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Full Length Research Paper

Some physico-chemical characteristics and heavy metal profiles of Nigerian rivers, streams and waterways

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Water samples of 72 rivers, streams and waterways in Southern Nigeria were carefully collected and the following physico-chemical analyses subjected on the samples. Temperature, colour, taste, turbidity, pH, total dissolved solids (TDS), conductivity and heavy metal profiles (Pb, Cr, Cd, Fe, Zn, Mn, Cu) were assessed among the entire samples collected. The turbidity (NTU) of 93% of all the samples was higher than World Health Organisation (WHO) and European Economic Community (EEC) standards. 57% of the entire samples had conductivities above normal limits. The pH of 81% of the entire samples also were above WHO and EEC guide limits. Profiles of the heavy metals showed Pb, Cd, Cr, Zn and Mn levels in some of the samples being above the guidelines of WHO and EEC. Fe had 55% of all the samples exceeding recommended standard of 0.20 ppm; Cr had 15% exceeding the recommended 0.05 ppm, Cd had 11% exceeding 0.003 ppm while 7% of both Zn and Pb exceeded 3 ppm and 0.10ppm respectively. These results indicate that heavy metal pollution and toxicity might pose serious risks to the health of communities residing around and using these surface waters for domestic, commercial and socio-cultural purposes.

Key words: Water, physico-chemical characteristics, heavy metals, pollution, toxicity, health.

INTRODUCTION

As the world is ushered into the modern era of civilization, water and its management will continue to be a major issue, which will definitely have profound impact on our lives and that of our planet Earth than ever before (Herschy, 1999). Indeed water is life. According to Gore (1993), "Human beings are made up of water, in roughly the same percentage as water is in the surface of the Earth. Our tissues and membranes, brains, and hearts, our sweat and tears - all reflect the same recipe for life, in which efficient use is made of those ingredients available on the surface of the earth". Unequivocally, water is essential for the development and maintenance of the dynamics of every ramification of society (UNSCD, 2000).

Water is indeed life and thus the most important natural resource without which life would be nonexistent. Availability of safe and reliable source of water is an essential prerequisite for sustained development. Deserts are not habitable because of lack of water. The significance of water dates back to ancient civilizations such as the Egyptian, Minoan, Roman, Greek, etc, civilizations. The modern world is aware of the relationship between water and water-borne diseases as a vital public health issue. The pandoras box was opened in London in 1854 during the incidence of Broad street pump cholera outbreak that killed 10,000 people. This gave Dr. John Snow the impetus to demonstrate the linkage between pollution of drinking water and disease (Tebbutt, 1992).

Continuous urban development and large solid waste pose as major environmental risks because of the difficulties in disposal. Landfills and other solid wastes disposal sites are major targets of pollution because rainfall and groundwater leach these highly contaminated substances into rivers, streams and waterways (Surface waters) which are inadvertently used by people residing in such

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areas.

Water borne diseases kill 50,000 people daily (Herschy, 1999) and yearly, about 4 million children under the age of five die in developing countries due to water related problems (USAID, 1990; Warner, 1998). Throughout the world, about 2.3 billion people suffer from diseases that are linked to water related problems (U.N, 1997; WHO, 1997) which, continue to kill millions of people yearly, debilitate billions, thereby undermining developmental efforts (Nash, 1993; Olshansky et al., 1997).

The industrial revolution of the early 19th Century gave great impetus to the factors that brought dramatic changes in the Earths waters. Ever since then, the human impact on Earths waters has increasingly been detrimental to human survival. Though water pollution is an old phenomenon, the rate of industrialization and consequently, urbanization has exacerbated its effect on the environment. This is because, the process of urbanization has considerable hydrological impact both in terms of controlling rate of erosion, delivery of pollutants to rivers, and in terms of influencing the nature of runoff and other hydrological characteristics (Goudie, 1990).

