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Influence of Landuse Patterns on Otamiri River, Owerri and Urban Quality of Life

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Abstract: Research was conducted on the impact of landuse patterns in the pollution of Otamiri river to ascertain the environmental quality of life of the city dwellers. Water and sediment samples in Otamiri river were obtained from locations closest to landfill, mechanical workshop village and sand and gravel mine. Samples were subsequently subjected to standard analytical procedures. The ranges of the result for the physicochemical parameters analyzed include pH (5.28-5.63), temperature (27.3-28.2°C), Conductivity (123-203 µS/cm), turbidity (6.4-16.3 NTU), DO (1.9-2.1 mg/l), BOD (30.00-39.50 mg/l), TSS (2.0-2.9 mg/l), total hardness (40.5-61.2 mg/l), phosphate (3.45-6.99 mg/l), Nitrate (0.5-3.0 mg/l), Sulphate (5.07-10.0 mg/l), Lead (0.02-0.60 mg/l). Result of the analysis showed that for all sampled points, the values of some variables exceeded the safe limits of WHO standards. The increased Lead concentration in the sediment, low value of dissolved oxygen and high acidity shows that landuse patterns along the Otamiri watershed deteriorated its quality, rendered it unfit and posed a health risk to Owerri residents. Consequently these activities should be zoned out of their present areas of operation to secure a better quality of life for the city dwellers.

Key words: Otamiri, landuse, quality of life, sediments, water samples

INTRODUCTION

Generally, the use of land embraces all the various ways in which land serves to provide man with his needs and wants; which can be for the purposes of recreation, agriculture, transportation, mineral sources and water resources development (Oladeji, 2002). One of the most important factors that can affect the quality of surface water is the landuse within a watershed (Eckharodt and Stackellberg, 1995); which the increasing growth in urban development has begun to put under serious threats. Uncertainties face most Nigerian cities including Owerri since growth in population is not matched by corresponding development of infrastructure (Nnaji and Duru, 2007). Owerri is drained by two Rivers, Nworie River and Otamiri River; the later stretching its length to Etche in Rivers State from where it flows into the Atlantic Ocean. Industrial and commercial activities such as sand and gravel mining, landfill, motor mechanic village are all located along the Otamiri watershed. Quality of life refers to either the conditions of the environment in which people live, (air and water pollution, or poor housing) or to some attribute of people themselves regarding their health or education status (Pacione, 2003). The concept of quality of life as applied to the urban environment is usually understood in two ways: the first way concerns the environment and involves the pattern of inequitable advantages and opportunities that affect each citizen through accessibility to service, facilities and amenities. The second approach to understanding urban quality of life relates to the natural environment in urban spaces. This approach holds that such factors as air, water and soil quality and the amount of green space available affect the ways we live (Senecal, 2002).

The management of our environment and the control of discharges of waste products from different landuse patterns for specific anthropogenic activities are of specific interest. Rapid industrialization, urbanization and population growth have led to increase in waste generation (Ogbonna *et al*., 2007); leading to problems as surface water pollution, biodiversity loss, diseases, climate change, eutrophication and stress on the aquatic life.

Study area: The study area is Owerri, a rapidly growing urban centre consequent to its designation as the capital of Imo State in 1976. It has three Local Government Areas, Owerri Municipal, Owerri North and Owerri West and is located in the Southeastern Nigeria with longitudinal and Latitudinal locations, longitude 6°32^{1} to 7°11^{1} East and Latitude 6°21^{1} to 6°35^{1} North respectively (Fig. 1). The topography is fairy low and with comparatively few undulations. The area is well drained by rivers Otamiri, Nworie and seasonal Okitankwo an offshoot of Imo river. The Otamiri watershed covers about 10,000 km^{2} with annual rainfall 2250-2500 mm. The watershed is mostly covered by depleted rainforest vegetation, with mean temperatures of 27°C throughout the year. The Otamiri River is joined by the Nworie River at Nekede in Owerri, a river about 9.2 km in length (Anyanwu, 2009). Most of the wastes from Owerri are dumped at the Avu landfill in Owerri West on the Port Harcourt highway, which creates a high concentration of phosphate and Nitrate in Otamiri River (Ibe and Njoku, 1999) south of Owerri. The river flows through an alternating sequence of sands, sandstones and clay-shale (Uma and Kehinde, 1992).

