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Elemental compositions of the soil of Ogun-Osun river basins development authority headquaters, Ogun-state, Nigeria

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Abstract

Measurements of the elemental composition of soil samples were carried out using Atomic Absorption Spectrophotometer. The samples were collected from Ogun-Oshun River Basin Development Authority (O-ORBDA) Headquarters, Abeokuta, Nigeria. Samples were collected at a depth of about 10 cm and a total of 24 soil samples were taken from the labelled points, as shown in the map of the project site. The Global Positioning Satellite (GPS) was used to obtain the geographical position of each sample point. Four heavy metals (Th, U, Pb, & Cr), five major elements (K, Ca, N, P & Mg) and five trace elements (Zn, Mn, Cu, Al & Fe) were detected. Phosphorus had the highest average value of (78.71 ppm) while Nitrogen had the least (0.17 ppm). The significance of these results is discussed in the paper.

Keywords: Elemental analysis; trace elements; heavy metals; atomic absorption spectrophotometer.

Introduction

Soil is undoubtedly one to the most important components of the environment, yet it is perhaps one of the most undervalued, misused and abused of the earth's resources (Ellis & Mellor, 1995). Lying at the interface of the geosphere, biosphere and atmosphere, soil, represents the end product of a complex set of interacting processes operating over a vast range of time scales. To a very large extent, soils determine the agricultural potential of an area and they influence many geo morphological and hydrological processes. They also feature strongly in many aspects of rural and urban planning, including mineral extraction, construction, waste disposal and conservation (Ellis & Mellor, 1995). In terms of constituents, soil can be viewed as a three-phase system comprising solid, liquid and gaseous constituents (Bonneau & Souchier, 1982).

An understanding of soils within an environment context is important to many disciplines, and this is increasingly the case as environmental problems, such as pollution, acidification, erosion and climatic change, become a matter of increasingly public concern (White, 1979). The extent of soil pollution by heavy metals and base metal ions is alarming. It has been observed that the larger the urban area, the lower the quality of the environment (Eddy *et al.,* 2006).

In terms of soil contamination, especially by metals, Ademoroti (1993) found linear correlation between cadmium (Cd), lead (Pb), and nickel (Ni) in soils and vegetables grown on them. Similarly, Akaeze (2001) observed elevated levels of lead (Pb), copper (Cu) and Iron (Fe) in soils from Uyo another town in Nigeria. He opined that intake of these metals could arise via intake of the plants grown on them or/and intake of water associated with the soils.

On the toxicity of heavy metals, the World Health Organization (WHO) has identified abortion, infant mortality, malformation of foetus, genetic mutilation, retarded growth, intoxication, depression of respiration and chromosomal aberrations as possible health effects of lead in humans (Eddy *et al.,* 2006). It is therefore important to control intake of these toxic elements, starting with the measurements of their concentrations in the relevant media, including soil.

Project site

The samples were collected from the permanent site of the Ogun-Oshun River Basin Development Authority (O-ORBDA) headquarters. O-ORBDA is a parastatal of federal ministry of water resources and rural development charged with the responsibility for the development and management of the water resources in its area of coverage. The site is located in Abeokuta, Ogun state, Nigeria. Abeokuta is in the western part of Nigeria that lies approximately on latitude $7^0 3^1$N and longitude $3^0 54^1$E. The average annual minimum temperature of Abeokuta lies around 22^0C and maximum of about 30^0C. The site is about 2.4 square kilometer (236.4 ha) land area. The template of the map of the project site is shown in (Fig. 1). The soil of this site are found to be the complex basement rock of coastal area. Most of the soils are sand-loamy compacted with clays. The soils of this area are ferralitic, i.e. they are formed from complete basement rocks.

Methodology

Soil sample collection and sample preparation

Soil samples were collected at the labelled points, as shown in the map of the project site (Fig.1). The geographical location of each sample point was taken by means of a GPS. Each soil sample was packed separately in a nylon bag sealed and labeled to avoid the mixing up of samples or contaminations. The samples were dried, grounded and sieved.

Elemental analysis procedure

The elemental analysis was carried out using the Atomic Absorption Spectrophotometer (AAS). The wavelength of the elements of interest range from 213.8

nm to 766.5 nm. Two g of each sample was digested by adding a tablet of selenium and 10 ml each of concentrated nitric and perchloric acids in a digestion tube and centrifuged at 3000 rpm for 30 min. The supernatant was measured for its absorbance and compared with a standardized AAS.