Water pollution is of grave consequence because both terrestrial and aquatic life may be poisoned; it may cause disease due to the presence of some hazardous substances, may distort the water quality, add odours and significantly, hinder economic activities. The causes and forms of water pollution according to Strandberg (1971) include sewage and other oxygen demanding wastes, infectious agents, organic chemicals, other chemicals and mineral substances, sediments (turbidity), radioac-tive substances and thermal pollution. Additionally, several human activities that may result to water pollution include the following, agriculture, irrigation, urbanization, mining, fire, and industrialization (Goudie, 1990). These activities have been documented to have impacted negatively in some specified Nigerian surface waters especially in the Niger Delta region (Izonfuo and Bariweni, 2001). Also, these activities have affected the soils of industrial areas in Southern Nigeria (Olajire et al., 2003).

Of particular interest to us are the heavy metals because among the very toxic elements are heavy metals. The modern era of industrialization has increased the spread of environmental contamination by heavy metals. Heavy metal toxicity dates back to the ancient period, especially the famous story of the decline of the Roman Empire being caused by lead toxicity which resulted in mental retardation of the rulers.

The heavy metals of interest to us include the following Lead (Pb), Chromium (Cr), Cadmium (Cd), Iron (Fe), Zinc (Zn), Manganese (Mn) and Copper (Cu). According to Freedman (1989) "the chemical form of toxic elements dissolved in water is generally relatively available to biota, even seemingly small aqueous concentration may exert a powerful toxic effect. Though these trace elements are usually present in the environment, they are potentially extremely toxic and not only would they affect the biota at a water soluble concentration at less than 1 part per million (ppm), humans can be grossly affected". Several studies on Nigerian surface waters have been conducted (Imevbore, 1967; Adebisi, 1981; Onyeike et al., 2002, Ibe and Sawa, 2002). The hydrological charac-teristics investigated by these authors include plankton, physicochemical properties such as transparency, pH, conductivity, inorganic ions, heavy metals, crude oil, and so on. However, majority of these studies were targeted at just a few of these surface waters (one river or stream). It is therefore pertinent that somehow, the entire freshwater bodies that abound in Nigeria should be investigated.

The aims of this study therefore, were to compare the heavy metal content of 72 Nigerian rivers, streams and waterways in Southern Nigeria and also to assess some physico-chemical characteristics of these rivers, streams and waterways.

MATERIALS AND METHODS

Materials

These include Bulk Scientific Atomic Absorption Spectrophotometer (AAS) computerized model 210VGP with Epson printer LX 300+ and replaceable lamp holder. This was used to measure the heavy metals. The turbidity was measured with Hach Spectrophotometer, model DR2010 and the Total Dissolved Solids (TDS) was measured with the Hach TDS meter, model C020. Conductivity was measured with the Suntex Conductivity meter and the pH was with H. Tester 1TM, model Cole-Plamer® and temperature was measured with a mercury thermometer.

Methods

Running water (2.0 l) from 72 rivers, streams and waterways in the Western, Midwestern and South eastern region of Nigeria (in March / April 2006) were carefully collected with plastic containers that had earlier been evacuated and fully sterilized. These were then assessed immediately for physical characteristics such as temperature, turbidity, total dissolved solids, conductivity, pH, colour, smell and taste. These data were recorded in special log books. Temperature of the surface waters were measured using a mercury thermometer (Aldrich). Turbidity was assessed by first adjusting the wavelength at 750 nm (for turbidity). Then a 25 ml curvette was filled with the water sample to the 25 ml mark. Subsequently, this was placed inside the Hach spectrophotometer and the turbidity reading was taken immediately. For the total dissolved solids (TDS) the Hach TDS meter was put on, the reading zeroed and then the electrode dipped into the water sample and reading taken appropriately. Conductivity was assessed by putting on the Suntex Conductivity meter, adjusting the reading portion and dipping the electrode into the water sample and appropriate reading taken. The pH tester was standardized with buffers of pH 4 and 7 prior to usage. Subsequently, this was dipped into the water sample to take the pH reading of the sample.

To assess the levels of the heavy metals, a portion of all the water samples (50 ml) were initially subjected to fixing using concentrated nitric acid and concentrated hydrochloric acid in a ratio of 1:10 respectively which, was meant to digest particulate matter inside the sample by heating carefully in a water bath to obtain thick yellow solution, and later was cooled and made up to 100 ml with distilled water. After this fixing, the samples were directly analyzed using the Bulk Scientific AAS. For each heavy metal, specific concentration standard was run to prepare a calibration curve from which the concentration of the heavy metal was read directly from the AAS VDU system.

