International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 3 No. 7, July, 2013

Quarrying of Sand and Proposed Reclamation Method in Akure, Nigeria

[1]Akande J.M., [2]Jimoh B. O.
[1]Department of Mining Engineering, The Federal University of Technology, Akure
[2]Department of Mineral Resources Engineering, Federal Polytechnic, Ado-Ekiti.

ABSTRACT

The paper reports the study of extraction of sand from the deposit. The objective of the research was achieved by taken soil and water samples from seven locations in Akure. Strip mining was used to excavate sand in all the deposits. The samples were analyzed for physical and chemical properties which include temperature and colour and the amount of macro and micronutrients such as Ca, Mg, K, Na, Fe, Cu, Pb, Mn, Zn, Cl, Acidity Alkalinity and Organic matter. The result show that the subsoil are acidic (pH varies from 5.0 – 7.0). While the topsoil varies from slightly acidic to highly basic (pH ranges from 5.7 – 8.1). Cultural, Aquaculture and Nature trial recreation are however suggested for reclamation.

Keywords: *words: Sand, Topsoil, Subsoil, Akure, Mining, Chemical Properties.*

1. INTRODUCTION

Sand refers to fine loose grain resulting from the erosion of rocks especially siliceous rocks forming the seashore and desert. Most sand deposits represent one of the following principal types; river channel deposit, flood plain deposits, delta deposits, shore (sand dune) deposits formed by sedimentation in standing water and residual soils formed in place by weathering. Sand deposit in Akure and its environment are either of these two; (i) the flood plain deposit (those carried from the source depending on the capacity of the agents of transportation) and (ii) the residual soils (sand) formed in place by weathering (Rahaman, 1997). Mining is the act of reconverting the ground in order to win valuable and economic viable mineral deposits from the earth crust for the benefit of mankind. In Nigeria mining started with exploitation of cassiterite, produced about a thousand ton in 1909, Nigeria Mining Corporation (NMC) was responsible for the mining of Gold in 1914, coal in 1915 (in collaboration with Nigeria Coal Corporation NCC) and lead and zinc in 1947 (National policy of solid mineral, 1999). Exploration of crude oil started in 1958 by shell petroleum. The mining of some industrial mineral like Talc, mica, banter sand and limestone have been limited to individuals who have been authorized by Federal Ministry of Solid Mineral through the issuance of mining right and licenses (Williams, 2001).

From time mining companies were hold responsible for primary restoration of mined out areas. The power to declare any area closed to prospecting and mining was vested on the minister of mines and power under section 8(1) of the Act. The first record of reclamation work was carried out with the planting of eucalyptus trees directly into the overburden heap near Barkin Ladi. The success recorded influenced the establishment of the Mines Land Reclamation Unit (MLRU) in 1948 by the then Northern Regional Government (Mallo, 1995). Sand grains are worn and rounded owing to movement by rivers, streams and wind. This gradually turns the sand from sharp angular grains into more rounded grain. Sand is a range of grain size of material; it's however defined as materials between 1/16mm to 2mm in size (John, 1998). Many of the method employed and principle of control in hard rock quarries are equally applicable in sand mining (Ferguson, 1974). Three types of in stream sand mining exist. Dry pit mining refers to pits excavated on dry ephemeral streambeds. Wet pit mining involves removal of sand from below the water table or in perennial stream channel (Imasiku, 2002). Bar skimming or scalping requires scraping off the top layer from a gravel bar without excavating below the water level.

1.1 Quarrying Method Used in Akure Sand

The mining method use for Akure sand is strip mining. Strip mining or shoveling according to Opafunso, 1990 is a method of mining used in loose deposit such as sand any type of loose overburden. It makes use of two major tools:

1. Diggers for loosing of the sand where it is compacted and
2. Shovel for packing/scooping the loose material and loading.
3. 3 – 6 tons truck for haulage.

The following impacts were noticeable from the sand quarrying sites:

(i) surface disturbance and loss of aesthetic value from pits left as a result of quarrying,
(ii) loss of land use for agriculture and forestry,

(iii) the elimination of habitat for animal species due to loss of bio-diversity,

displacement or extinction of animal species due to loss of habitat.

2. MATERIALS AND FIELD STUDY

2.1 Location of the Study Area

The study areas are: Ado road located at Isinigbo/Igoba along Akure-Ado-Ekiti road;

Owo road; Abo; and Oda; Igbatoro, located on the North east of Akure; Itaoniyan; and Olokuta are located on the southwestern region of the metropolis (Fig.1).

Thirty-five soil samples and twenty-one water samples were taken from the quarries. Random sampling technique was used to collect five soil samples in each of the quarries. To these is added a control sample taken at an average distance of about 200m to the quarry site. Hand held auger drill was used in taken the soil samples. Three grab water samples were equally taken at each of the pits formed in the quarry.

2.2 Determination of Total Solids (TS), Total Dissolved solid (TDS), Total Suspended solid (TSS) and Total Hardness (TH)

The amount of total solid was determined in the laboratory by

$$\text{Total Solids (ppm)} = \frac{Difference\,in\,weight}{vol(ml)\,of\,sample} \times 10^6 \quad (1)$$

Total Dissolved solid (ppm) =

$$\frac{Difference\,in\,weight}{vol(ml)\,of\,sample} \times 10^6 \quad (2)$$

Suspended solid (ppm) =

Dissolved solid (ppm) - Total Solids (ppm) (3)

$$\text{Total Hardness (ppm)} = \frac{\text{Titre x 1000}}{\text{Vol (ml) of sample}} \quad (4)$$

2.3 Determination of Organic Matter And Total Nitrogen In The Soil Samples

Walkey-Black method (Awojobi, 2002) was employed to determine the percentage of carbon in the soil sample.

% organic carbon in soil is calculated using the following formula:

$$\%C = \frac{(MeqK_2Cr_2O_7 - MeqFeSO_4) \times 0.3 \times f}{weight\,of\,dried\,sand} \quad (5)$$

f = correction factor = 1.33

Meq = Molarity of Solution x vol (ml) of solution used.

