchy for rural water need in Isiala-Ngwa. Amaise-Ahaba, Okporo-Ahaba and Ovungwu have the most extreme need for water supply (highest priority) as discussed in section 4.5. These areas do not have any form of surface water, so to supply water to these areas, the use of deep boreholes/wells/handpumps is the most appropriate. However, since it is not possible at this time to drill handpumps in all the villages due to cost, the drilling of boreholes with piped water systems complemented by the use of wells and individual storage reservoirs are the most appropriate to solve the water problem of these communities without any reliable surface water. The dried up wells could be renovated and if possible the number increased to guarantee all year supply of water for domestic and non-domestic activities.

For the communities with low extreme need (very low/low priority zones) for rural water supply, which fortunately coincides with the communities with reliable surface streams, the most appropriate way to supply water to these areas notably Mbutu, Nsulu and Ntigha is by pumping water from the streams to serve the villages. This can be done by building a storage reservoir of about 690,000 litres (690 cubic metres). Then, from these reservoirs, the water will be piped to different villages within the catchment area shown in Fig.18. For areas within the communities which will involve high cost to be supplied with piped water from the streams, deep wells could be constructed or old dried up ones renovated.

For Nsulu community, the desirable streams to be tapped are the Ahii stream at the villages of Umuode, Umuakwu and Ohuhu-Nsulu; and the Otamiri stream between the villages of Ubaha and Umuala. However, the most appropriate site in Nsulu community is the Otamiri stream near the Imo State Games village at Ubaha-Umuala border. This stream and site is selected because it has a more central position than the other streams and springs in the zone and therefore will have a wider coverage in terms of catchment area as shown in Fig.18. This site is situated in a valley that separates Ubaha with Umuala villages. In order to distribute the water to the villages,part of the stream could be dammed to provide an artificial water reservoir. A high level storage reservoir of about 690 cubic metres should be built and a booster pump/station provided to boost the energy grade line of the water from the reservoirs to the service centres. This booster pump is very necessary because the proposed site is in a lowland and therefore more hydraulic energy is needed for the water to reach different parts of the community. Water from the Otamiri stream could apart from serving the people of Nsulu villages could be distributed to some parts of Nvosi villages such as Umunevo, Obuba and Umunkpeyi.

For Mbutu community, the most appropriate site is Owerrinta, where the Imo river will be tapped to supply water to serve the villages of Mbutu, and some parts of Amaise, Amaise-Ahaba and Ngwaobi communities. The Mbutu rural water scheme which has its pump house in Uhum near Ugba junction and also very near to Owerrinta (see Fig. 11) could utilize the Imo river as an alternative source of water supply to the existing borehole (groundwater) strategy. The technology here will only require the construction of a small dam to create artificial reservoir, building of a large storage reservoir of about $690m^3$ and the provision of a booster pump. Water from this stream could be connected to the existing water network system. This will involve the installation of new water pipelines to the villages without pipelines or pipeborne water.

For Ntigha community, the oji stream could be utilized and the appropriate site is in Umuekpe-Ntigha. To guarantee the supply of large volume of water, the stream should be dammed and a high level service reservoir of about $690m^3$ provided. A booster pump is also needed here to supply the hydraulic energy required for the free movement of water to all the villages served. This site will enable the water to serve the people of Ntigha, and some parts of Ngwaukwu community such as the villages of Abayi, Ihie, Ahiaba Ubi, Umuchima and Amaoji. However, the water from the oji stream could equally be connected to the Ngwaukwu rural water works at Amaoji to supplement the borehole water.

The water from these suggested streams (Fig.18) have for long, acted as a source of domestic and non-domestic water supply for both the villagers and the water vendors (see Plate 9) from Aba and Umuahia towns. The people of the area have been using the water from these streams without any serious bacteriological or chemical harm. Therefore, the mass utilization and integration into the existing rural water works will do little or no harm to the people.

It is important to point out that emphasis on a combination of groundwater through the use of boreholes/ wells, and water from surface streams (Fig.18) is borne out of the fact that each will complement the other