RESULTS AND DISCUSSION

Some immediately measurable chemical and physical characteristics of these surfaces waters were assessed. These are useful because they are easy to measure and results easily obtained. All results were indicated in Table 1. The temperature of majority of the rivers, streams and waterways etc fell within a range of between 19.5 and 21^{0}C hence our finding it unnecessary to include the temperature result in the table. Taste and odour though assessed, were not included because of the purely subjective attributes which made it difficult to measure and when measured, were prone to errors. Also, the colour of majority of the water samples was not good. Moreover, due to subjective properties, this was also difficult to measure. Therefore, this was not recorded specifically for each of the samples so as to avoid subjective errors in judgment.

Turbidity was measured in Naphenometric Turbidity Units (NTU) using the Hach spectrophotometer, model DR2010. It is quite revealing that approximately 93% of these waters were above the World Health Organisation (WHO) and European Economic Community (EEC) drinking water standard which is 5 NTU. The most turbid sample was stream I in Shagamu Local Government Area with 344 NTU. Total dissolved solids (TDS) were measured in mg/L and none of the samples was up to the maximum admissible concentration of total solids as stipulated by WHO and EEC. The guide limit (EEC, 1976) of water conductivity is 400µScm. From our data, out of the 72 samples, 41 exceeded this guide limit. That is, 57% of the rivers streams and waterways had conductivities above the guide limit. The intensity of acidity or alkalinity of a sample is measured on the pH scale which actually measures the concentration of hydrogen ions present (Tebbutt, 1992). Though normal biological activity is restricted to pH 6 - 8, for natural water, the EEC (1980) guide limit for waters requiring simple physical treatment and disinfection is 6.5 - 8.5. We used this limit because of our level of technological development on water treatment techniques. Therefore, among the water samples, 14 (19%) of them fell within the 6.5 - 8.5 range while 58 (81%) fell below towards acidity.

For the heavy metals, perusal of the results in Table 1 showed that Cu was not detected in any of the samples. This indeed was quite surprising and we do not understand the reason for this. For cadmium, apart from the first three rivers i.e. Rivers Orionwon, Ethiope and Ethiope extension in the Midwest, the other rivers that cadmium were from southeastern Nigeria. Out of the 72 rivers, 34 (47%) of them contained some levels of Pb. Also 15% of the rivers had some levels of Cr. Fe was almost ubiquitous while zinc was actually ubiquitous in which some rivers showed high levels of zinc. Mn was not that much in the rivers. Apart from zinc and iron, other heavy metals assessed did not show any regular pattern of manifestation.

However, we have reasons to be very concerned because WHO (1998) recommended 0.10 (ppm) for Pb and 0.003 (ppm) for Cd. All the samples in which Cd was detected (11%) were potentially toxic. Cadmium has a long biological life of 20 - 30 years in the kidney (WHO, 1992). Chronic exposure may eventually accumulate to toxic levels, one of whose consequence may be Itai-itai Byo disease, which is characterized by anemia, damaged proximal tubules, severe bone pain and mineral loss (Hodgson and Levi, 1987). Lead is the most ubiquitous toxicant in the environment (Goyer, 1993). Therefore, body levels depend on environmental exposure conditions. Lead may impair renal function, red blood cell production, the nervous system and causes blindness. Water, especially lead polluted water is a major source of lead toxicity. Children are very susceptible to lead poisoning resulting to clinically overt encephalopathy. 7% of the samples had excess Pb above WHO (1998) recommendation.