% Nitrogen content in the sample is calculated as follows:

$$\%N = \frac{T \times M \times 14 \times 100}{weight\,of\,soil\,used} \quad (6)$$

Where T = titre value

M = Molarity of HCL

2.4 Determination of NO_3 and SO_4 in the Water Samples

Sulphate (SO_4) in the water sample was determined by adding 1% solution of hydroxylamine hydrochloride and 20ml of benzidene hydrochloride to 250ml of the water sample in a beaker. The precipitate obtained after filtration was titrated with 0.05m NaOH after adding 3 drops of phenolphthalein indicator.

$$SO_4\,(\text{ppm}) = \text{vol (ml) of 0.05molar of NaOH} \times 0.6 \quad (7)$$

The nitrate (NO_3) was determined by adding 2ml of bruicine reagent. Absorbance at 470nm was measured after allowing the mixture to stand for 5 minutes.

2.5 Determination of Na, K, Ca, Mg, Fe, Zn, Cu, in the water samples

Na, K, Ca, Mg, Fe, Zn, Cu were extracted using Acetic acid, ammonium hydroxide and ammonium acetate. Amount of Na, K, Ca were determined using flame photometer while Mg, Fe, Zn, Cu were determined using an atomic absorption spectrometer.

3. RESULTS AND DISCUSSION

The temperature of the water samples is in the range of 27.8^0C-27.9^0C (fig. 2) thus representing the mean temperature around Akure metropolis. Water for drinking purposes has better taste at lower temperature around 15^0C (Akande and Awojobi, 2003). However, higher temperature does not imply impurities or contamination. The colour of Samples of pond water from Abo, Owo, Itaoniyan and Olokuta could be observed to have higher values of 70, 110, 80 and 120pcu while samples from Ado, Igbatoro and Oda fall within acceptable limits of 50pcu (WHO, 1982). Turbidity values from the seven quarries range from range from 10.32NTU which fall

within permissible values of WHO, 1992. Results from the topsoil and the subsoil (Fig. 3 and 4) samples indicate that Ca has lesser values than 80mg/kg as recommended by Adulayi and Ekong, 1981. The presence of Calcium in the subsoil samples suggests the use of Calcium rich fertilizer because plants except lower crops cannot successfully grow in these areas as drought is evidenced on them. Mg is present in sufficient values in thye control samples except Abo and Itaoniyan. However the presence of Mg in Ado road and Owo road are adequate in the subsoil; unlike samples from Abo, Igbatoro, Oda, Itaoniyan, which have less value. Olokuta has value that is close to the critical value of 15mg/kg as suggested by Akande and Awojobi (2003). It is however noticed that there is concentration of the said nutrient in the topsoil. Application of fertilizer and manure could be used to improve the supply of the magnesium ion. Higher values of K are obtained in the topsoil except Ado road and Owo road in the subsoil than the topsoil (15 and 36mg/kg against 38 and 48mg/kg) this could be as a result of leaching of the nutrient. The subsoil could be treated with NPK fertilizer to improve on the nutrient uptake by plant. None of the values could be seen to match with the acceptable limit suggested value of 58.5ppm by Sobulo and Osiname (1981).

12mg/Kg of Na was obtained from Ado road sample topsoil while Owo road; Igbatoro and Olokuta are with 4, 8 and 3mg/Kg respectively. The subsoil samples have less values of the nutrient than the topsoil except those of Oda and Itaoniyan. Values from Owo road are the same; but all the samples could be seen to have fallen bellow the required Na level of 80ppm suggested by Tisade and Werner (1985).

The acceptable limit of Fe is about 30 – 150ppm (Wendell, 1966). Results show that all the samples fall within the required limit except that of Abo topsoil. However, there is evidence of leaching of the nutrient comparing the topsoil to the subsoil samples. The high presence of iron may be responsible for the acidic nature of the subsoil samples more so the absence of manganese and copper that might oxidize it to a less soluble form of it.

Lead value range from 60 to 330mg/kg in the all the soil samples; while Manganese and copper were however not present in measurable amount in all the samples. Manganese fertilizer and $CuSO_4$ could be applied to introduce the missing ions.

Zinc is absent in both the control and subsoil samples of Oda; while the control samples from Igbatoro and Olokuta show that the soils are depleted of the element (10 and 30mg/kg against 50 and 40mg/kg respectively). There are more Zn in the topsoil of Ado road, Owo road and Itaoniyan than in the subsoil. However Owo road Igbatoro and Olokuta subsoil samples fall within acceptable limit. Samples from Abo and Igbatoro have 10mg/kg which fall below the required value of 25-150ppm.

The acceptable limit of Chlorine according to Wendell (1966), Awojobi (2002) and Akande and Awojobi (2003) is about 250ppm. There are higher values of 380, 270, 320 and 260mg/kg respectively for Ado, Abo, Igbatoro and Olokuta (Figs. 5 and 6) indicating a good support for plant growth; while other topsoil samples are slightly below the acceptable limit, a good rainfall will favour its balance on the soil. However, 100mg/kg was recorded for the subsoil sample of Owo road while others fall below this limit. The result obtained from the study areas show that Itaoniyan subsoil has more sulphate (250mg/kg) than the control sample (10mg/kg); this may be due to leaching effect on the topsoil. It is however noticed that Igbatoro, Owo road and Olokuta top and subsoil samples are reach in sulphate nutrient (400 and 300, 300 and 170 and 500 and 310mg/kg respectively). All the samples show a good representation of sulphate that could support plant growth.

According to Awojobi (2002), soil with about 2-20ppm will support plant growth. More nitrogen is present in the subsoil except in Igbatoro and Olokuta than the topsoil, this may be attributed to leaching (Figs 5 and 6). It is likely not going to support yield of fruits or grains. The pH in soil is between 3 to 10 (Rowel, 1993,). When it is lower or higher than 5.6 it is acting either as an acid or base. The result obtained from the study areas show that the control samples are all within the range of normal soil and their values range from 5.7 – 8.1. Comparing, the subsoil samples range from 5.0 – 7.0 which can be said to be slightly acidic except for samples from Ado road, Owo road and Igbatoro. This could be attributed to Fact that is present in large quantity and the absence of Mn and Cu. In this type of environment, most plants could still survive. Almond fruit, Oil palm and even Melaina being some examples.