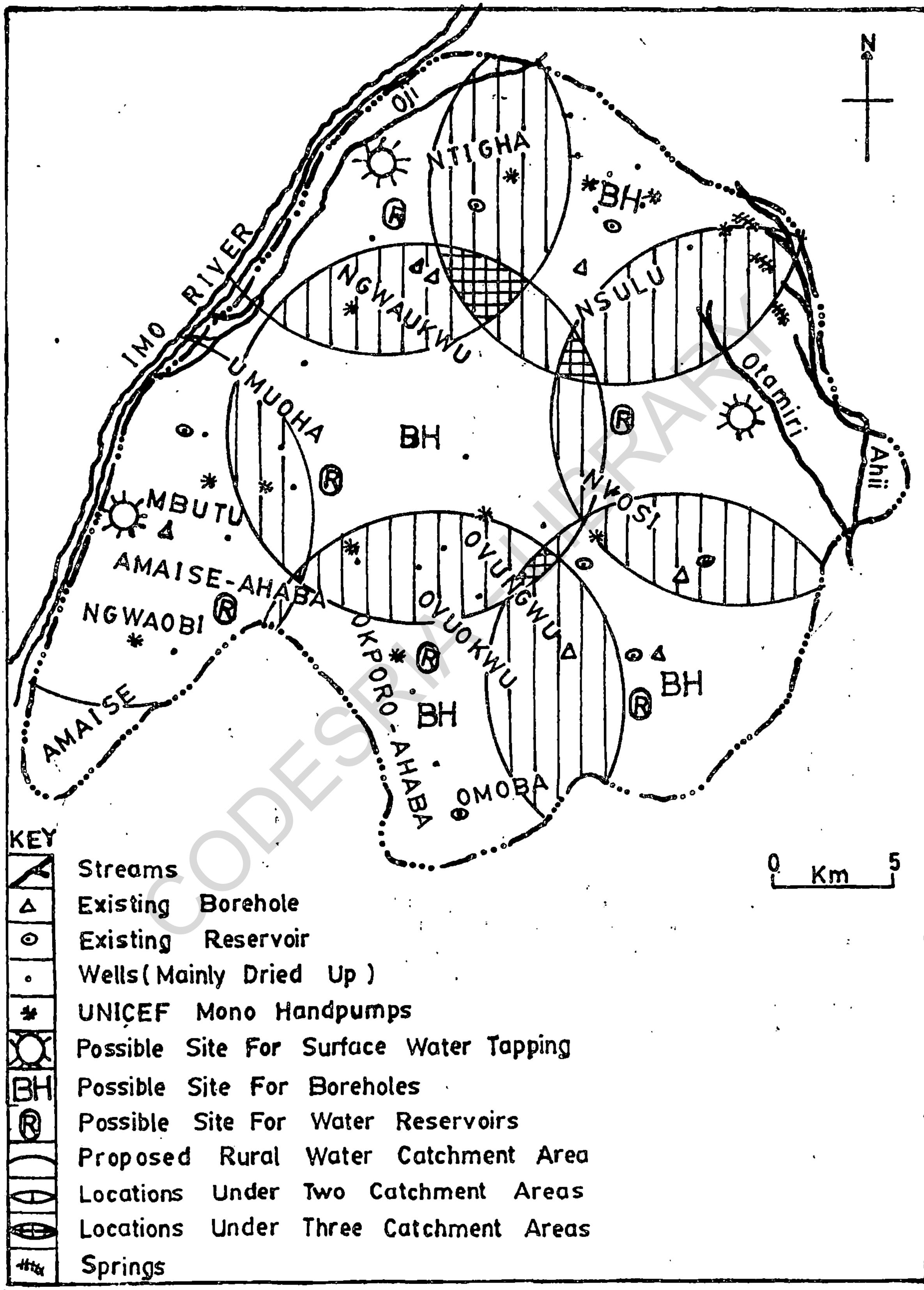


FIG. 18 : ISIALA-NGWA SHOWING THE EXISTING AND THE DESIRABLE RURAL WATER DEVELOPMENT SITES.

in case of any serious break down or hydrological draw-down of water. This will thus necessitate all year supply of water to the people of Isiala-Ngwa. We equally recognise that groundwater is generally more reliable from the quality point of view whereas the cost of operation of a water supply based on surface streams is considerably lower (in terms of durability, reliability and constancy of supply) than the utilization of a pumped groundwater source. However, in terms of monetary cost, the renovation of dried up and perhaps spoilt wells is the cheapest but the time and energy involved in getting the water from the wells is enormous. The wells may not be enough to adequately serve the population and thus minimise the distance travelled for water collection

CHAPTER 6

SUMMARY OF FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

6.1. Summary of findings:

This study has utilized and explored the different techniques and avenues of rural water resources analysis to arrive at its findings. Ten summaries of the major findings of the work have been made. They are:

1. The total household water demand for Isiala-Ngwa is 1108 lhd, while the consumption (supply) is 355 lhd. This gives a deficiency of 753 lhd representing a percentage margin of about 68%. On the whole, the mean per capita water consumption per person per day for the area is 42 lpd. This represents some 36.5% of the Federal Government of Nigeria recommended minimum of 115 lpd.
2. The average distance travelled for water collection in the area is about 5km. The people of Isiala-Ngwa spend about 2 hours in water collection and about 18% of the day time in water collection. This figure is very high and thus affects other productive activities such as farming and hawking activities as well as children missing or going to school late.

3. As a result of shortage of water in the area, some social/household and health problems are encountered. The social/household problems include people not bathing when wanted, toilets not washed, buildings stopped, palm oil processing stopped, and death of crops. Health problems encountered as a result of water fetching are mainly headache, malaria, and painful and stiff joints. The water-related diseases suffered as a result of shortage of water are mainly diarrhoea and dysentery.
4. As a result of shortage of water, some rural development activities have been seriously militated. These are mainly in the areas of agricultural production, rural industrialisation, and tertiary activities. This has affected the development of the area.
5. The total number of public standpipes (both functional and non-functional) in the area is 783. Out of this number, 564 standpipes (about 74%) are non-functional for upward of 1-18years. This is due mainly as a result of road construction and disuse (see Appendix C). Some of the non-functional standpipes have been uprooted from their bases. There are only 219 functional standpipes (about 26%) in the area. The functional standpipes do not supply water for more than 18 hours in one week. Generally, the average

daily per capita water supply from the Isiala-Ngwa public water works is 25 lpd. The water is rationed to different villages at different time and days of the week.

