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Characterization of Dumpsite Soil: Case Study of Ado – Ekiti and Ijero Ekiti Nigeria

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Abstract: *Study on the elemental composition of soils at dumpsites was conducted by analyzing samples of soil at different dumpsites located within Ado-Ekiti and Ijero Ekiti, South Western Nigeria. The samples were analysed for the concentration of Pb, Ni, Nn, Mg, Fe, Cu, Zn, organic matter and silt + clay: control soil samples were taken away from the dumpsites. The result of the analysis shows a significant difference between the concentration of these elements in the dumpsites and control (P < 0.05). Correlations between them were negative in some cases and positive in some cases.*

Coliform bacteria such as Bacillus Megatarium, Chromatium Violasceus, bacillus substilis, Klebsiella Rhinosederomalis, Kurthia Zopfi, Clostridium Spirogenes, Bacillus Lichenifermis, Xanthomas fraganie, Bacillus cereus were present in the soil.

The moderately high concentrations of heavy metal in dumpsites and microbial present likely indicated that the environmental quality has been significantly affected hence remediation processes were suggested

Keywords*: Dumpsite, Heavy metals, Bacterial, Toxicity, Environment.*

I. Introduction

Heavy metal pollution of the environment, even at low – levels and their resulting long – term cumulative health effects are among the leading health concerns all over the world. For example, bioaccumulation Pb in human body interferes with the functioning of mitochondrion, thereby impairing respiration and also causes constipation, swelling of the brain, paralysis and eventual death (Chang, 1992)

The situation is even more worrisome in the developing countries where research efforts towards monitoring the environment have not been given the desired attention by the stakeholders

Heavy metals concentration in the environmental cannot be attributed o geological factors alone, but human activities do modify considerably the mineral composition of soils. In some cases, wastes are dumped recklessly with no regards to the environmental implications, while in some dumpsites wastes are brunt in the open and ashes abandoned at the sites. The burning of wastes get rid of the organic materials and oxidize the metals, leaving the ash richer in metal contents. After the processes of oxidation and corrosion, these metals will dissolved in rain water and leached into soil. (Harrison et al., 1989).

According to Bishop 2000, amongst all the classes of solid waste pose the greatest threat to life since it has the potential of polluting the terrestrial aquatic and aerial environmental land pollution by components of refuse such as heavy metals has been of great concern in the last decades because of their health hazard to main and other organism when accumulated within a biological system.

Many metals act as biological poisons event at part per billion levels. The toxic elements accumulate in organic matter in soils and sediments are taken by growing plants (Dara, 1993). The metals are toxic as the condensed free elements but are dangerous in the form of cation and when bonded to short chains of carbon atoms (Bairds, 1995).

The extent of soil pollution by heavy metals and base metal ions some of which are soil micro nutrient is very alarming. It has been observed that the larger the urban area, the lower the quantity of the environment

The recent population and industrial wastes which are indiscriminately dumped in landfill and water bodies without treatment. The use of dumpsites as farmland is a common practice in urban and sub – urban centres in Nigeria because of the fact that decayed and composted wastes enhance soil fertility (Ogunyemi, et al., 2003). These wastes often contain heavy metals in various forms and at different contamination levels. Some heavy metals like As, Cd, Hg and Pb are particularly hazardous to plants, animals and humans (Alloway and Ayres, 1997).

When waste is dumped on land, soil micro – organism including fungi and bacterial, readily colonize the waste carrying out the degradation and transformation of degradable (organic) materials in the waste (Stainer et al., 1989). Micro organisms in waste dump use the waste constituents as nutrients. This detoxifying the materials as their digestive processes breakdown complex organic molecules into simpler less toxic molecules.

This metabolic activity can be attributed to their high growth rate metabolism and their collective ability to degraded a vast variety of naturally occurring organic materials (Stainer et al., 1989)

In Nigeria, little information is available on the types of micro-organism associated with waste dumpsite heavy metals present as well as the relationship between the micro – organism and heavy metal. There is therefore the need to isolate characterize and identify the types of bacterial associated with waste dumpsite as well as study the contributions of selected municipal refuse dumps to heavy metals concentrations in the soil in Ado-Ekiti, and Ijero Ekiti southwest Nigeria.