The Organic matter of soil have been removed by quarrying, this could be noticed when comparing the topsoil with the subsoil samples. It ranges from 0.25- 0.85 in the topsoil, and 0.10-0.35 in the subsoil samples. Only Olokuta sample has the same value of organic matter (Figs. 7 and 8).

The Suspended Solid values range from 47.2 to 80mg/l which are above the WHO recommended value of 25mg/l. The range of value for the pH is 5.6 to 8.1for all the pond water at the quarry sites. However the recommended range of WHO, 1981 is 6.5-9.2 in which only Abo and Oda fall bellow this limit.

The Electrical conductance is a function of total amount of dissolved solids in water. Drinking water is recommended to have not more than 500mg/l of dissolved solids, although water with up to 1000 mg/l is allowed

where there is no alternative source. Range obtained was between 110.1μs/cm for Abo pond water to 390 μs/cm Ado pond. This indicates that stream water draining into the mine site has low degree of contamination or pollution coupled with no level of contamination from the mined out space (Fig. 9).

Acidity and Alkalinity in water is a function of hydroxyl ions and this is closely related to the pH of the water. Values obtained for all the samples range between34.8 to 86.2mg/l for acidity and 90.1 to 150mg/l for alkalinity thereby falling within permissible limits of 500mg/l recommended by WHO, 1992. The water samples have values that range from 18 to 130mg/l of hardness (fig. 10). This classes all the water samples between soft water to hard water and fall below the recommended value of 500mg/l by WHO, 1982. The level of Na and K could not be traced to any environmental problem in that the range of values obtained are 0 to 10.2mg/l Na and 22 to 45mg/l which fall bellow the acceptable WHO limit for the two ions. The presence of Ca and Mg in the water samples do not indicate contamination. WHO accepts 200 and 150mg/l. The level of Mn and Cu in the water samples could not be determined. The level of Fe in the water indicates that Abo and Ado road has 0.1 and 0.09mg/l respectively while others have higher values that range between 0.23 to 0.73mg/l.

The chlorine level in the water samples fall below acceptable limit of WHO (250mg/l) (fig 11). The samples present values that range between 0.028-0.075mg/l, this range could support aquaculture. Sulphate is present in minimal quantity in all the samples giving a value of 49mg/l for Ado road; others are however having less value. The values obtained fall below the recommended limit of the World Health Organization of 500mg/l. All the samples of water indicate that there is low level of Nitrate (NO_3) in them. The value range from 0.12 (Ado) to 0.70mg/l (Itaoniyan), conforming to the recommended WHO standard of 44mg/l.

Reclamation: It is a process by which previously unusable land is returned to a state whereby some use may be made of it. According to James et al, 1998, it refers to areas which were heavily contaminate or were geologically unstable, and may now be used for civil reengineering, construction or limited growth such as sports fields which require high inputs to be maintained.

3.1 Possible Reclamation Method

Cultural: Rehabilitation of claimed mined areas, as in the opinion of Mallo, 1999 will start with the planting of trees such as casuarinas trees, oil palm, almond fruit, ticks, eucalyptus as the case may be in addition to this many species of insects reptiles birds and mammals could be introduced into the young forest to aids the development of the ecosystem.

Aquaculture: The chemical and physical analysis of this study have shown the presence of an unpolluted water draining into the quarry underlying ground water which suggests that the development of aquaculture projects could be possible both for rehabilitation purposes and as economic venture.

Nature Trial Recreation: The essence is to create new habitats with expanding food sources to provide wide range of animals, birds and insects. The establishment of such a green haven can attract tourism (game reserve).

4. CONCLUSION AND RECOMMENDATION

Sand is a vital material in construction hence it has a great role it plays in national development. The range of grains sizes of sand is between 0.0625 – 1.000mm and could be quarried by Dry pit, Wet pit, Bar skimming, and even the use of modern machineries such as front end loaders, power shovel and the like. The presence of macronutrients such as Ca, Mg and K in most of the samples are inadequate when compared with standard values. The pH of the subsoil varies from5.0 to 7.0. This indicates that the subsoil is acidic. While the pH of the topsoil ranges from 5.7-8.1 which indicate soil that is slightly acidic to highly basic. The pH values of the water sample vary from 5.6 to 8.1 indicating slightly acidic to highly basic water. The stream water draining into all the ponds are not of a polluted or contaminated source.

The abandoned pit resulting from mining should be used as a refuse dump. After some period of time the decomposed refuse can be mixed together and spread over the pit. This could successfully allow the growth of plants on it thereby reclaiming the land for agricultural practices. A commission such as Industrial Mineral Producing Areas development commission [IMPADEC] should be set up by the federal government to supervise the reclamation of the devastated lands where sand and other industrial minerals are extracted. The Federal Government should uphold and implement the FEPA requirements that every proposal for mining be accompanied by an appropriate environmental impact statement. There has to be the closest possible liaison between the environmental and engineering teams so that all relevant environmental parameters are considered.

REFERENCES

[1] Adulaji E.A. And Ekong E.E.(1981); General Agriculture And Tool. London Cassell. Pp. 100 – 106.

[2] Akande J.M. And Awojobi D.A., 2003, Assessment Of Environmental Impacts Of Exploitation Ofd Granite Deposits In Ilorin, Journal Of Engineering And Technology 10 (2) 4891-4900.

[3] Aso Isife And Adeloye A.O. (2001), Introduction To Mining Vol. 1 Pp65-85

[4] Awojobi, D.A. (2002); Environmental Impact Assessment Of Exploitation Of Granite Deposits In Ilorin, M_{ENG} Project FUTA.

[5] FAO (Food and Agriculture Organization) (1993): Soils Bulletin 68

[6] Ferguson S.R. (1974), The Velocity Of The Sea-Bed And Basement Rocks Between Leigh And The Mokohinau Islands. Msc Thesis, University Of Auckland.

[7] Hilson G. (2002): An overview of land use conflicts in mining communities. Land Use Policy vol. 19 No. 1.