6. Small diameter pipelines (from 50mm-100mm) dominate in Isiala-Ngwa. These pipelines are two small for large public water distribution and are thus responsible for the frequent pipe burst which occur in the area. Nbawsi rural water works have the smallest (50mm) diameter pipeline in the area.

7. Many attempts by the people to provide water supply through community efforts have been militated mainly as a result of lack of fund, embezzlement of fund meant for water supply development, and lack of adequate knowledge of the type of water development strategy to adopt. This has tended to limit all efforts by the people to supply water within mere planning stage.

8. Six underlying components have been identified as responsible for water deficiency in Isiala-Ngwa. These are:

   (i) The general limitation of the available water sources
   (ii) The problem of public water operation/distribution
   (iii) The influence of locational factors
   (iv) The influence of technological/financial inadequacies.
   (v) The problem of road construction/road grading.
   (vi) The influence of management/policy inadequacies.

9. Five zones of relative deficiency of water supply (priority zones) have been delineated in Isiala-Ngwa. They are:

    (i) very high priority zone
    (ii) High priority zone
    (iii) medium priority zone
    (iv) low priority zone
    (v) Very low priority zone

10. The existing water development strategy(ies) adopted by the government and people of the area to supply water is ineffective and not in line with the water needs of the people. There is then need for an alternative water development strategies that will integrate past experiences with new thinking in order to necessitate all year supply of water to the area.

6.2. <u>Summary of Recommendations:</u>

Based on the major findings of this research, we make the following recommendations which will act as a canon to the rural development planners and other agencies responsible for rural water planning and supply in Imo State.

1. Non-functional standpipes should be repaired to make them functional as well as increasing the number of functional standpipes. This will bridge the gap of the long distance travelled for water collection as well as reduce the time spent in water collection.

2. The villages supplied with water from the public water works should be made to know the time and days of the week their villages will be supplied with water. This is necessery since water is rationed to different villages at different time and days of the week. A new and efficiently regularized water supply time table should be provided and made known to the villages concerned so that they can know the exact days of the week they will be supplied with water. This scheme will help the people to schedule their activities to fit their water collection activities.

3. To prevent constant pipe burst in the area, fairly medium (such as 150mm to 250mm) diameter pipelines should be used in place of the small diameter pipelines. The dominance of the small diameter (75mm) pipelines in Amaiyi, Nbawsi, and Ovungwu/Ovuokwu rural water works should be rectified and replaced with large diameter pipelines to guarantee and remedy constant pipeburst as a result of high hydraulic pressures. The 50mm diameter pipeline in Nbawsi should be replaced to avoid the constant pipe burst and water leakage in the area.

4. We request for a total review of the whole rate of ₦200.00 per month per standpipe much as the water taps do not give steady water supply to the public to justify the ₦200.00 rate. This is because the continuous payment of

₦200.00 rate per month per standpipe by the Local Government cannot be justified in the light of the number of hours in which these public standpipes run per week/month. This review is necessary which will include a total review of the activities of the Water Board, estimation of the amount (rate) to be paid by the people/local government to guarantee all season supply of water, and the repairs of spoilt and constant fuelling of pumping plants. The habit whereby members of the public buy fuels for the powering of the pumping plants (as well as paying for their usual water rates) should be discouraged.

5. Proper feasibility studies of the appropriate site of boreholes/wells/handpumps should be made by those that know the hydro-geological dynamics of the area. This is necessary to prevent these water projects drying up immediately as they are commissioned/opened. Thus, the people need to be equipped of the average depth of the water table (found in this research to be about 49 meters below ground surface) so that they can no longer be deceived by the exploitative hands of the water contractors.

6. A rural water development committee should be set up in all the villages/communities of Isiala-Ngwa. This committee should be charged with the mobilization and organisation of the people for water supply programmes through community efforts. They should equally be charged

with finding the best water development strategy to adopt as well as the infrastructures that will guarantee successful implementation based on the local conditions and the resources available. This committee should equally monitor the functionality of the public standpipes/wells/handpumps as well as making recommendations to the water board on the water failures and the need for improvement. The committee would work hand in hand with the present Local Government committee on water supply which at present, has not achieved much.

7. Emphasis need to be directed to ways and means of tapping the surface streams mainly the Imo River, the Otamiri and Oji streams, to supply water to the people of Isiala-Ngwa. This new water development strategy is feasible and requires proper feasibility studies of the discharge rates, solid waste contents, possible dangers of contamination, the chemical and bacteriological contents, as well as the type of infrastructure that will necessitate all season supply of water. This new water development strategy could be integrated to the already existing borehole strategy of groundwater resource utilization, adopted by the Imo State Water Board. These two strategies will complement each other and thus guarantee all season supply of water to the people of Isiala-Ngwa. Also, the dried up wells could be renovated to make them functional and if possible new wells

should be bored in some high water priority zones that do not have pipeborne water. Individuals should equally be encouraged to buy many storage reservoirs to retain water during the rainy season.