II. Materials And Methods

The study areas are the Ado Ekiti, and Ijero Ekiti Dumpsite in Ekiti State, South western Nigeria. It is locates approximated on longitude and latitude $5^0 15^1$E, 70 371N and 5^0 05^1E, $7^0 49^1$N. A GPS 76 garnier model was used to determine the position of the dumpsites. Fig I, II show the map of Ado Ekiti and Ijero Ekiti in Ekiti State showing the location. As well as the type of the dumpsite.

Soil sampling: Two municipal refuse dumpsite were randomly selected for investigation in each of the towns. Soil samples were obtained in triplicate at each site at depths of 0 – 15 and 15 – 30cm using a depth calibrated soil auger. Each sample was immediately placed in a fresh plastic bag and tightly sealed.

***Physico chemical analysis*:** The soil temperature, PH and conductivity were assessed. The organic matter content was determined using the loss of ignition method as described by Lee et al., (2002). The soil nitrate; (NO_3-), phosphate (PO_4-) and cation exchange capacity (CEC) were determined as described in AOAC (2005)

***Heavy Metal Analysis*:** The fresh soil was spread on a clean plastic sheet placed on a plate surface and air – dried in open air in the laboratory. Under room conditions for 24 hours. After wards, the soil was sieved using a 0.5mm serve. After sieving, 0.5g was weighed from the sieved soil of each sample and put into a Pyrex beaker. Ten ml of perchloric/nitric acid mixture ratio 1:2 was added to the sample. The beaker was then covered with a lid and placed on a hot plate at 105^0C for 30 minutes in a fume cupboard for digestion. After the 30 minutes period, the beaker containing the digested solution was brought out of the fume cupboard and allowed to cool. After cooling, the mixture was transferred into a 25ml volumetric flask and made to 25ml mark with distilled water. Next, the 25ml solution was used for the determination of Co, Cr, Cd, Pb and Ni

Determination of the concentration of heavy metals was done using an Atomic Absorption spectrophotometer AAS (Model 210/211 VGP); 220GF Graphite furnace 220AB Auto sampler.

***Microbial Analysis*:** 10g of five soils from each sample was thoroughly shaken in 10ml of sterile normal saline. 1.0ml of soil sample was transferred into the next tube and diluted serially in a one – tenth step wise to 10^{-17} dilution. The organism were isolated and identified using standard Bacteriological methods (Paul and Clark, 1988; Harrigan and McCance, 1990; Obire et al., 2002)

III. Results And Discussion

The concentrations of metals in soils at the decomposed biodegradable wastes dumpsites indicate that there is an evidence of relative increase in the concentration of heavy metals organic matter and silt + clay in soils at dumpsite in Ado-Ekiti compared to these in soils from Ijero Ekiti dumpsites.

The metals considered in the study include metals which are micro – nutrient such as copper, manganese, iron and zinc, and the non – essential/toxic heavy metals which are toxic to plants when present in the soil at concentrations above tolerance level. This latter class of heavy metals includes lead and nickel.

Data from statistical analysis as shown tables I, II, IV and V were in agreement with the basic idea of the soil quality in and around land fill site which relates with the presence of heavy metals.

The mean concentration of chromium in the Ado Ekiti dumpsite soil was 9.42mg/kg, the mean concentration at Ijero Ekiti was 8.40mg/kg.

Allowable limit of Cr concentrations vary widely with country, being 150mg/kg in France, 100mg/kg in Austria and Spain, 60mg/kg in Germany and Sweden; and 30mg/kg in Denmark and the Netherlands (table 5). The values of Cr obtained in this study were lower than the 900 – 2000mg/kg reported by Adefemi and Awokunmi (2009). The concentration of Cr was higher in Ado-Ekiti than Ijero Ekiti

Chromium is one of the heavy metals whose concentration in the environment is steadily increasing due to industrial growth (Adelekan et al., 2011)

The mean concentration of Ni in the soil samples at Ado Ekiti was 7.53mg/kg and Ijero Ekiti was 7.54mg/kg, Nickel levels were higher than the 1 unit of 15mg/kg set in Denmark and Netherlands (table 3). The study by Awokunmi et al., (2010) found Ni to range between 0.2mg/kg and 450mg/kg although the average is about 20mg/kg (Lenntech, 2009). Nickel accommodation in plants can develop cancers of the lung, nose and birth defect (Duda – Chodak and Blaszczyk, 2008). The concentration of Ni in ado-Ekiti (Urban) and Ijero Ekiti (Rural) were the same this might be as a result of higher background concentration of nickel in Ijero soil (Olusiji Ayodele, 2011)

The mean concentration of manganese in the dumpsite soil at Ado-Ekiti was 16.13mg/kg and Ijero Ekiti was 16.13mg/kg and Ijero Ekiti was 11.14mg/kg

Higher concentration of Mn was obtained at Ado Ekiti which is the range of acceptable range of concentration. Dara (1993) reported that manganese may be found in most soil it is one of the elements in the earth crust.