[8] Imasiku, A.N., (2002): Economic, Environmental and Social Impacts of Small Scale Mining. http://www.32igc.org.

[9] James A, Harris, Paul Birch and John P. Palmer, (1998): Land Restoration And Reclamation; Principles And Practices., Addison Wesley Longman Limited Pp. 3 –25.

[10] Opafunso Z.O. (1990): Personal communication

[11] Rahaman M.A., (1997): Review of Basement Geology of south-western Nigeria by C.A. Kogbe (ED), Elizabethan Publication Co. Lagos, Nigeria. 41-51.

[12] Rowel D.L., (1993), Soil Science. Methods And Applications Pp 232-249.

[13] Sobolu A.R. And Osiname B., 1981; Sales And Of Fertilizer In Nigeria I.A.R.T. Res. Bulletin No. 11, Pp. 42.

[14] Stephen Malloy J, (1999): Reclamation of mined out areas: A case study of the Jos Plateau. Nigeria mining journal Vol. 3. (1); Pg 19 & 20).

[15] Tisdale S and Werner N (1985); Soil Fertility And Fertilizers. Macmillan Books: New York, 4th Edition Pp 64 – 69.

[16] Wendell H., (1966): Compilation Of Soil Science Lecture Series For Students Of University Of Nsuka.

[17] WHO (World Health Organization) (1982): guidelines for Drinking Water quality in Small Communities. World Health Organization. Geneva

[18] WHO (World Health Organization) (1992): Our Planet Report of the WHO commission on health and environment. Geneva

[19] Williams F.A. (2001): Disposal mining in Lagos state, an unpublished HND thesis, the federal polytechnic, Ado Ekiti 23-32