8. The method of selecting villages for the supply of water should be based on worst-first/extreme need strategy. The high water priority zones mainly Amaise-Ahaba, Ngwaobi, Okporo-Ahaba, Ovungwu, Ovuokwu and Umuoha should be provided with water first before the low water priority zones like Nsulu and Ntigha communities. For the supply, the villages/communities could contribute 20% of the running cost if the government cannot supply the water free. For the water distribution, the public standpipes should be sited in areas of population concentration and in locations that are central to the population to reduce the water collection distance.

9. The water sources should be protected from environmental pollution. The ponds, streams and springs should be demarcated between drinking water zones and sacrificial areas to avoid water pollution. Also people should be educated on the health dangers of bathing on the same zone where drinking water is fetched. People mainly children should also be educated on the dangers of throwing stones into the wells. Laws should be made against

any possible offender which should attract penalties.

6.3 Conclusion:

This work is set out to investigate the water supply situation in Isiala-Ngwa Local Government Area of Imo State. It tries to find out the quantity of water demanded and supplied as a basis of determining whether there is deficiency of water supply relative to the demand. The causes of the water deficiency in the area were determined and the effect of the deficiency on the people were also enumerated. The area has been divided into 5 zones (priority zones) of relative deficiency of water supply. The existing water development strategies were examined and alternative strategies were suggested. Also, the desirable locations for the siting of water development projects were suggested. A summary of findings and recommendations were then made.

It is important to point out here that some problems were encountered during the course of acquiring data for this research. Some of the major problems include:

(i) The lack of a comprehensive information of the number of villages with streams, springs, and ponds as well as a map showing the comprehensive locations of public standpipes (both functional and non-functional) in the area, from the water board.

This therefore subjected us to take a rigorous community to community water survey of the area. We did this by the help of paid fieldworkers. The financial burden was really enormous.

(ii) We were asked to go to the headquarters of the Imo State Water Board at Owerri (State Capital), to get clearance/ permission from the general manager for water) before attention could be granted us at Isiala-Ngwa zone of the board. As would be expected in Nigeria, it took an average of five calls before the permission was granted to us. You can then visualize the time, cost and danger of travelling from Isiala-Ngwa to Owerri (which is about 40km) for an average of five call days.

(iii) We equally discovered during the process of fieldwork that the area was too large for a study of this sort. In order to finish the fieldwork (data collection) within the short period of time and start with the organisation and analysis of the data, we had to put extra time and energy.

(iv) The researcher faced serious financial problems during the process of fieldwork and had to stop travelling by public transport. The researcher therefore travelled by bicycle and was badly inconvenienced by the hot sun and dust raised by speeding cars/vehicles. This is because the fieldwork was conducted during the dry season.

(v) Another problem we encountered during the process of this research is that the university of Nigeria's I.B.M 4361/4 computer broke down. This therefore prolonged our work since we cannot compute principal components analysis manually.

However, despite all these limitations, it is our belief that the issues that stimulated this research as enumerated in the statement of problem and incorporated in the aims of study, have been fairly investigated as spelt out in the summary of findings and recommendations. This work, among other things, has exposed the core components responsible for water deficiency in the area. It has also provided a spatial delineation of zones of relative deficiency of water supply (priority zones) in Isiala-Ngwa. It is therefore hoped that with these tools, this work will act as a guide to water resource and rural development planners in Isiala-Ngwa and other parts of Imo State.

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APPENDIX A

DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF NIGERIA, NSUKKA

HOUSE-HOLD QUESTIONNAIRE

Sir/Madam,

I am a postgraduate student of geography, specialising in Hydrology and Water Resources, in the University of Nigeria, Nsukka. I am carrying out a research on rural Water Supply in Isiala Ngwa Local Government Area of Imo State.

You are please requested to supply information for the following questions which will be used in my research. The information you give is thus purely of an academic nature, and will be treated in the strictest confidence.

In answering the questions below, fill the blank spaces and tick (_/) the letter of the correct option.

Thanks for your anticipated co-operation

Yours faithfully,

GEORGE N. CHIMA.

SECTION A: GENERAL FOR HOUSE-HOLD WATER-SUPPLY (To be answered by the Family Head or the person who sees to the family's household activities).

1. What is the name of your Village? ....

2. How many of you are in the house-hold? ....

3. From what source(s) do you get your Water supply?

A. River B. Stream C. Spring D. pond

E. rainwater F. tap G. well H. borehole.

4. What is the local name of the ticked source(s)?

   a. .... (b) .... (c) .... (d) ....

5. Who collects the water from the source?

   a. Mother (b) Father (c) Son(s) (d) Daughter(s)
   e. house-boy/maid.

6. How far is the source of water from your house? ....

7. From what source(s) do you get water in the rainy season?

   a. Stream (b) river (c) spring (d) pond (e) rainwater
   f. tap (g) well (h) borehole.

8. From what source(s) do you get water in the dry season?

   a. stream (b) river (c) spring (d) pond (e) rainwater
   f. tap (g) well (h) borehole.

9. Do you have pipeborne water in your area?

   a. Yes (b) No.

10. If yes, do you have a public tap in your village?

11. Do you get water from the public tap always?

12. Also, do you have a private water connection to your house?

13. Do you get water from the private water connection always?

14. How do you supplement water if the taps do not run?

    a. Fetch from the river/stream (b) fetch from the spring

    c. fetch from the pond (d) fetch from the well

    e. fetch from the borehole (f) buy water.