The WHO (1998) recommended limit for Cr is 0.05 ppm and most (15%) of the samples containing Cr far exceed this recommended limit. Though an essential trace nutrieent and a vital component for the glucose tolerance factor, chromium toxicity damages the liver, lungs and causes organ hemorrhages (WHO, 1988; Q'Flaherty, 1995). For Cu, the recommended level in food is 20 ppm (Pearson, 1976). For all the water samples, Cu was not detected. Though widely distributed and an essential element, acute toxicity of Cu results to hypotension, coma and death. Cu poisoning also causes hemolytic anemia (Manzer and Shreiner, 1970). Also, iron is an essential metal but due to frequent acute and chronic Fe over load which may result to renal failure and hepatic cirrhosis it is worthy to note its adverse effects which is usually common (Muller-Eberhard et al., 1977). There were very unacceptable levels of iron in majority (55%) of the samples which may constitute risks to health. Considering the WHO standard of 0.01 ppm, some of the samples were excessively overloaded. This indeed is a cause for great concern. Zinc is a ubiquitous essential trace mineral. All the samples contained Zn. Happily, zinc does not accumulate with continued exposure; rather, body content is modulated by homeostatic mechanisms that act mainly on absorption and liver levels (Walshe et al., 1994). From the results, the zinc level of 7% of the samples may be life threatening (WHO action level for zinc is 3 ppm). Manganese is an essential element and cofactor for several enzymatic reactions. WHO (1984) action level for Mn is 0.1 mg/L. Therefore, results from the samples showed no major threat from Mn poisoning except one sample (Ihuke stream). Toxicity from Mn manifests with profound increase in the incidence of respiratory diseases. In chronic cases, there may be a neuro-psychiatric disorder characterized by irritability, difficulty in walking, speech disturbance, compulsive behaviour that may involve running, fighting and singing. If there is chronic Mn toxicity, it results to Parkinsonlike syndrome (Mena et al., 1967). This

Table 1. Physico-chemical characteristics and heavy metals of rivers, streams and waterways in Southern Nigeria.

Name of River/Stream	L.G.A./ Community Located	State	TDS (mg/L)	Conductivity (µScm)	pH	Turbidity (NTU)	Pb (PPM)	Cr (PPM)	Cd (PPM)	Fe (PPM)	Zn (PPM)	Mn (PPM)	Cu (PPM)
Orionwon River	Itshekiri community, Ologbo	Delta	8	130	6.4	10	0.10	0.10	0.10	ND	0.16	0.10	ND
Igbagho River (Ethiope)	Mosogar	Delta	5	70	6.4	2	0.10	0.10	0.10	ND	0.47	0.10	ND
Ethiope Extension	Mosogar	Delta	7	120	5.8	5	0.10	0.10	0.10	ND	0.23	0.10	ND
Enume stream	Enume Junction	Delta	9	170	5.4	28	0.20	0.10	ND	0.20	0.31	0.10	ND
Agwah stream	Okwetolo junction Okpe	Delta	10	180	5.8	34	0.10	0.10	ND	0.60	0.31	0.10	ND
Oren stream	Oriri community, Okpe	Delta	38	810	6.5	55	0.30	ND	ND	0.30	0.62	0.10	ND
Abefe Stream	Ometa Village, Okpe	Delta	91	1970	7.1	19	0.20	ND	ND	ND	3.90	0.10	ND
Ohorhe River	Ohorhe Community, Effurun/Okpe Boundary	Delta	90	5450	5.8	12	0.20	ND	ND	ND	2.18	0.10	ND
Agbaro River	Agbaro community,	Delta	25	180	6.4	14	0.10	ND	ND	ND	0.16	0.10	ND
Uvbieawugire River	Uvbiearnougie community, Uvbie	Delta	10	300	6.2	15	0.10	ND	ND	ND	0.39	0.10	ND
Obalegbe Stream	Uvbie	Delta	16	300	5.8	26	0.10	ND	ND	ND	0.31	ND	ND
Afisere Stream	Ughelli	Delta	16	200	5.8	27	0.10	ND	ND	ND	0.23	ND	ND
Unenurhie Stream	Ughelli	Delta	11	160	6.2	13	0.10	ND	ND	ND	0.16	ND	ND
Onidor Stream	Ughelli	Delta	9	150	6.8	16	ND	ND	ND	0.10	0.23	ND	ND
Uniriri Stream	Ughelli	Delta	9	290	6.8	15	0.30	ND	ND	0.20	0.55	0.10	ND
Oghoro Stream	Ughelli – North	Delta	15	370	5.8	68	ND	0.10	ND	3.20	0.70	0.10	ND
Ameja River	Ughelli – North	Delta	16	670	6.0	62	ND	0.10	ND	1.60	0.94	0.10	ND
Oruvbe– Oghoro stream	Ughelli - North	Delta	33	610	5.8	55	ND	ND	ND	0.40	0.94	0.10	ND
Ejubi Stream	Ughelli – North	Delta	29	620	6.6	165	ND	ND	ND	8.70	0.78	ND	ND
Umeh Stream	Patani	Delta	27	910	6.4	36	ND	0.10	ND	ND	1.25	ND	ND
River Niger	Patani	Delta	30	690	6.3	60	ND	0.10	ND	1.10	1.01	ND	ND
Kayama I	Yenegoa	Bayelsa	48	1030	6.2	164	ND	0.10	ND	2.80	1.56	ND	ND
Kayama II	Yenegoa	Bayelsa	37	1610	5.8	53	ND	0.10	ND	0.60	1.79	ND	ND
Odi Stream	Yenegoa	Bayelsa	77	780	6.4	291	ND	0.10	ND	5.50	1.09	ND	ND
River Nun	Yenegoa	Bayelsa	37	650	6.5	46	ND	0.10	ND	1.40	1.01	ND	ND
Okoso River	Yenegoa	Bayelsa	31	640	5.6	50	ND	ND	ND	1.30	0.01	ND	ND
Powe Creek Waterway	Yenegoa	Bayelsa	31	780	6.5	23	ND	ND	ND	ND	0.94	ND	ND
Zarama Stream	Zarama	Bayelsa	38	430	6.8	17	ND	ND	ND	ND	0.55	ND	ND