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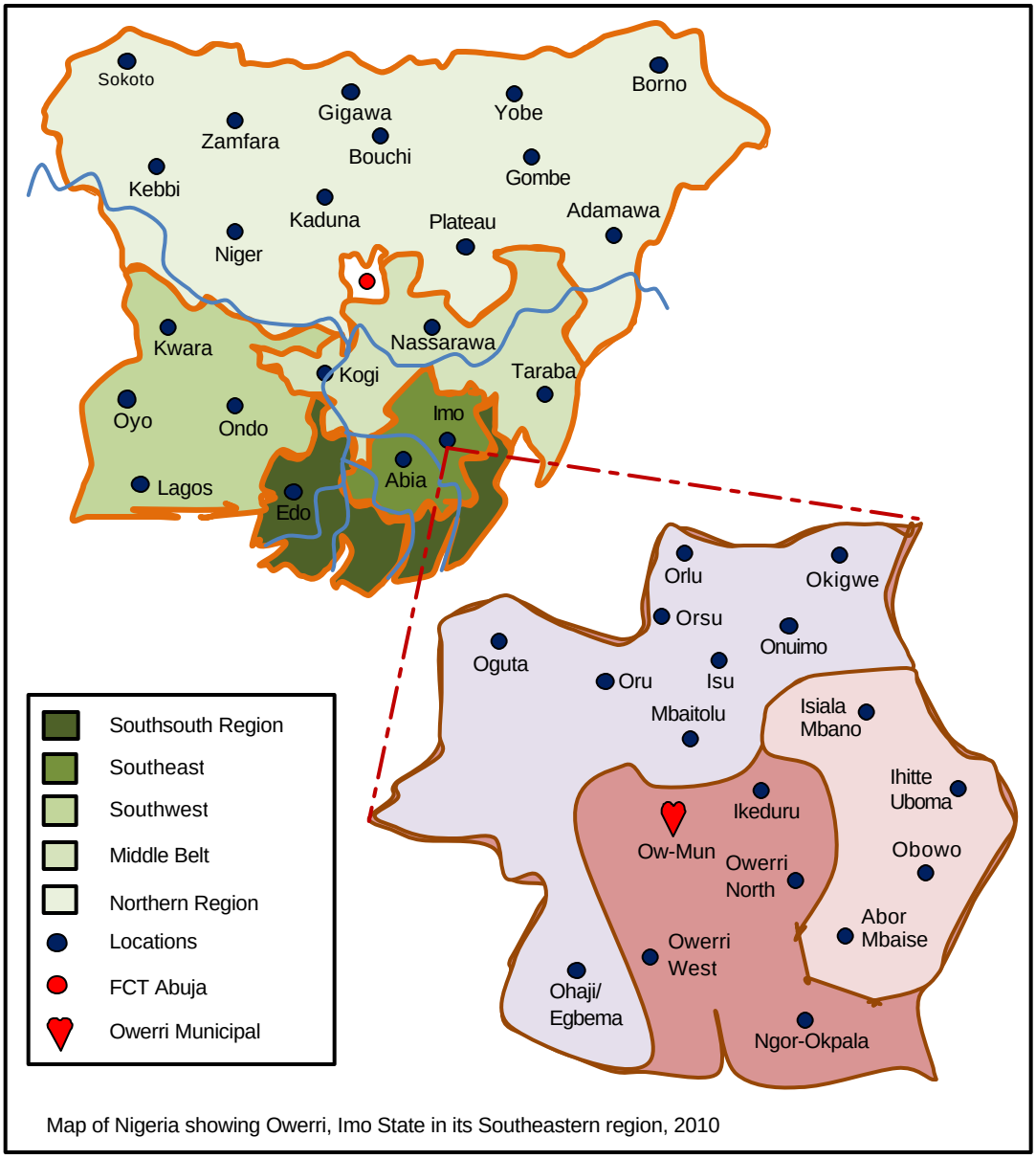