The mean concentration of Fe in the soil samples at Ado Ekiti was 13.66mg/kg and Ijero Ekiti 15.22mg/kg. The concentration of Iron in Ijero Ekiti was higher; this might be as a result of background concentration of Iron in Ijero Ekiti (Olusoji et al., 2011).

It has been confirmed that natural soils contains significant concentration of iron (Ademoroti, 1996; Aluko et al, 2003; Dara 1993; Eddy, 2004a). Eddy et al., (2004) suggested that the pollution of the environment by iron cannot be conclusively link to waste materials alone but other natural sources of iron must be taken into consideration.

The mean concentration of Pb in the soil Pb in soil samples at Ado Ekiti was 48.60mg/kg and Ijero Ekiti 36.72mg/kg. The values are within the allowable limits of Pb in several countries (table 3)

The concentration of lead in Ado-Ekiti was higher; this is higher than the natural level for soil which implies that the decomposing of wastes at the dumpsite might have introduced lead into soils. Aluko et al., (2003) reported the mean concentration of lead in soil at Ibadan dumpsite is high. The pollution of soil by lead is very serious problems that have been given much attention by environment chemist. This is dude to the fact that lead is cumulative pollutant (Dara, 1993) and the continuous disposal of lead contain waste into the environment should be discouraged.

The mean Cadmium value at the Ado-Ekiti is 1.72mg/kg and Ijero Ekiti is 1.88mg/kg were below detection level at all soil layers of the profile. The study by Awokunmi et al., (2010) reported higher cadmium level of 219 – 330mg/kg at the surface layer of dumpsite and more at 200m away

Correlation analysis is a preliminary descriptive technique to estimate the degree of association among the variables involved. The estimate the degree of association among the variables involved. The purpose of the correlation analysis is to measure the intensity of association between two variables such association is likely to lead to reasoning about causal relationship between the variables. According to Table 2 for Ado Ekiti dumpsite, PH and Pb were well correlated with Cr ($r = 0.138$, 0.138 at $P < 0.05$) significant correlation were also observed between organic matter and Cd ($r = 0.502$, $P < 0.05$) silt + clay were correlated with pH ($r = 0.580$, $P < 0.05$)

Organic matter and silt clay were negatively correlated with heavy metals (table 2). The negative correlation coefficient indicated that the inverse relationship exists between the variables. Pb, Cd and Zn are from anthropogenic sources because of their negatively correlated with measures of organic matter, which clearly showed that the metals are not degraded since metals are not biodegradable (Ogundiran and Afolabi, 2008). The landfill site, however, was a potential source of Pb, Cd and Zn and a source of pollution to the environment if the present trend of indiscriminate disposal of waste on the site is not controlled.

Xiaolis et al., (2007) observed that most organic chemical substances are either degraded through biochemical reactions in the landfill, or leached out form the landfill with water movement.

According to table 7 for Ijero Ekiti dumpsite, a positive correlation was observed between organic matter and chromium ($r = 0.479$, $P < 0.05$) Fe and Cr ($r = 0.443$, $P < 0.05$) in the dumpsite

Correlation coefficients for the metals silt plus clay and organic matter were low. This result was in excepted, since heavy metals has a high affinity for organic and silt and clay fraction (Mihaly – co_Zmuta et al, 2005, Zonta et al., 1994). This low correlation can be indicative of distinctive sources for these metals in these areas.