Table 1. Contd.

Onukwuemeke Stream, Emekuku	Owerri-North	Imo	23	130	6.2	23	ND	ND	ND	0.40	0.23	ND	ND
Mmuru Ezi Stream	Enorhua	Rivers	9	30	6.6	2	ND	ND	ND	0.20	0.08	ND	ND
Sangaro Stream I	Ahoada-East	Rivers	4	690	5.8	47	ND	ND	ND	8.20	1.09	ND	ND
Sangaro Stream II	Ahoada-East	Rivers	34	80	6.4	7	ND	ND	ND	0.16	ND	ND	ND
Ihuke Stream	Ahoada-East	Rivers	7	310	6.0	23	ND	ND	ND	3.70	0.31	0.30	ND
Akala-olu stream	Ahoada-West	Rivers	17	210	6.0	40	ND	ND	ND	2.40	0.23	ND	ND
Urashi river	Ahoada-West	Rivers	12	210	6.0	18	ND	ND	ND	ND	0.23	ND	ND
Choba/Aluu river	Choba	Rivers	9	120	5.8	22	ND	ND	ND	ND	0.70	ND	ND
Imo River	Owerrinta	Abia	80	180	6.4	20	ND	ND	ND	ND	0.73	ND	ND
Mmiri-ojii Stream	Okpala, Ngor Okpala LGA	Imo	10	30	6.8	8	ND	ND	ND	0.10	0.70	ND	ND
Onuohia Stream	Okpala, Ngor Okpala LGA	Imo	4	40	6.2	15	ND	ND	ND	ND	0.08	ND	ND
Ovia River	Ovia North-East	Edo	15	300	6.0	19	ND	ND	ND	0.10	0.55	ND	ND
Ofumwengbe Stream	Ovia North-East	Edo	20	570	6.2	67	ND	ND	ND	2.80	0.78	ND	ND
Igborgor/Aden Stream	Ovia-West LGA	Edo	27	710	6.4	37	ND	ND	ND	4.30	0.86	ND	ND
Aden Stream II	Ovia-West LGA	Edo	33	1240	6.7	38	0.10	ND	ND	1.50	1.01	ND	ND
Evbonogbon River	Edo/Ondo Boundary	Edo	57	1590	6.2	13	ND	ND	ND	0.10	2.11	ND	ND
Stream, (after Ufosu)	Ofosu	Ondo	73	970	6.2	43	ND	ND	ND	0.70	0.70	ND	ND
Stream 2	Ofosu	Ondo	47	670	6.2	26	ND	ND	ND	0.50	0.70	ND	ND
Stream 3	Ofosu	Ondo	31	900	6.1	28	ND	ND	ND	1.20	1.25	ND	ND
Owina River	Ofosu	Ondo	42	1380	6.3	9	ND	ND	ND	0.10	2.11	ND	ND
Ore-Ofe River	Ore-Ofe	Ondo	64	830	6.2	146	ND	ND	ND	4.50	0.78	ND	ND
Irnore Stream	Ore Odugbo	Ondo	40	860	5.9	149	0.10	ND	ND	2.70	0.78	ND	ND
Oluwa River	Omotosho, Odugbo LGA	Ondo	39	1300	6.0	7	ND	ND	ND	0.60	2.18	ND	ND
Ikonle Stream	Ikwale, Okitipupa LGA	Ondo	59	610	6.0	14	ND	ND	ND	1.70	0.70	ND	ND
Steam I at T_4	T_4 I	Ondo	29	540	6.0	32	0.10	ND	ND	0.90	0.70	ND	ND
Stream II at T_4	T_4 II	Ondo	27	1550	6.2	186	ND	ND	ND	1.30	2.26	ND	ND
Owi Stream	Gadaga Odigbo	Ondo	74	680	6.3	32	0.10	ND	ND	1.20	0.78	ND	ND
Ogun River	Ijebu-East LGA	Ogun	31	880	6.0	24	0.10	ND	ND	1.10	1.09	ND	ND
Omo River	Ijebu-East LGA	Ogun	42	1150	6.2	9	0.10	ND	ND	1.30	1.64	ND	ND