15. If you buy water, from who do you buy the water?

    a. Local water hawkers (b) water vendors

    c. others (specify) ....

16. How much do you buy the following:

Water container	Price (in Naira (₦) and Kobo (K)					
	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season
One bucket (size 30						
One jerry can (size 40)						
One drum (medium size)						
One tank (500 gallons)						

17. Do you include the money for buying water in your daily/weekly budgets? (a) Yes (b) No.

18. If no, how do you get extra money to buy water?

(a) cutting down other expenses
(b) selling your agricultural produce
(c) borrowing (d) others (specify) ....

19. If you decide to go and fetch water yourself, by what means do you get there and how long will the journey take?

(a) By bicycle/motorcycle ..... hour(s) ..... minute(s)
(b) By trekking ... hour(s) .... minute(s)
(c) By driving ...... hour(s) ..... minute(s)

20. Do you pay for the water at the source? (a) Yes (b) No.

21. If yes, how much? .... ₦ .... K

22. How many buckets of water do you get in a day? ....

23. How many buckets of water do you use? ....

24. Do you have enough water for your needs? (a) Yes (b) No.

25. Assuming there is plenty and constant water supply, how many buckets will be enough for your household in a day?

26. What do you think are the causes of water shortage(s) in your village/area? (a) .... (b) ..... (c).... (d) .....

27. In what ways can these causes be controlled or eradicated?

(a) .... (b) .... (c) .... (d) ....

28. Have you or your village (community) made any attempt to solve the problem of water shortage? (a) Yes (b) No.

29. If yes, how? (a) by building a water storage tank
(b) by constructing a village well
(c) by drilling a borehole (d) others (specify) ....

30. How successful has been the attempt to solve this water problem? (a) very successful (b) fairly successful (c) Not successful.

31. If Not successfully, why? ....

SECTION B: <u>WATER USE AND PROBLEMS OF SUPPLY</u>

32. How do you use water in your household?
(a) .... (b) .... (c) .... (d)...... (e) ....
(f) ....

33. Where do you wash your clothes ?
(a) At home (b) at the stream/river/pond (c) at the tap.

34. What non-domestic uses do you make of water? (a) ....
(b) .... (c) .... (d) ....

35. How much water do you need for the non-domestic uses .....

36. How much water do you finally get for the non-domestic uses. ....

37. What physical problem do you encounter most in fetching water? (a) Trekking/riding long distances in search of water (b) climbing steep and hilly parts to the water source. (c) Digging hole to search for water when the stream/pond dries. (d) Queuing and struggling for water (e) Others (specify) ....

38. What health problem do you mostly encounter with fetching of water? (a) Headache due to carrying of water on the head. (b) tiredness from climbing hilly slopes
(c) painful and stiff joints as a result of trekking
(d) Malaria due to exposure when fetching water
(e) Others (specify) ....

39. Have you ever suffered from any water related disease?
(a) Yes (b) No.

40. If yes, what types of disease?
(a) Diarrhoea (b) Scabbies (c) cholera (d) dysentery
(e) Others (specify) ....

41. What loss(es) do you encounter most during water shortage?
(a) missing or going to farm late.
(b) not going to hawk (c) missing of lessons by pupils
(d) Injuries and sometimes major accidents
(e) Others (specify) ....

42. What inconvenience do you encounter most during water shortage? (a) clothes not washed
(b) cooking delayed (c) cannot bathe when you want
(d) No water for drinking (e) others (specify) .....

43. What social problem(s) do you encounter most in the attempt to get water during the shortage(s)?
(a) struggling (b) fighting (c) quarrelling
(d) others (specify) ....

44. What do you think could be done to solve the problems caused by shortage of water in your area?
(a) .... (b) ....
(c) .... (d) ....
(e) .... (f) ....
(g) .... Others (specify) ....

45. To you, what do you think is/are the best way(s) to supply water to your village/community? ....

....

....

APPENDIX B

INTERVIEW SCHEDULE FOR PUBLIC WATER BOARD

Sir/Madam,

I am a postgraduate student of geography, specialising in Hydrology and Water Resources, in the University of Nigeria, Nsukka. I am carrying out a research on rural water supply in Isiala-Ngwa Local Government Area of Imo State. You are please requested to supply information for the following questions which will be used in my research. The information you give is thus purely of an academic nature, and will be treated in the strictest confidence.

1. What is the name of the Water Board?
2. When was the development started and when was it completed?
3. How do you distribute your Water?
4. Which villages/Communities do you pump water to?
5. What are the criteria for choosing these villages/ Communities for pipeborne Water?
6. What is the number of Public taps in each Villages/ Community?
7. What also are the criteria for locating or siting these taps where they are presently located?
8. What are the pipe sizes used, where are their different location?
9. How many public taps are functioning in each village/community?
10. Why are they not Functioning?
11. What are the number of Private Tap Water connections in each Village/Community?
12. How many of them have been disconnected in each Village/Community?
13. Why have they been disconnected?
14. What is the average cost of laying pipes to a village for public taps?
15. What is the average cost for a private tap water connection to a house?
16. What quantity of Water is pumped to a Village/Community per hour and for how many hours per day.