The present study show the types of bacteria and their frequency of isolation from the waste dumpsite in Ado-Ekiti and Ijero Ekiti. The bacterial isolated from the dumpsite include Bacillus Megaterium, Chromatuim Violascens, bacillus subtilis, Klebsiella rhinoscle romalis, Kurthia Zopfii, Clostridum pirogenes, Bacillus Licheniformis, Xanthomonas fragarine, Bacillus cereus and Gemella haemolysans. Only Bacillus Megaterium, Kurthia Zopfii and Xanthomonas fraganie were isolated from the Ijero Ekiti dumpsite while, chromatium Violascens, bacillus subtilis, Klebsiella rhinoscleromalis, Clostridium Spirogenes, bacillus Lichenifromis and bacillus cereus were isolated from Ado Ekiti dumpsite.

All the bacterial isolates reported in this study have been reported to be associated with waste and waste biodegradation. Bacillus species were reported by gray (1967); to be associated with waste Klebsiella species were also reported to be soil bacterial and they are potential pathogen. The presence of these potential pathogens reported in the present investigation may be attributed to the disposal of raw human faecal discharges and other human wastes at the waste – dumpsite. These observations compares favourably with the study conducted by Hammond and Beliles (1986) and in a separate study by McGraw Hill Encyclopedia (1977).

IV. Conclusion

In this study, correlation analyses were used for determining the environmental quality of Ado Ekiti and Ijero Ekiti in terms of heavy metal accumulation, some soil properties and bacterial present. Correlation analysis shows a strong relationship between organic matter content on cadmium metal accumulation. This study generally concludes that the statistical methods can be a strong tool for monitoring of current environmental quality of Ado Ekiti and Ijero Ekiti in terms of heavy metal accumulation and type of bacterial present. The statistical analysis showed that clay + silt and organic matter were negatively correlated with the heavy metals which clearly show that the metals are not biodegradable

The results also revealed that though Ijero Ekiti being a rural settle have high heavy metal in the dumpsite soil as a result of background heavy metal in the soil compare to Ado-Ekiti an urban settlement.

The presence of these potential pathogens reported in the present investigation may be attributed to the disposal of raw human faecal discharges and other human wastes at the waste – dumpsite.

The health hazard associated with the indiscriminate dumping of waste round residential areas and other ecologically sensitive areas such as rivers and streams and arable land cannot therefore be under – estimated.

Nigeria should therefore direct here efforts toward the treatment of waste before disposal as to minimize the health hazards associated with dumping of waste.

Table I:- Basic statistical parameters for the distribution of selected metals (mg/kg) in dumpsite soil samples from Ado-Ekiti

	Min	**Max**	**Mean**	**Median**	**SD**	**SE**	**Skewness**	**Kurtosis**
Cr	2.00	13.00	9.47	8.00	2.12	0.47	-0.63	0.41
Ni	1.00	11.00	7.53	6.00	2.74	0.78	0.34	1.04
Fe	8.20	24.70	13.66	12.35	2.19	0.85	0.82	1.23
Mn	1.20	60.80	16.18	6.15	21.90	4.82	1.71	2.70
Zn	2.40	72.00	12.89	9.60	15.40	3.60	3.02	12.68
Cu	2.36	86.40	11.64	6.20	20.82	5.64	3.48	14.88
Pb	7.28	72.50	48.60	60.15	30.20	8.76	0.43	-1.24
Cd	1.42	3.62	1.72	1.46	0.64	0.14	2.02	4.03

Table II:Pearson correlation coefficient matrix for heavy metals in Ado Ekiti Dumpsite soil

		Cr	**Ni**	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**	**pH**	**Organic matter**	**Silt + clay**
1.	Cr	1.000									
2	Ni	0.214	1.000								
3	Mn	0.033	-0.214	1.000							
4	Zn	-0.239	-0.277	0.476	1.000						
5	Cu	0.288	0.182	-0.211	-0.080	1.000					
6	Pb	0.138	-0.120	-0.034	0.280	0.189	1.000				
7	Cd	0.106	0.265	-0.234	-0.159	-0.104	0.228	1.000			
8	pH	0.138	-0.269	-0.351	-0.276	0.346	0.270	-0.360	1.000		
9	Organic matter	0.357	0.136	0.222	-0.010	-0.126	-0013	0.502	-0.228	1.000	
10	Silt + clay	0.320	-0.448	0.201	-0.059	-0.094	0.330	-0.332	0.580	0.049	1.000

Table III: Allowable limits of Heavy metal concentrations in soil (mg/kg)