Table 1. Contd.

Osun River	Ogbore, Ogbore LGA	Ogun	54	1270	6.2	19	0.10	ND	ND	0.40	1.79	ND	ND
Okomonyo River	Okouwa I, Odogbolu LGA	Ogun	61	4720	6.6	90	0.10	ND	ND	1.50	3.43	ND	ND
Okomonyo River Branch	Okouwa II, Odogbolu LGA	Ogun	121	4150	7.4	72	0.10	ND	ND	0.30	6.32	ND	ND
Okomonyo River branch	Okouwa III, Odogbolu LGA	Ogun	186	5610	6.4	41	0.10	ND	ND	0.60	4.76	ND	ND
Stream 1 btw Shagamu and Redemption camp	Shagamu, Shagamu LGA	Ogun	190	420	6.5	344	0.10	ND	ND	12.1	0.62	0.1	ND
Stream II btw Shagamu & Redemption camp	Kemta village, Shagamu LGA.	Ogun	29	560	5.8	38	0.10	ND	ND	2.50	0.70	ND	ND
Stream III	After Kemta village, Shagamu	Ogun	23	15290	7.3	25	0.10	ND	ND	0.70	7.10	ND	ND
Akpa Ipong	Atai-Effiwatt, Odukpani LGA	Cross River	10	220	7.7	4	0.03	0.02	0.02	0.11	ND	ND	ND
Usok	Atan, Odukpani LGA	Cross River	25	570	7.4	14	0.03	0.03	0.01	0.10	ND	ND	ND
Calabar River	Calabar River village, Odukpani LGA	Cross River	11	240	7.1	1	0.03	0.03	ND	0.02	ND	0.01	ND
Itu River	Itu LGA	Cross River	12	250	7.3	27	0.02	ND	0.01	0.38	ND	ND	ND
Ikot Ebom	Ibiam Ibom, Ibono Ibom LGA	Akwa Ibom	5	110	6.1	10	0.02	0.01	0.01	0.43	ND	0.01	ND
Nwankwo River	Ikot-Osura, Ikot Ekpene LGA	Akwa Ibom	6	130	6.3	6	0.03	0.01	ND	0.08	ND	0.01	ND
Nwaigwe Stream	Allagu village, Onicha Ngwa LGA	Abia	5	110	6.1	9	0.03	0.02	0.01	0.15	ND	0.01	ND
Waterside	Aba North LGA, Aba	Abia	17	370	6.9	15	ND	0.01	ND	0.04	ND	0.02	ND

neural manifestation is due to the easiness at which Mn crosses the blood brain barrier and its half time in the brain is longer than in the whole body.