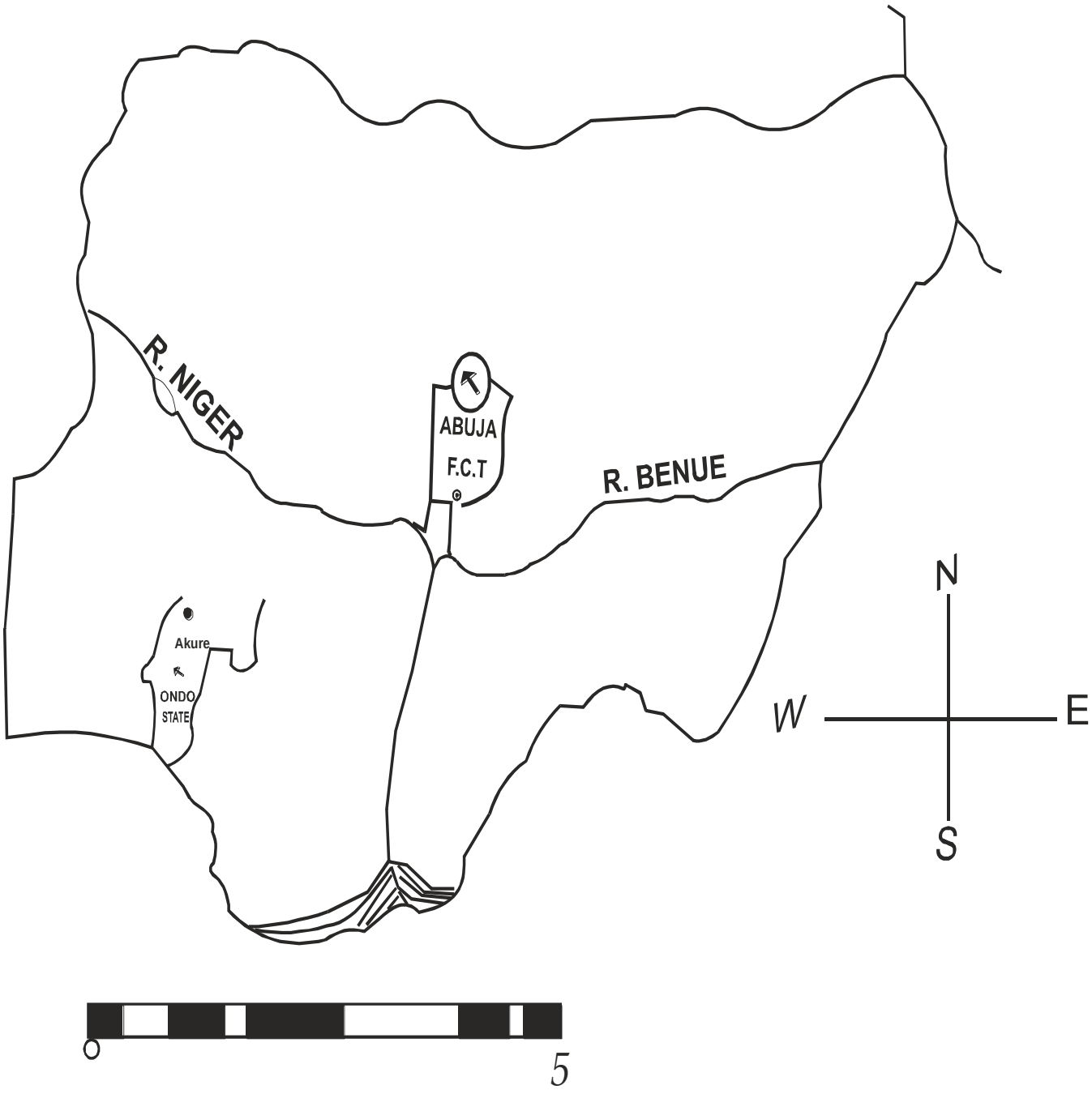

Fig: 1. Map of Nigeria indicating Akure in Ondo state

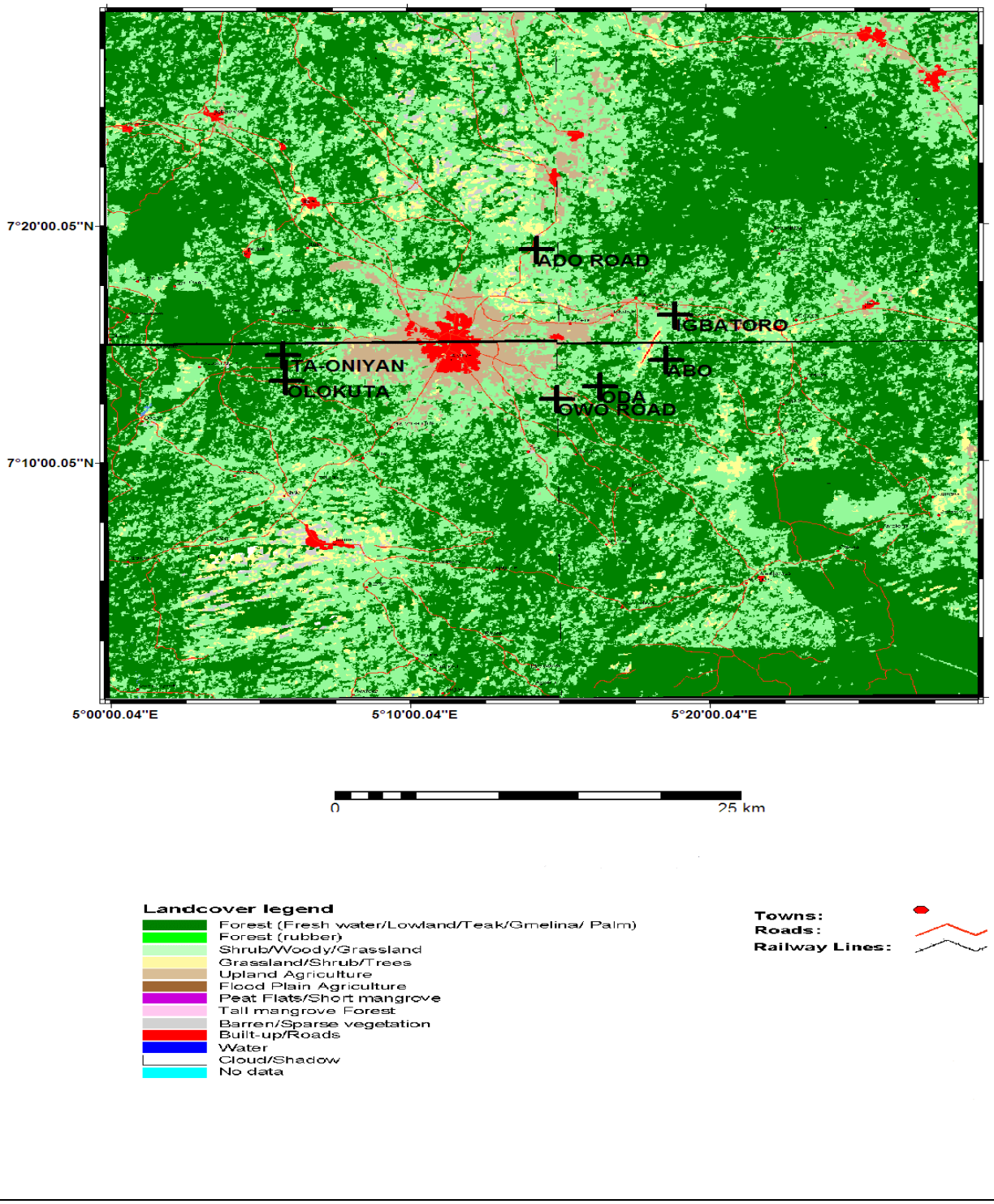

Fig 2: Location Map Showing The Study Area
(Source: Area Photography, Ground Control and Compilation)