Heavy metal	Austria	Germany	France	Denmark	Netherlands	Sweden	Spain (pH <>)
Cd	1 – 2	1	2	0.5	0.5	0.4	1
Cr	100	60	150	30	30	60	100
Co	50	-	-	-	-	-	-
Ni	50 – 70	50	50	15	15	30	30
Pb	100	70	100	40	40	40	50

Source: ECDGE (2004)

Table IV: Basic statistical parameters for the distribution of selected metals (mg/kg) in dumpsite soil samples from Ijero Ekiti

	Min	Max	Mean	Median	SD	SE	Skewness	Kurtosis
Cr	1.10	10.20	8.40	6.55	1.53	0.35	-0.46	0.48
Ni	1.00	16.80	7.54	8.00	4.20	1.06	0.32	1.20
Fe	9.20	26.40	15.22	12.35	4.09	1.02	1.02	1.93
Mn	1.12	50.00	11.14	14.12	34.64	3.42	1.88	3.68
Zn	3.40	70.00	13.80	9.40	15.40	3.70	3.42	13.00
Cu	3.30	94.00	11.62	6.18	22.81	5.68	3.94	15.74
Pb	7.40	88.82	36.72	78.12	35.19	8.80	-0.74	-1.41
Cd	1.66	3.74	1.88	1.61	0.68	0.17	2.42	4.52

Table V: Pearson correlation coefficient matrix for heavy metals in Ijero Ekiti dumpsite soil

		Cr	Ni	Fe	Mn	Zn	Cu	Pb	Cd	pH	Organic matter	Silt + clay
1.	Cr	1.000										
2	Ni	0.324	1.000									
3	Fe	0.443	-0.334	1.000								
4	Mn	-0.119	-0.304	0.169	1.000							
5	Zn	0.398	-0.347	0.492	0.467	1.000						
6	Cu	0.316	0.284	0.268	0.216	-0.088	1.000					
7	Pb	0.236	-0.110	-0.132	-0.031	0.284	0.069	1.000				
8	Cd	0.204	0.330	-0.246	-0.236	-0.165	-0.044	-0.260	1.000			
9	pH	0.256	-0.369	0.364	-0.349	-0.276	0.324	0.452	0.228	1.000		
10	Organic matter	0.479	0.264	0.324	-0.212	-0014	-0.116	-0.322	-0.019	-0.324	1.000	
11	Silt + clay	0.442	-0.462	0.302	-0.201	-0.058	-0.064	0.249	0.430	0.418	0.038	1.000

Table:VI Characteristics of bacterial isolate from Dumpsite soil

colour	White	Orange	White	Cream	Grey	Cream	White	Yellow	White	Cream
Surface	Rough	Rough	Rough	Smooth	Rough	Rough	Rhizoid	Smooth	Rough	Smooth
Edge	Rhizoid	Circular	Rhizoid	Entire	Lobate	Lobate	Lobate	Entire	Rhizoid	Entire
Elevation	Flat	Raised	Flat	Flat	Flat	Flat	Flat	Raised	Flat	raised
Shape	Rod	Ovoid	Rod	Rod	Rod	Rod	Rod	Rod	Rod	Rod
Gram stain	+	-	+	-	+	+	+	-	+	-
Catalase	+	+	+	-	+	+	+	+	+	-
Starch hydrolysis	+	+	+	-	-	+	+	-	+	-
Motility	+	+	+	-	+	+	+	-	+	-
Spare	+	-	+	-	-	+	+	-	+	-
Indole	-	-	-	-	-	-	-	-	-	-
Methyl red	+	-	-		+	-	-	-	-	-
Vogesproskauer	-	-	-	-	-	-	-	-	+	-
Glucose	-	A	A	-	A	AG	A	A	A	-
Lactose	A	A	-	-	-	-	A	-	-	A
Mannitol	-	A	A	-	-	A	A	AG	-	A
Galactose	-	A	A	-	-	-	-	AY	A	A
Fructose	A	-	A	A	-	-	-	-	AY	AG
Maltose	A	-	A	-	A	A	AG	A	A	-
Sucrose	AG	A	-	A	-	-	-	-	-	-
Surbitol	A	-	-	A	-	-	AG	-	-	-