Results and discussion

The result of the analysis of each soil sample is presented in Table 1. Fig. 2 shows the mean distributions of each element. Phosphorus had the highest value of concentration in parts per million out of the fourteen elements detected in the soil sample. This is due to larger percentage of clay mineral components in the soil of the area. Phosphorus is usually held by soil clay minerals. Also, phosphate enters into the biosphere by being absorbed by plants and microorganisms, upon decomposition of plants and their animal consumers, soluble phosphate returns to soil. Though, the release of phosphate from insoluble form in rocks and soils is slow, the sum total of phosphate carried by the rivers into the ocean each year is enormous, therefore the Earth Dam in the project site and the three rivers flowing through it can also be responsible for the high composition of phosphorus in the site. Soil pollution by phosphorus is not a significant environmental issue except when the phosphorus is leached into the surrounding water. Phosphorus, nitrogen and potassium are the major elements needed for healthy plant growth (Effiong & Ibiam, 2003)

Among the trace elements, iron has the highest levels, and it is fairly distributed in the site. In its natural form, it occurs in large amount in relatively few minerals of which biotie; some pryoxene; and olivines are the principal contributors and it is mainly in the ferrous state. It has been confirmed that natural soils contain significant concentration of iron (Ademoroti, 1996; Aluko *et al.,* 2003; Dara, 1993; Eddy, 2004). The highest amount of iron is found in the locations 11,17 and 21 with the mean value of 37.55 ppm. This may be due to the drainage of the location, which favours the availability of iron because flooding normally makes iron more available. The next in concentration is copper with the mean value of 29 ppm at location 3. The least value of Copper was found at location 18 with value 19 ppm. This is due to the large organic matter content of the soil at this location since copper deficiency are most likely to occur in organic soil.

Zinc is the least of the trace elements with average value of 1.74; this is good for the site because zinc can be toxic to plants if present in more than very small quantity. Manganese is another trace element detected with average value of 9.61 ppm and highest value was recorded at location 21 with value of 14.70 ppm and least value at location 1 with the value of 5.60 ppm. Manganese may be found in most soils, since it is one of the elements in the earth crust (Dara, 1993).

Heavy metal such as thorium, uranium and lead were also detected in this work, with thorium having the highest average value of 37.25 ppm and the highest value at location 3 with the value of 43.50 ppm. This is because this location is mainly of sandy soil and monazite which is