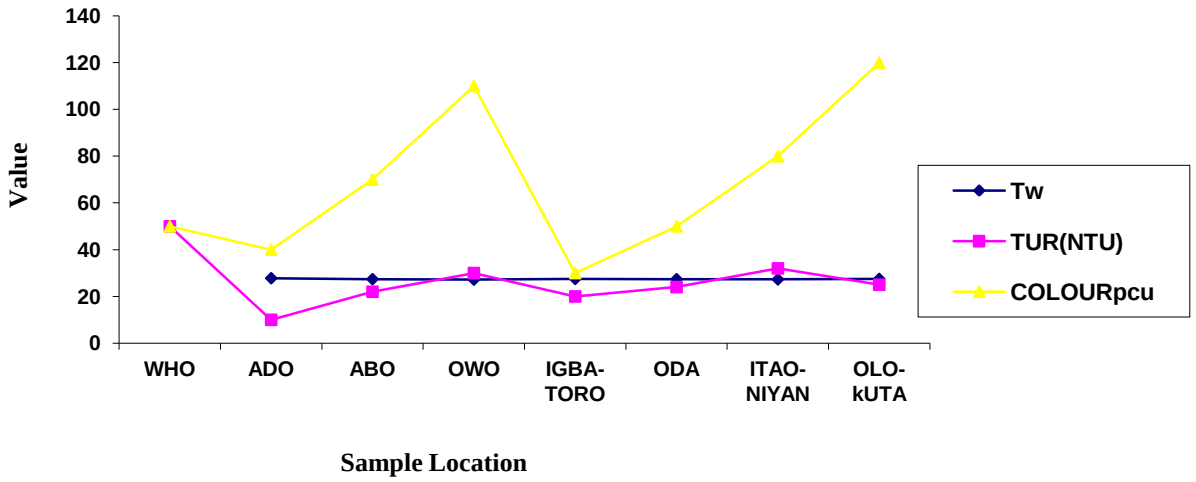

Fig 3 : Result of the field measurement of water samples from the study area

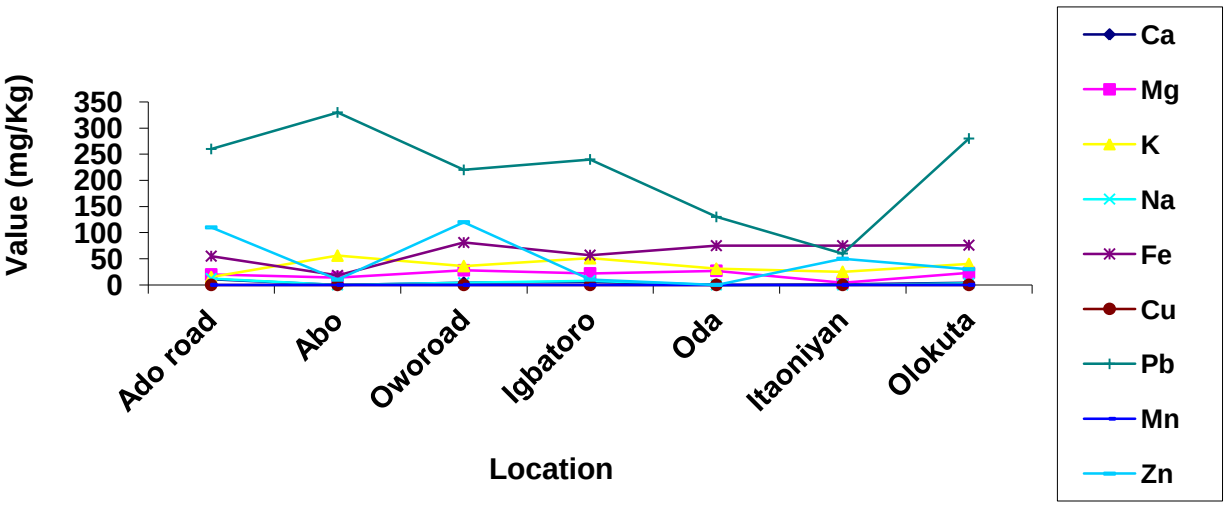

Fig 4: Result of the chemical analysis for the control soil samples

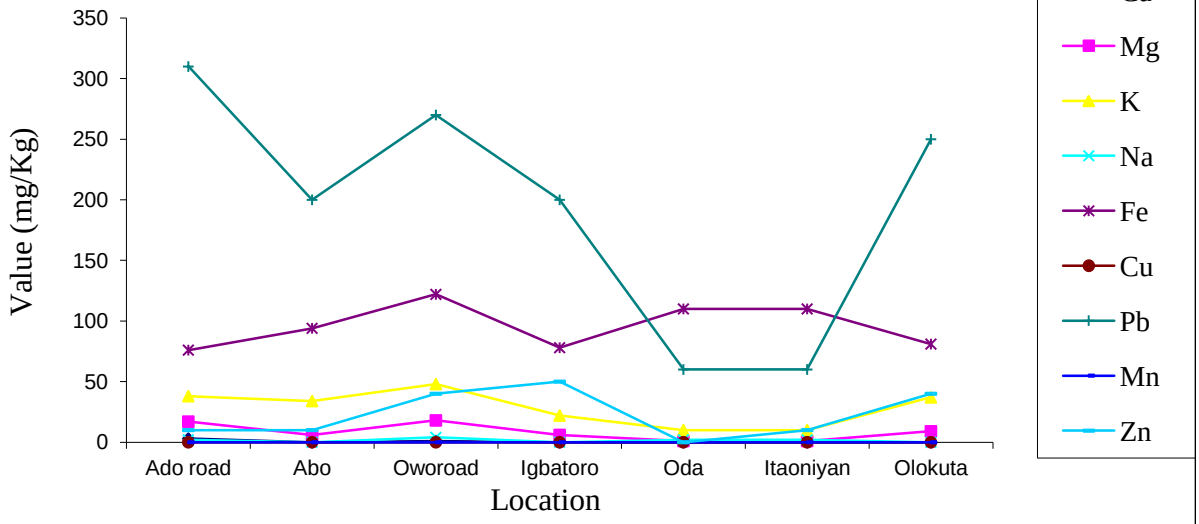

Fig 5 : Result of the chemical analysis for the sub-soil samples

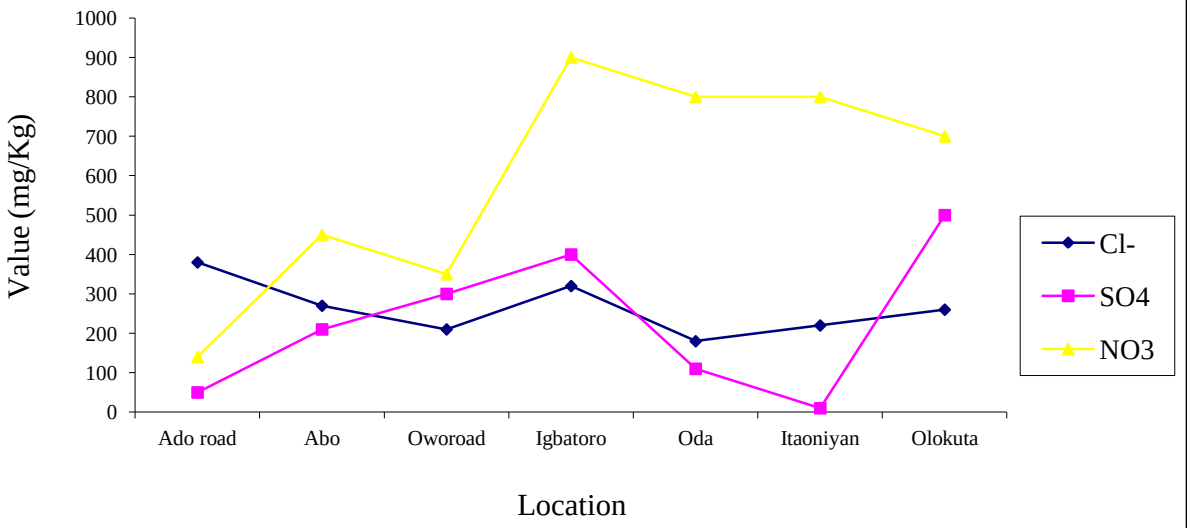