Key: A = Acid production AG = Acid and Gas production + = positive - = negative

	Bacillus megatarium	Chromatium violasceus	Bacillus subtilis	Klebsiella rhinosderomalis	Kurthia zopfii	Clostridium spirogenes	Bacillus licheniformis	Xanthomanas fragenee	Bacillus cerenus	Gemella haemolysans
Ado Ekiti	+	+	+	+	-	+	+	+	+	+
Ado Ekiti	+	-	+	-	+	-	+	+	-	+
Ado Ekiti	-	-	-	-	+	-	-	+	-	-
Ijero Ekiti	-	-	-	-	+	-	-	+	+	+
Ijero Ekiti	-	+	+	+	-	+	-	-	-	+
Ijero Ekiti	-	+	-	-	+	+	-	+	-	+

Key:
+ = Present
- = Absent

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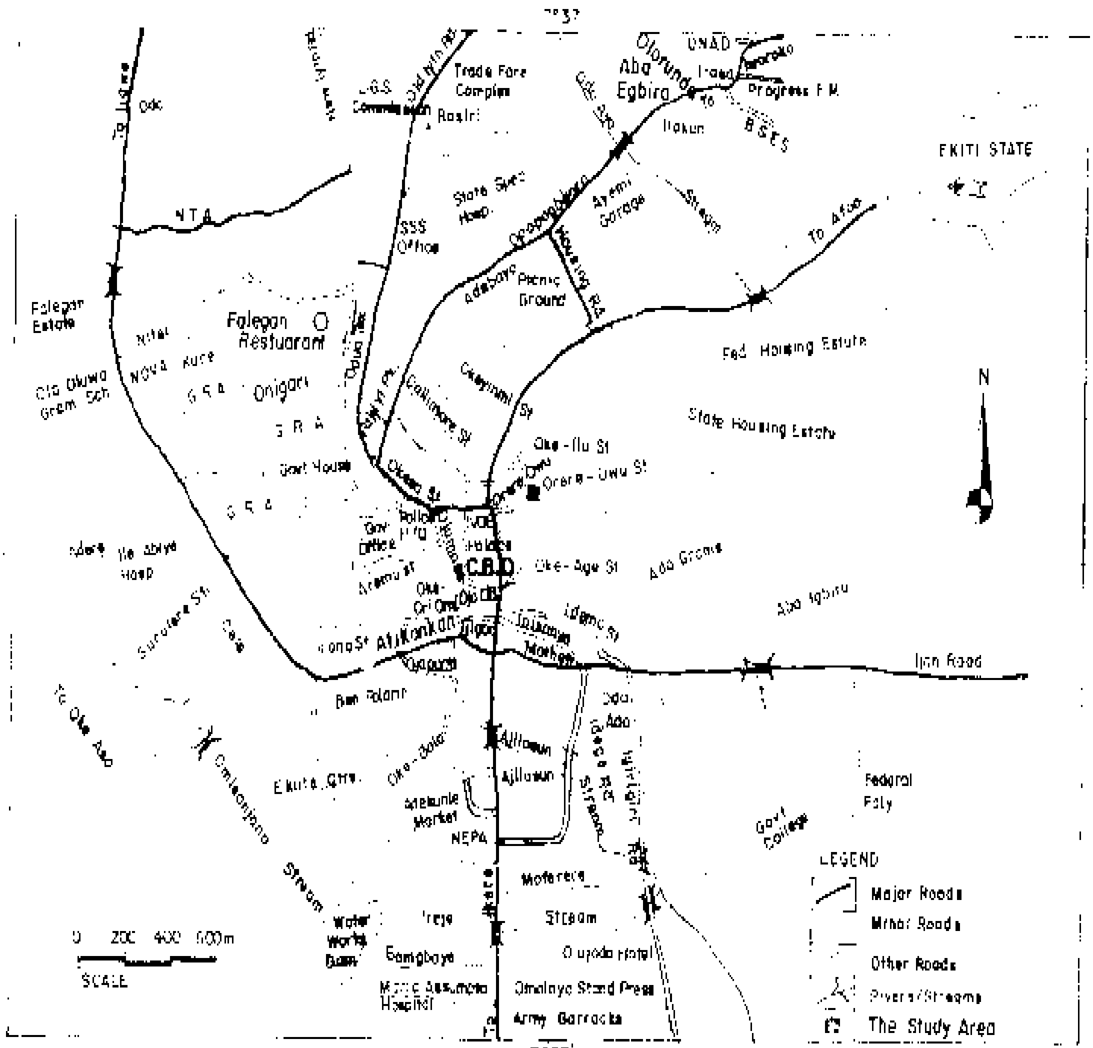
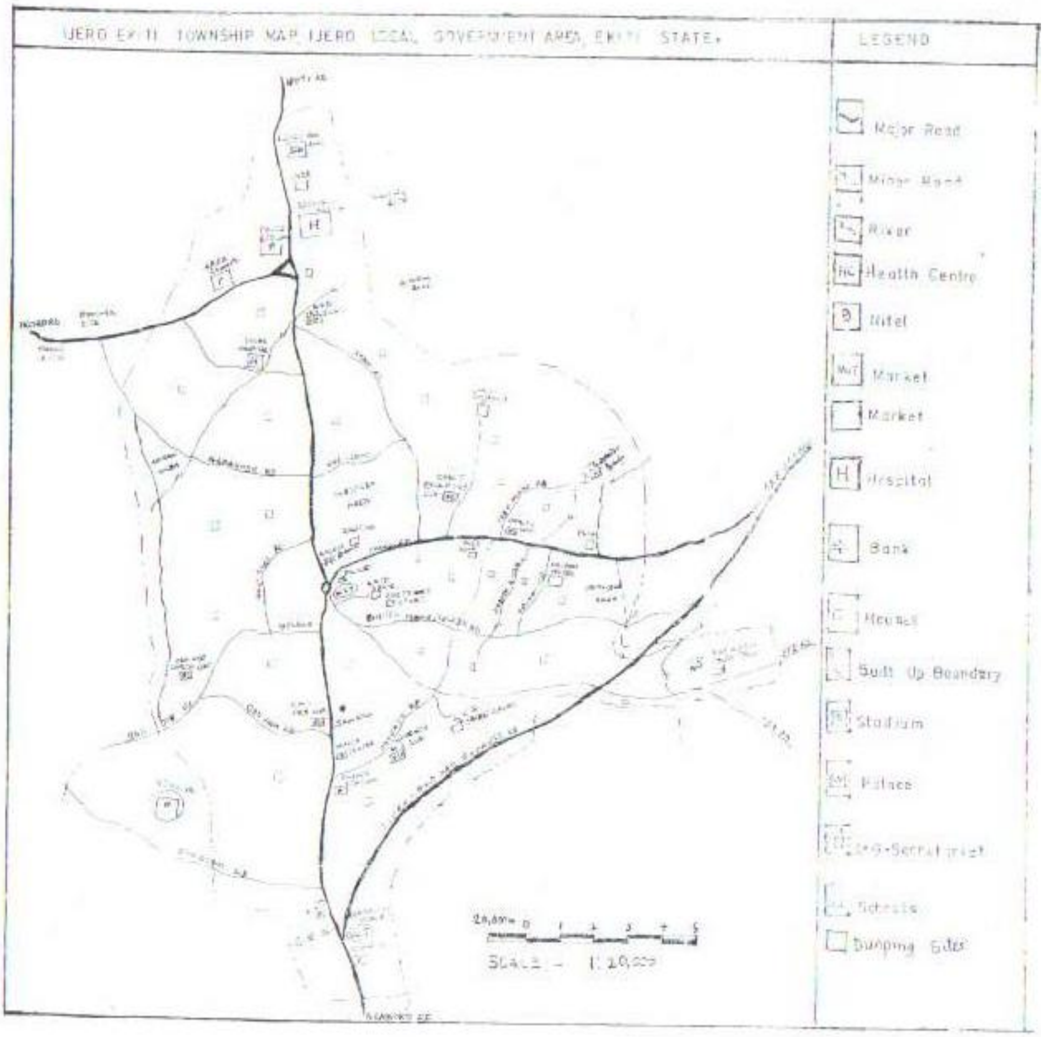


Fig 1 : Sketch map of Ado-Ekiti showing the sampling locations.


IJERO EKITI TOWNSHIP MAP IJERO LOCAL GOVERNMENT AREA, EKITI STATE.
LEGEND
Major Road
River
Health Centre
Hospital
Bank
Stadium
Palace
Dumping Sites
SCALE :- 1:20,000