Table 1. Elemental concentration (ppm) of the samples

Sample	K	Ca	P	N	Mg	Zn	Mn	Cu	Cr	Fe	Al	Th	U	Pb
1	1.1718	7.500	54.760	0.130	34.00	0.60	5.600	21.90	29.90	23.50	5.50	39.30	15.5	39.45
2	1.1052	5.750	57.470	0.120	28.50	1.90	10.700	25.50	30.10	30.00	6.35	40.05	12.0	49.60
3	1.1139	6.100	70.120	0.240	29.65	5.60	8.500	29.00	33.15	23.50	5.50	43.50	7.15	29.20
4	0.7290	3.830	65.590	0.310	18.85	5.60	8.600	19.50	21.45	30.50	6.55	31.80	6.25	8.550
5	1.0296	5.683	76.320	0.320	28.00	5.65	8.400	20.50	31.15	28.65	6.20	41.80	7.00	26.35
6	1.1844	5.930	114.96	0.180	29.15	0.80	8.750	23.50	30.90	28.15	5.20	41.45	6.00	30.95
7	1.1718	7.500	54.760	0.130	34.00	0.60	5.600	21.90	29.90	23.50	5.50	39.30	15.5	39.45
8	1.1718	7.500	54.760	0.130	34.00	0.60	5.600	21.90	29.90	23.50	5.50	39.30	15.5	39.45
9	1.1052	5.750	54.470	0.120	28.50	1.90	10.700	25.50	30.10	30.00	6.35	40.05	12.0	49.60
10	1.1139	6.100	70.120	0.240	29.65	5.60	8.500	29.00	33.15	23.50	5.50	43.50	7.15	29.20
11	0.7524	4.280	65.250	0.130	20.50	0.70	15.700	19.90	19.65	37.50	6.60	29.35	7.50	26.20
12	1.1844	5.930	114.96	0.180	29.15	0.80	8.750	23.50	30.90	28.15	5.20	41.45	6.00	30.95
13	0.7128	3.850	113.05	0.170	19.00	0.85	8.400	28.50	22.35	25.50	6.20	33.20	5.50	33.80
14	0.7128	3.850	113.05	0.170	19.00	0.85	8.400	28.50	22.35	25.50	6.20	33.20	5.50	33.80
15	1.1052	5.750	54.470	0.120	28.50	1.90	10.700	25.50	30.10	30.00	6.35	40.05	12.0	49.60
16	0.7128	3.850	113.05	0.170	19.00	0.85	8.400	28.50	22.35	25.50	6.20	33.20	5.50	33.80
17	0.7524	4.280	65.250	0.130	20.50	0.70	15.700	19.90	19.65	37.55	6.60	29.35	7.50	26.20
18	0.7524	4.280	65.250	0.130	20.50	0.70	15.700	19.90	19.65	37.55	6.60	29.35	7.50	26.20
19	0.7128	3.850	113.05	0.170	19.00	0.85	8.400	28.50	22.35	25.50	6.20	33.20	5.50	33.80
20	1.1844	5.930	114.96	0.180	29.15	0.80	8.750	23.50	30.90	28.15	5.20	41.45	6.00	30.95
21	0.7524	4.280	65.470	0.130	20.50	0.70	15.700	19.90	19.65	37.55	6.60	29.35	7.50	26.20
22	1.1052	5.750	54.470	0.120	28.50	1.90	10.700	25.50	30.10	30.00	6.35	40.05	12.0	49.60
23	1.1718	7.500	54.760	0.130	34.00	0.60	5.600	21.90	29.90	23.50	5.50	39.30	15.5	39.45
24	1.1844	5.930	114.96	0.180	29.15	0.80	8.750	23.50	30.90	28.15	5.20	41.45	6.00	30.95
Mean	0.99 ± 0.21	5.46 ± 1.27	78.97 ± 25.98	0.17 ± 0.06	26.28 ± 5.59	1.74 ± 1.82	9.61 ± 3.17	23.97 ± 3.35	27.10 ± 4.93	28.54 ± 4.78	5.96 ± 0.53	37.25 ± 4.95	8.90 ± 3.71	33.89 ± 9.61

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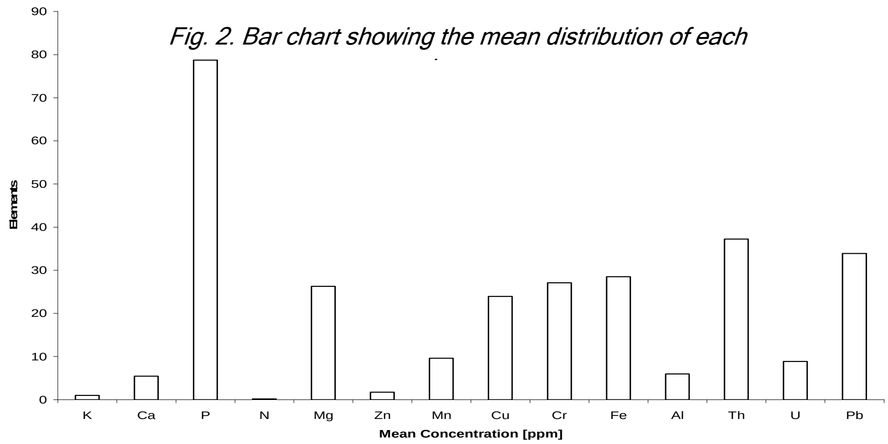