Fig. 1: Map showing Owerri, Imo State in Southeastern Nigeria. Source: Federal Survey Maps Owerri, Imo State Nigeria (2010)

Conceptual frame work/literature review: Lotfi and Solamimani (2009) stated that there is a general agreement among researchers that there are two linked dimensions to the concept of quality of life, namely a psychological one and an environment one. In quality of life research, distinction is made between the subjective and objective quality of life. Subjective quality of life covers perceptions, evaluations and appreciation of life and living conditions by the individual citizens (Shackman *et al*., 2005). Subjective quality of life is the outcome of the gap between people's goals and perceived resources in the content of their environment, culture, values and experiences (Campfield, 2005). Objective and subjective indicators are designed to measure quality of life. Indicators used by Discoli (2006) in developing urban life quality include infrastructure basic services, sanitation basic services, social services, urban aspects and environmental aspects.

Landuse patterns have varied impacts on both the quality and quantity of surface and groundwater resources system and have been variously reported for major Nigerian cities. The assessment of the

Table 1: Composition of site samples

Parameters	WHO's STD (2006)	Surface water A[1]	Surface water B[1]	Surface water C[1]	Sediment A[2]	Sediment B[2]	Sediment C[2]	Mean	Standard Deviation
pH	6.5-8.5	5.42	5.28	5.62	5.63	5.37	5.58	5.52	0.20106
Temperature (°C)	20-30	28.10	28.20	27.30	28.00	28.20	27.60	27.90	0.36878
Conductivity (µS/cm)	100	123.00	133.00	196.00	165.00	178.00	203.00	166.33	13.35581
Turbidity (NTU)	50	16.30	6.40	7.10	-	-	-	9.933	3.81974
DO (mg/l)	4.0	1.90	2.00	2.10	-	-	-	2.000	0.05774
BOD_5 (mg/l)	40	30.00	31.5	39.50	-	-	-	39.3	0.20817
TSS (mg/l)	35	2.90	2.00	2.60	-	-	-	2.333	0.49329
Total hardness (mg/l)	50	50.50	61.20	40.50	-	-	-	50.733	10.35197
Phosphate $(PO_4)^{2-}$	5	3.45	3.68	4.29	5.12	6.73	6.99	5.0433	1.52349
Nitrate (NO_3) (mg/l)	40	1.50	0.90	0.50	2.60	2.60	3.00	1.8333	0.41446
Sulphate (SO_4^{2}) (mg/l)	250	7.55	5.07	6.35	8.50	10.00	9.80	7.8783	1.94479
Lead (Pb) (mg/l)	0.05	0.08	0.02	0.02	0.40	0.60	0.45	0.2617	0.25254

N/B Sampling Stations: A = Sand and Gravel mine, B = Mechanic Workshop Village, C = Landfill

environmental impacts of landuse patterns on ground water quality in Ogbomosho revealed that activities such as petrol stations, burial ground, car wash, mechanic workshop, soak-away, refuse dumpsites and motor park show grievous impacts on the quality of ground water (Oladeji, 2002). Iwegbue (2007) studied metal fractionation in soil profile at automobile mechanic waste dumps around Port Harcourt and observed that heavy metals such as Pb, Cd, Fe, contaminated the soil. Nnaji and Duru (2007) in his work on water samples collected from Nworie river close to fertilized farm, hospital and waste disposal sites found that the river was polluted and posed health threat to Owerri residents.

The increasing growth in urban development in our cities has begun to put under serous threats, the treasured physicochemical and biological qualities of the surface and ground water resources.