17. What quantity of Water is Pumped to a house per hour, and for how many hours per day.

18. How many storage reservoirs are under your jurisdiction and Where are they Located?

19. What are the types of reservoirs?

20. What is the capacity of each reservoir?.

21. What is the general Water rate charged for supplying water in each Village?

22. What is the rate charged per house connection?

23. Do Consumers pay Water rates even if the Water does not flow for a whole month or more? If Yes, Why?

24. Who collects the public Water rates in each village, and what is the amount?

25. Is the amount paid enough?

26. If not enough, how much do you think would be enough to provide all year round water supply to the villages?

27. Do you encounter any problem in the collection of the Water rates?

28. What do you think are the causes of Water shortage(s) in Isiala_Ngwa Local Government Area as regards this Water Board?

29. In your opinion, what are the effects of this Water shortage on the people of Isiala-Ngwa?

30. What efforts are you making to solve these problems?

31. How much does it cost to set up a village Water Supply?

32. What type of Capital equipment is needed and what are their cost?

33. What types of buildings and what are their cost?

34. What is the ideal water storage capacity that will necessitate all year round water supply for a village of 7,000, 10,000, 12,000 and 15000? And what will be the cost of each?

35. What water supply development strategy do you use?

36. Why have you adopted this strategy?

37. Which Water supply development strategy do you think is better and why?

38. Which Strategy is the cheapest to adopt and which is the contlest?

APPENDIX C

ISIALA-NGWA LOCAL GOVERNMENT AREA, IMO STATE: PUBLIC TAP SURVEY

WATER SCHEME: NVOSI

COMMUNITY: ISIALA NVOSI

Village	No. of water taps	No. of functional taps	Duration per week	No. of non-functional taps	How long has it stopped functioning	Remarks
Umuehim	2	1	2 times	1	Four years	
Ebeyi	6	2	2 "	4	(i) One has stopped for 3 years (ii) Three for over 1 year	
Amayi	8	5	2 "	3	(i) One for 6 months (ii) Two for over 4 years	
Umuguru	3	3	2 "	-	-	
Eziama Nvosi	12	9	1hr 2times	3	3 yrs	
Obuba Nvosi	3	-	-	3	4 yrs	
Umuogele Nvosi	2	1	2times	1	5 yrs	One disconnected from the main line along Obuba, Umuguru Road.
Ohuhu Ekwuru	4	-	-	4	4 yrs	
	6	Nill	Nill	6	6 moths	
Umuamocha	2	Nill	Nill	2	6 months	
Umuokiri	3	Nill	Nill	3	6 months	
Amaku Nvosi	4	2	2 times	2	over 2 yrs	The 2 non-functional taps have been dug out.
Umunkpeyi/Umuawuru	7	4	-	3	5 yrs	
Umunevo	4	-	-	4	10 yrs	
Umunko	2	-	-	2	10 yrs	
Umuejia	3	-	-	3	15 yrs	
Mgbokonta	3	-	-	3	15 yrs	
Total	74	27	47			

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OSOKWA NVOSI

Village	No. of water taps	No. of functional taps	Duration per week	No. of non-functional taps	How long has it stopped functioning	Remarks
Umuabali	7	1	Once in 4 wks.	6	Over 5yrs (since 1982)	Even the only functional tap has not had water since the onset of the rainy season.
Umuada	4	1	Once in 4 wks.	3	Over 5yrs Isince 1982)	-same-
Umuhu	2	1	Once a week	1	4 yrs	Duration per week not regular
Umuezu	4	1	Once a week	3	4yrs	Duration per week not regular
Umuetegha	5	2	" "	3	4yrs	- same-
Umungbogho	1	1	" " "			- same-
Ntigha-Umuetegha	3	1	2 times	2	3yrs	
Kputuke-Isiala Nvosi	5	Nill	Nill	5	For over 4 yrs	
Ikem Osokwa	5	Nill	Nill	5	For over 3yrs except one that stopped after the grading of the 'C' road by May, 1987.	
Umuohia	5	Nill	Nill	5	Over 10 yrs	
Umuokenyi Ndiolumbe	3	Nill	Nill	3	Over 10 yrs	

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OSOKWA NVOSI (Contd).

Village	No of water taps	No. of functional water taps	Duration per week	No. of non-functional taps	How long has it been non-functional.	Remarks
Akpuruta-Ndiolumbe	2	2	14hrs	1	Over 10 yrs	
Umuocho-Ndiolumbe	2	Nill	Nill	2	-do-	
Mgbogho-Ndiolumbe	-	-	-	-	Nill	
Umuike-ukwu-Ndiolumbe	1	Nill	Nill	1	Over 10 years	
Total	49	9		40		

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OVUNGWU

Okpungwu	4	-	-	4	1976	Up rooted during Aba/Obikabia road construction by Nigeri Cartio
Agbanagwu	3	-	-	3	1976	As above
Ihenaeri Ala	3	-	-	4	1976	As above
Umuakpor	4	-	-	4	1976	
Umuapu I	4	3	2 hrs 3 times	1	1980	
Umuapu II	12	5	2hrs e			

WATER SCHEME: OVUNGWU/OVUOKWU (Contd)

COMMUNITY: OVUNGWU:

Umuotiri	4	1	2hrs Once	3	1970	-
Umuejije	-	-	-	-	-	
Amaede	5	4	1hr per month	1	1980	
Umuaja	8	3	2hrs 2 times	5	2 in 1970, 3 in 1980	
Ngwa-Ama	3	1	2hrs 2times	2	1980	
Umuokoro	5	4	4hrs 2 times	1	1976	Receives water from Nenu water station
Eke-na-Ekpu	3	3	2hrs 2times	-	-	-do-
Umuihi	3	3		-	-	
Total	61	27		34		

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OVUOKWU:

Okpuala	4	-	-	4	3yrs	Damaged by the Niger Co. during road construction.
Amauha	3	-	-	3	6months	Damaged during road construction.
Obekwensu	4	-	-	4	8 yrs	Damaged by the Niger Co. during road construction.
Umueleghele	7	-	-	7	3yrs	- do-
Umuakwa	3	-	-	3	8yrs	-do-
Amamgborogwu	-	-	-	-	-	None at all
Ovuorji	7		Once	6	3yrs	

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OVUOKWU (Contd)

Umuegoro	3	Nil	-	3	3yrs	Damaged during road construction work
Umuene	7	Nil	-	7	8yrs	-do-
Umurasi	1	Nil	-	1	2yrs	
Umuawa	5	Nil	-	5	2yrs	
Umuikogele	1	Nil	-	1	2yrs	
Amairi	1	Nil	-	1	3yrs	
Umuokoro-miri	2	Nil	-	2	3yrs	
Umuopia	2	Nil	-	2	3yrs	
Obichukwu	-	-	-	-	-	None at all
Total	50	1	-	49		

WATER SCHEME: MBUTU
COMMUNITY: AMAISE-AHABA

Mgbedeala	7	Nil	Nil	7	10yrs	Pipes were damaged during the construction of Express Road
Umuacha	4	Nil	Nil	4	10yrs	-do-
Mkpuka	5	Nil	Nil	5	9yrs	Pipes were broken during road construction Company in 1977.
Umuikaa-Umu-ochiagu	10	Nil	Nil	10	9yrs	Both pipes and taps were removed during the construction of Owerri-Express Junction road in 1978.
Egbelu-Umu-ikaa	3	Nil	Nil	3	2yrs	Pumping Engine damaged pipes removed during construction of Aba-Owerri road and some taps removed too.
Umunvo	14	Nil	Nil	14	9yrs	
Total	43	-	-	43		

WATER SCHEME: MBUTU
COMMUNITY: AMAISE

Aga Amaise	7	Nil	Nil	7	5yrs	Pipes were destroyed during the construction of the Express rd.
Amaokpu	3	Nil	Nil	3	5yrs	Pipes were damaged
Nneoyi	7	Nil	Nil	7	4yrs	Construction Company destroyed the Pipes.
Umuekene	5	Nil	Nil	5	5yrs	Pipes were damaged
Umuwandu	2	Nil	Nil	2	7yrs	Has stopped before the road construction.
Total	24	-	-	24		

WATER SCHEME: MBUTU

COMMUNITY: NGWAOBI

Village	No. of water taps	No. of Function-al water taps	Duration per week	No. of Non-fun-ctional taps	How long has it stopped funtion-ing	Remarks
Umunduogu	5	Nil	-	5	over 3yrs	Most of the taps are broken
Umuebi	2	Nil	-	2	over 1yr	Some of the pipes are leaking
Umunta	4	Nil	-	4	over 1yr	At the base
Emaudara	3	Nil	-	3	-do-	
Umuezeorji	2	Nil	-	2	-do-	
Umueme	4	Nil	-	4	-do-	
Umuaka	3	Nil	-	3	-do-	
Umuwoma	1	Nil	-	1	-do-	
Total	24	-	-	24		

WATER SCHEME: MBUTU

COMMUNITY: OKPORO-AHABA

Umuajuju	4	Nil	-	4	17yrs since after the war	3 taps were removed during Aba-Obikabia road construction.
Umuoko	4	Nil	-	4	17yrs	
Mba	6	Nil	-	6	17yrs	
Okpuline	5	Nil	-	5	17yrs	
Umuline	5	Nil	-	5	17yrs	The 5 taps were removed during rd. costr.
Umuakuma	2	Nil	-	2	17yrs	
Amuke	-	Nil	-	-	-	
Amuenere	2	Nil	-	2	17yrs	
Mbutu	4	Nil	-	4	17yrs	3 out of the 4 taps were removed during road construction.
Umuosi	5	Nil	-	5	17yrs	
Umueze	2	Nil	-	2	17yrs	The taps were removed during road constr.
Umumbahia	1	Nil	-	1	17yrs	The taps were removed during road constr.
Total	40	-	-	40		

WATER SCHEME: AMAIYI

COMMUNITY: AMASA

Amachi	15	13	2 times a week	2	Since April, 1987	
Usaka-Umuofor	4	-	-	4	Since April, 1987	
Umuosu-Onyeike	2	2	1 hour	-	-	No tap
Ohuhu-Nsulu	-	-	-	-	-	No tap
Umuakwu	-	-	-	-	-	No tap
Eziama	-	-	-	-	-	No tap
Aro-Achara	-	-	-	-	-	No tap
Total	21	15	-	6		