The future of our planet and all ramifications of its inhabitant are threatened. Though we all own one Earth, we are just not one whole owner. Moreover, though we all depend on one biosphere for sustenance of life, every community, local area, country and region struggle to exist and prosper at the detriment of others (WCED, 1989). Thus while a few countries consume and despoil Earths resources with impunity others are relegated to abject poverty, squalor, disease and death. This survival of the strongest syndrome is being made manifest in the Niger Delta region where multinational companies pollute the environment without remorse and are still doing so continuously (Chindah and Braide, 2004).

According to WCED (1989), environmental stress is a consequence of several factors such as increased demand for now very scarce resources and the subsequent pollution generated by the living standard of the affluent. Additionally, there is poverty which necessitates environmental degradation by the poor and is usually extreme (e.g. deforestation) as they just want to survive by all means. Other factors include population explosion, economic growth and development and survival.

The quality and quantity of rivers, streams and waterways are usually affected by channel manipulation, modification of watershed characteristics, urbanization and pollution (Mrowka, 1974). According to Egborge (1994) rapid urbanization, industrialization and high population gave impetus to the pollution potentials to rivers and streams in the western and eastern Niger Delta. Egborge further stated that the petroleum industry is a formidable source of pollutants due to activities such as drilling, production and refining of crude and the production of petrochemicals including carbon black, marketing, utilization and disposal of spent petroleum products and the event of major oil spills. Heavy metals are amongst the major and dangerous pollutants from the petroleum industry (Egborge, 1994). Major crude oil spillage has adversely affected inorganic levels of soils and streams in Ogoni land in the Niger Delta heart land with significantly higher levels of the heavy metals Pb, Cd, Cr and Ni. The entire areas affected by oil spillage were polluted with inorganic ions (Onyeike et al., 2002). The water quality of some tropical freshwater bodies in Uyo, Akwa Ibom State has been shown to be polluted by city effluents, slaughterhouse washings and land use (Akpan, 2004). These are problems of urbanization. According to Adeyemo (2003), Nigeria's vast freshwater resources are among those most affected by environmental stress imposed by human population growth, urbanization and industrialization and the major culprit is disposal and management of wastes accrued from these human activities.

Other sources of heavy metal pollution are by discharges from non-ferrous metal production. The primary heavy metals discharged are lead, zinc, and cadmium especially in non-ferrous metal industries in which steel is plated, batteries, pigments, stabilizers and plastics are produced. Iron and steel production also result to emission of cadmium and lead. Additionally, cement manufacture results to high emission of cadmium, lead, mercury and other heavy metals. The manufacture and use of fertilizers also result to elevated amounts of cadmium, arsenic, lead and mercury. Moreover, another major source of heavy metal pollution is the now very lucrative exploration of solid minerals up country. These exploration sites are on the increase everyday. Some of them are industrially extracted in rivers and streams. Though these elements are consistently present in trace amounts in the environment, they are potentially toxic and could affect the biota at water-soluble concentration of less than 1 ppm (Freedman, 1989). Also, the dose received by a target organism is not only a function of the concentration, but also a function of the period of exposure (Freedman, 1989). Human factors, such as exploration of petroleum and solid minerals, industrialization and urbanization, population growth etc are still persisting mostly in southern Nigeria.

Cadmium has both long and short term effects on specific tissues/organs of the body. Kidney damage, ocular damages are long term effects while testicular damage is short term. Exposure to lead may be directly due to the metal, or indirectly, the lead salts or organic lead. Lead causes damage to a variety of organs with significant biochemical effects. It affects the kidneys, testes, bones, gastrointestinal tract and the nervous system and causes blindness (Timbrell, 1991). Other heavy metals even when considered as essential trace elements are very toxic. Currently, the Niger Delta region is a cauldron of violence, hunger, starvation, disease and death. The current restiveness by the youths is sort of a reflex response to the balkanization of the environment without adequate regulatory and compensatory measures. In fact, Nigeria is tending to be among the countries in the world with the least effective environmental impact assessment mechanism. It is therefore not surprising that the Niger Delta region of Nigeria is in a state of unprecedented environment distress.

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