Fig 6: Result of the chemical analysis for the control soil samples

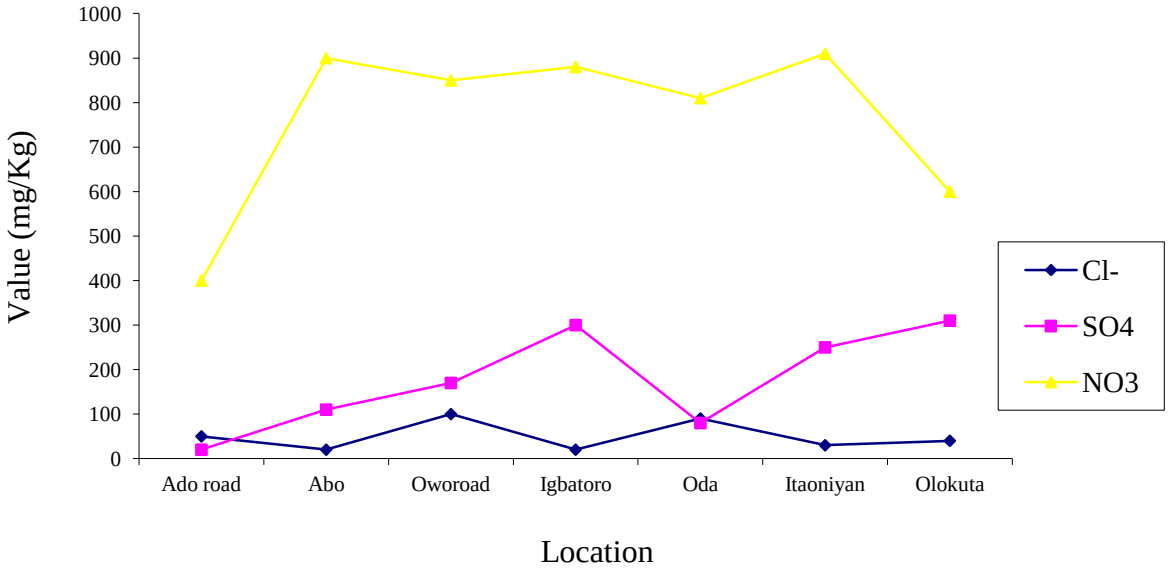

Fig 7 : Result of the chemical analysis for the sub-soil samples.

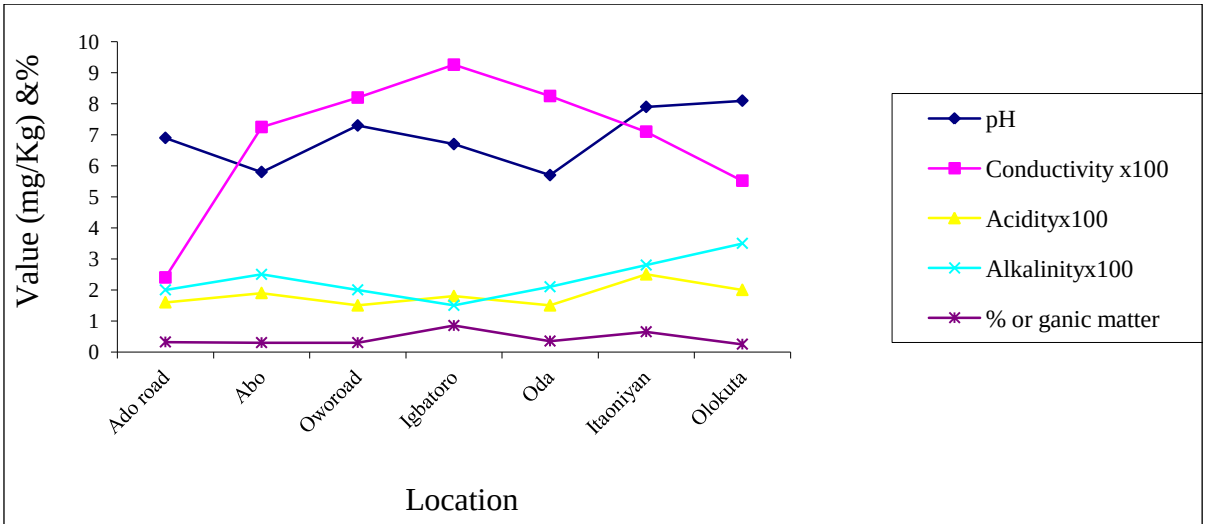

Fig 8 Result of the chemical analysis for the control soil samples

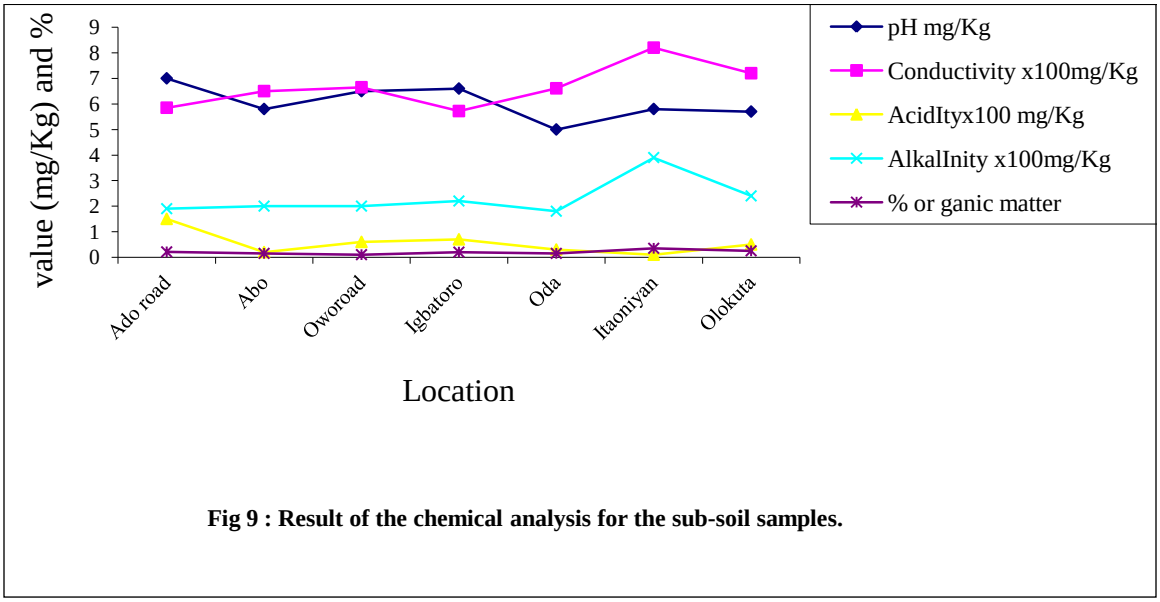

Fig 9 : Result of the chemical analysis for the sub-soil samples.