MATERIALS AND METHODS

Data collection utilized sampling method whereby sediment and water samples from Otamiri river were subjected to physicochemical analysis (APHA, 1992) to determine the level of concentration of identified parameters. Three sampling stations were selected representing some landuse patterns along the watershed of Otamiri river (Fig. 2). They include a landfill, mechanic workshop village and sand and gravel mine; to assess their impact on some physicochemical variables such as pH, temperature, conductivity, turbidity, Dissolved Oxygen, DO, Biochemical Oxygen Demand, BOD, total hardness, phosphate, Nitrate sulphate and Lead. Their levels were analyzed in the laboratory with data logging spectrophotometer and *in situ* measurements in the field, were taken with *multiprobe* meter. The results of the physicochemical analysis of the parameters were interpreted by comparing with international standard for safe limits of water quality. The environmental evaluation of impacts of the various activities in the Otamiri river was done by determining the deviations between the laboratory results and the international standards. This serves as a subjective indicator for the environmental quality of life.

RESULTS AND DISCUSSION

Result of analysis shows that:

- pH of the sites sampled ranged between 5.28 and 5.63. This range is higher than WHO standards. By implication they are acidic and the water is not fit for human consumption.
- The Dissolved Oxygen, DO was very low at the sampled sites ranging between 1.90 mg/l and 2.10 mg/l. This low oxygen concentration cannot support aquatic fish life. It is below WHO safe limits.
- The total hardness concentration ranged between 40.50 mg/l and 61.20 mg/l. This is slightly above the WHO standard values and by implication the water cannot lather effectively.
- The results for Lead were higher in the sediment samples than the water samples. The mean for surface water was 0.03 mg/l while sediment was 0.48 mg/l. This value in sediment samples for Lead was higher than the safe limits standard set by WHO. Lead, apart from its toxicity effect to living organisms could through bioaccumulation and biomagnifications be transferred from one trophic level to another. Lead affects developing foetus and infants more than adults. High levels of exposure may result in toxic biochemical effects in humans which in turn cause problems in the kidney, gastrointestinal tract, synthesis of haemoglobin, joints, reproductive system and acute damage to the nervous system.
- The conductivity level ranged between 123.00 µS/cm and 203.00 µS/cm with a mean of 166.33 µS/cm.
- The concentration of turbidity, total suspended solids, phosphates, nitrates were within acceptable limits set by WHO standard. Eutrophication might not occur.