WATER SCHEME: NBAWSI
COMMUNITY: NSULU

Umuomainta-Nbawsi	63	5	2 times per month	58	Since after the war	Some are uprooted
Umuati	4	-	-	4	Since after the war	
Agburuke	11	2	Once in 2 weeks	9	Since after the war	
Umuomaiukwu	5	Nil	Nil	5	Since after the war	
Eziala	7	-	-	7	12 yrs	
Umuezeukwu	8	-	-	8	14 yrs	
Umuogu	7	-	-	7	18 yrs	
Umuezegu	9	8	2 times per week for 2 hrs	1	4 yrs	
Total	114	15		99		

WATER SCHEME: MBUTU:
COMMUNITY: MBUTU AMAIRINAISI

Uhum	5	5	24hrs	-	5yrs	
Amankwo	2	-	-	2	17yrs	
Umuogwo	2	2	24hrs	-	3yrs	
Umuocheala	66	6	24hrs	-	3yrs	
Owerrinta	13	-	-	13	10yrs	The pipes were destroyed during road construction
Owerrinta (water side)	3	-	-	3	10	-
Umuojima Efere	5	5	36hrs	-	3yrs	
Obekwesu	2	2	24hrs	-	3yrs	

WATER SCHEME: MBUTU

COMMUNITY: MBUTU AMAIRINAISI (Contd)

Umuokwo/Umuosoala	3	2	24hrs	1	4yrs	The taps have not been functional for over 4yrs.
Umuezeocha	1	1	35hrs	3	4yrs	The first tap at Ahia Oria has been removed, the traces of it can still be seen.
Umuduru/Okpungwu	3	2	24hrs	1	5yrs	
Umuojima Ukwu	3	2	36hrs	1	3yrs	
Umuokorie	1	-	-	1	3yrs	
Egbelu Mbutu	3	1	24hrs	2	3yrs	
Umueleke	4	2	24hrs	2	8yrs	One tap at Amaikoro was destroyed during road construction.
Umuichu	-	-	-	-	-	No taps at all. People go to other villages for water.
Total	59	39	-	29		

WATER SCHEME: OVUNGWU/OVUOKWU

COMMUNITY: OMOBA

Village	No. of water taps	No. of functional taps	Duration per week	No. of non-functional taps	How long has it stopped functioning	Remarks
Umuzechi	4	2	96hrs	2	8yrs	
Umuamosi	2	Nil	Nil	2	5yrs	
Umuokegwu	7	2	4hrs	5	6yrs	
Umuagu	9	1	48hrs	8	2yrs	
Umuokoroukwu	6	Nil	Nil	6	7yrs (1980)	
Umuoke	Nil	Nil	Nil	Nil	Nil	
Umuolike	Nil	Nil	Nil	Nil	Nil	
Umuoba	6	Nil	Nil	6	3yrs (since 1984)	
Umuire	15	3	3hrs for 3days	12	3yrs (since 1984)	
Total	49	8	-	41		

WATER SCHEME: NGWA-UKWU

COMMUNITY: NGWAUKWU, UMUCHA, NTIGHA, IHIE, AND AMAPU-NTIGHA

Amaoji	16	5	Once in 2weeks	11	Since the end of civil war	2 are uprooted
Abayi	17	5	Bi-monthly	13	Over 9yrs	2 are uprooted
Osusu	9	3	Once a week for 2hrs	6	-	
Ahiaba Ubi	10	8	2hrs	2	One year	
Umuchima	14	5	1hr	9	One year	I is uprooted
Amapu Ngwa	3	3	2hrs a week	-	-	-
Ahiaba-Okpuala	7	7	2hrs	-	-	-
Umuoha	4	3	Once a month	1	two years	-
Obikabia	7	3	2times for 5hrs	4	three years	-
Okpuala-Ngwa	7	2	-	5	Since after the war	-
Ihie	13	8	2hrs monthly	5	-	-
Amapu-Ntigha	34	16	2hrs monthly	18	Four years	-
Ntigha	34	19	2hrs for every 3 weeks	15	Four years	-
Total	175	87	-	88		
GRAND-TOTAL						
For all communities	783	219		564		

APPENDIX D

SPSS JOB EXECUTION FOR ISIALA-NGWA RURAL WATER SUPPLY

```
RUN NAME            CHIMA WATER SUPPLY (GEOG0016)
VARIABLE LIST       FS, POWS, CNAT, DIST, DAM, AGOV,
                    STP, PIPE, ATT, WLK, BORE,
                    DRY, FUEL, CORP, PPWL, COL,
                    TAPS, TANK, POLIT,
INPUT MEDIUM        CARD
N OF CASES          13
INPUT FORMAT        FIXED (14F5.1/5F5.1)
FACTOR              VARIABLES = FS TO POLIT/
                    TYPE = PAI/
                    NFACTORS = 6/
                    ROTATE = VARIMAX/
STATISTICS          1,2,4,5,6
READ INPUT DATA
FACTOR              VARIABLES = FS TO POLIT/
                    TYPE = PA2/
                    NFACTORS = 6/
                    ROTATE = VARIMAX 1
STATISTICS          1,2,3,4,5,6
FINISH
```