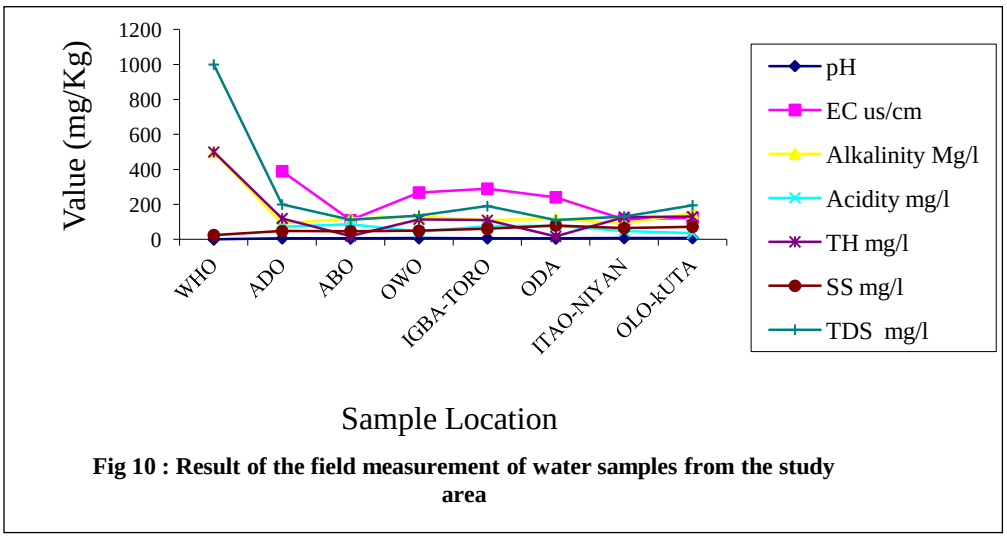

Fig 10 : Result of the field measurement of water samples from the study area

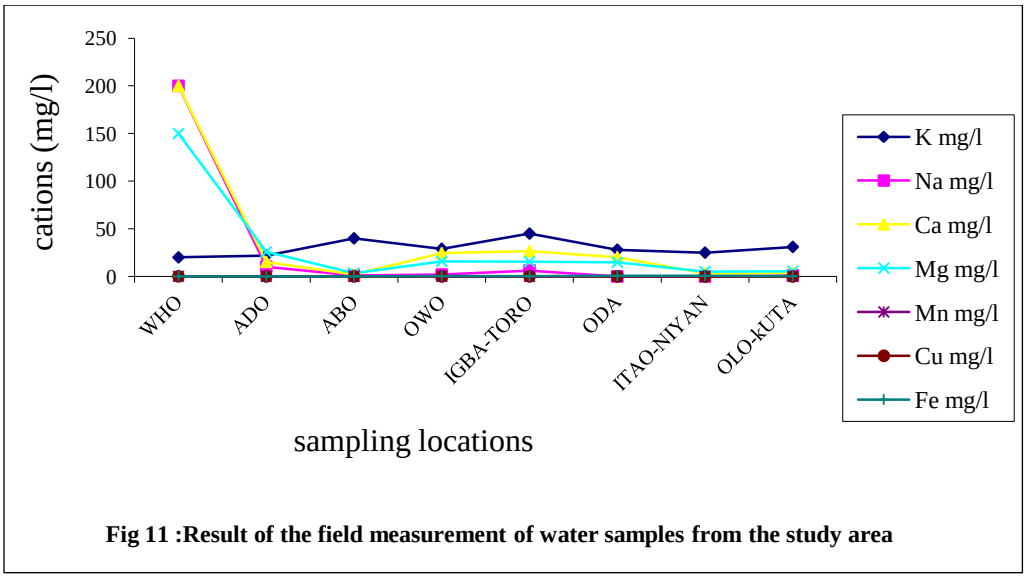

Fig 11 :Result of the field measurement of water samples from the study area

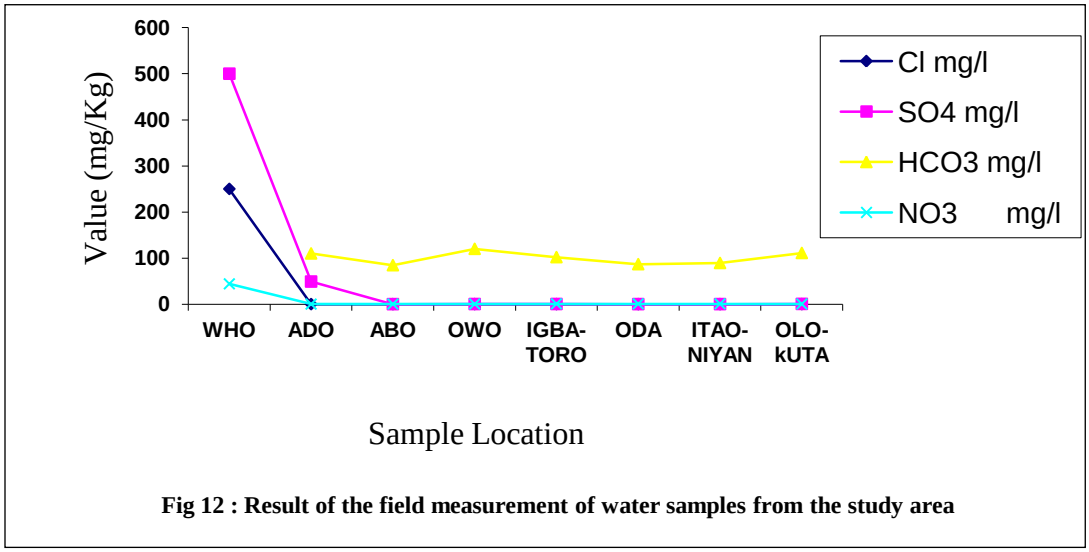

Fig 12 : Result of the field measurement of water samples from the study area