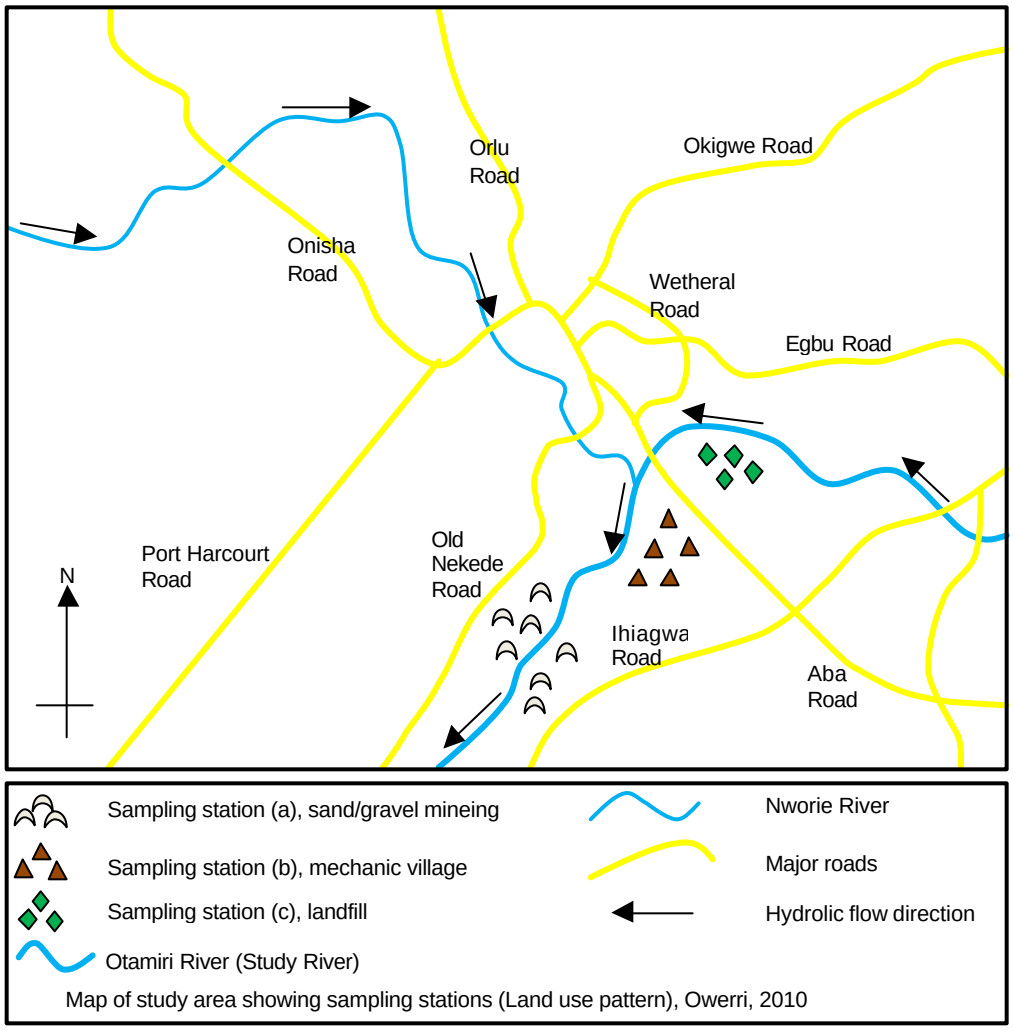

Fig. 2: Map of study area showing sampling stations. Source: Federal Survey Maps Owerri, Imo State Nigeria (2010)

- Statistical tools such as mean, standard deviation and variance were used to analyze the data obtained to ascertain how representative and close the data obtained were. Two-way analysis of variance was used to show significance difference between the samples and the stations. Correlation analysis was carried out to show the relationship among the physicochemical and biological parameters.
- After the statistical analysis, there was significant difference between the water samples and sediments samples at $p<0.05$.

Quality of life and related concepts: Cities should be able to provide healthy and stimulating environments for their dwellers. Developing country cities still utilize sewage on open channels which gets blocked by careless disposal of wastes giving rise to flooding. Moreso they act as breeding grounds for mosquitoes. The healths of residents are adversely affected through the spread of such diseases as, typhoid fever, malaria, diarrhoea among others. The Stockholm declaration on the human development was, perhaps, the first authoritative instrument recognizing the sustainability of the human environment as a fundamental aspect of human rights. Principle of that deceleration states that: "Man has the fundamental right to freedom, quality and adequate conditions of life in an environment that permits a life of dignity and well being and he bears a solemn responsibility to protect and improve the environment for present and future generation" (Cited in Worika, 2002).

The contamination of Otamiri river can be attributed partly to rapid urbanization and on poor sanitation habits. The rate at which infrastructure and social services are provided has not been commensurate with the pace of

population growth. The effluents are discharged into the surface water untreated or partially treated.

Conclusion: The surface water and sediment samples from Otamiri river have been analyzed for some physicochemical parameters in relation to landuse patterns in Owerri. The result gave an insight into how activities such as mechanical workshop, land fill, sand and gravel mining impacts on the environment and illustrates the quality of life of the city dwellers. Most of the parameters analyzed exceeded the limits set by World Health Organization (WHO) standard; which shows the activities rendered the water unfit for drinking and other domestic use except they are treated. Most of these activities should be zoned out of their present places to improve the environmental quality of life. Finally, the observed high Lead content in the sediment samples, low values of the dissolved oxygen and high acidity level may pose high degree of health hazards and therefore it is urgent that an extensive study be carried out in which more representative samples would be used in order to go beyond the preliminary assessment as reported in this study with a view to corroborating our research results and thereby making appropriate recommendations.

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