Fig. 2. Bar chart showing the mean distribution of each

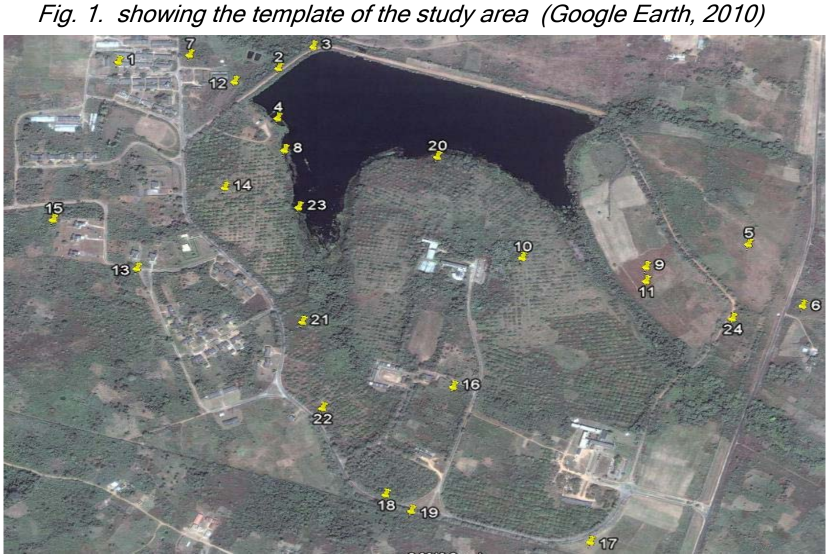
thorium bearing mineral. Lead (Pb) had highest percentage in the group of heavy metals with average value of 33.88 ppm and the highest value was obtained at location 9 with value of 39.45 ppm and least value at location 4 with 0.85 ppm. The highest lead content could be traced to the workshop; technical department and filing station very close to this location. Since the major source of lead pollution is industrial source (Dara, 1993). The pollution of soil by lead is a very serious problem that has been given much attention by environmental chemist. This is due to the fact that lead is a cumulative pollutant (Dara, 1993) and the continuous disposal of lead containing waste into the environment should be discouraged.

Conclusion

The elemental composition of soil samples from the Ogun Oshun river basin Development Authority Headquarters were analyzed using Atomic Absorption Spectrometer (AAS). Three main classes of elements were detected, i.e. heavy metals, trace elements and major elements. The three classes are almost evenly distributed with heavy metal having 37.11% minor elements, 24.18% and major elements 38.7%. The major elements include Potassium Calcium, Phosphorus, Nitrogen and Magnesium. The ones grouped as trace elements are Zinc, Manganese, Copper, Iron and Aluminium while Uranium, Thorium, Chromium and Lead are the heavy metals.

For all practical purposes, the value obtained in this study of elemental composition of the soil in Ogun Oshun River Basin Development Authority Headquarters can be taken as a value to determine the organic matter content of each location in the site and to allocate each part of the site for purposes which it is best for. These values could also be used as an essential yardstick for evaluating the extent of any pollution in the soil of the site or to compare in the nearest future any change in elemental composition of the soil. This value can be maintained by proper maintenance of the soil, practising cultural farm practices which involves the less or no use of chemicals and machineries, construction of proper drainage channel and by keeping the environment free of either radioactive or heavy metal pollution.

Fig. 1. showing the template of the study area (Google Earth, 2010)



References

1. Ademoroti CMA (1996) Standard methods of chemical analysis, March Print and consultancy, Benin, Nigeria.
2. Bonneau M and Souchier B (1982) Constituents and properties of soils. Academic press Inc. (London) Ltd. Vol 2 of pedology.
3. Akaeze CS (2001) Solid waste analysis, characterization and management along Abak/Ikot Ekpene roads of Uyo metropolis. A research project Dept. of Chemistry/ Biochemistry, University of Uyo. Nigeria.
4. Aluko OO, Sridha MKC and Oluwande PA (2003) Characterization of leachates from a municipal solid waste landfill site in Ibadan. *Nigeria. J. Environ. Health.* 2 (1), 32-37.
5. Dara SS (1993) A textbook of environmental chemistry and pollution control. S. Chand & Company Ltd. Ram Nagar, New Delhi 110055.
6. Eddy NO, Odoemelem SA and Mbaba A (2006) Elemental composition of soil in some dumpsites. *Electron. J. Environ. Agric. Food Chem.* 5(3),1349-1365.
7. Eddy NO (2004) Physicochemical parameter of water and heavy metal content of water, sediment and fishes from Qua Iboe River Estuary. M.Sc Thesis. Michael Okpara University of Agriculture, Umudike Nigeria.
8. Effiong GS and Ibia TO (2003) Mineral Fertilizers: manufacture and chemistry in the soil environment. Teaching monograph, University of Uyo. Nigeria.
9. Ellis S and Mellor A (1995) Soils and environment first edition, Routledge publisher, 2, park square, Milton Abington, Oxon.
10. White RE (1979) Introduction to the principle and practice of soil science. Blackwell Scientific Publication. Oxford.