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Water Quality Study of River Kaduna in Nigeria.

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Abstract

Water quality is a goal as well as very important requirement for healthy living of both humans and the entire global ecosystem. This research was conducted in order to find out the current quality status of river Kaduna; which is being depended upon by millions of people at its both up and down streams. Important parameters oh Acidity, Conductivity, COD, BOD, DO, DS, and heavy metals of Mercury, Lead, Cadmium, Rubidium, Were sampled along strategic locations of the river and analyzed for their present values in the river. Most of these parameters have recorded higher values than the WHO (1993) acceptable standards. It was also observed that the higher concentrations were traceable to sampling locations in which industrial and domestic wastes are being discharged. This therefore called for strict measures to control these sources of pollution as recommended in the last section of the paper.

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Introduction

Kaduna urban area is drained by a major river called River Kaduna. Studies such as Adakole et al (2012); Dike et al (2004); Mchivir (2013) and field observations have established the abstraction of water and discharge of toxic chemical effluent by industrial and municipal services in Urban Kaduna and are giving rise to the deterioration of both water quality. While this particularly calls for continuous monitoring of water quality level, given the immense importance of the river to the Kaduna Urban area, it specifically calls for proper examination of spatial variations in the pattern of deterioration since such a pattern has to be taken into account both in identifying the key areas that contribute the most to the deterioration.

In essence, an analysis of such spatial pattern can highlight to the public and the appropriate authorities on the particular activity or group of urban activities or sectors that should be of primary concern in controlling the level of stream water pollution in urban Kaduna.

As no much research documentation on spatial variation of stream water pollution and the adjoining

vegetation of urban Kaduna is available which may determine the variations in the water quality level of the Kaduna at different zones, the need for empirical research on the subject becomes highly imperative, and this constitutes the problem of interest to the present researcher.

The aim of this research is to critically analyze the spatial variations in stream water quality in urban Kaduna with a view to identifying key sources (and their spatial extent) of the pollutants to the River Kaduna.

Literature Review

Many studies have been carried out in the areas of water quality by various people in different locations. In an extensive study on Changzhou city in China, Balarabe et al (1991); Iguisi et al (2001) observed that, the Grand Canal and the city rivers were largely contaminated with industrial waste water particularly that discharged by industrial enterprises. With a self purification capacity of 30,000 to 40,000 tons per day, the canal and the city rivers are receiving daily discharged sewage of 190,000 tons per day. Clean

water can hardly be found in 07.36km of the city rivers from which there is a terrible odour in certain areas.

Butu (2011); Olofin (1991) and Tiri et al (2011) argued that it is generally accepted concept that water resources should be developed on multipurpose basis, but rarely has water quality been considered in the planning schemes in developing countries. The major water uses for which large schemes have been designed are power, flood control and irrigation. It appears, however, that in most developing countries, although water pollution control is very important, it has never been seriously considered in most project designs.

Caccia(2003);Lentech (2009) and Pekey (2006) for example, worked on the effects of brewery effluent discharge on water quality of the Ikpoba River in Benin City. Yusuf (1992); Massud (2011) and WAPDEKO (1991) also carried out a study on some heavy metals in Kubanni Dam, Zaria. Similarly, the Federal Environmental Protection Agency (FEPA) carried out a study to investigate mainly the extent of industrial Pollution of river Kaduna and its tributaries in 1996. The study showed that there is a significant relationship between industrial pollution and river Kaduna pollution. It also revealed that more than 25 million litres of industrial effluent containing various pollutants are discharged daily into the river which supplies water for the environs. The study, therefore confirmed the existence of the problem.

Post (1983) also conducted a study on water quality where he analyzed the concentrations of iron, calcium, magnesium, copper, zinc and lead as (pollutants) in the stream water of the upper Kubanni basin in northern zaria.

Farouk (1987) conducted a study on the Kaduna river pollution. Six streams namely Makera, Kakuri, Nasarawa domestic, Rafin Dadi, Rigasa and Romi were investigated. River sampling points were selected to reflect the progression of pollution, and later recovering, as the water passes through Kaduna town and beyond. Altogether fourteen sampling points were used.

He used water quality parameters such as temperature, dissolved oxygen (DO) (using YSI DO/T meter) PH (using coming EEL digital PH meter). Conductivity (Beckman lab. Conductivity meter) using Acidified dichromate method) Biochemical Oxygen Demand (BOD) (using BOD bottle tech) Ammonia Nitrogen (NH₄ +N) Nessler's reagent method. Total Solids (TS) Dissolved Solids

(DS) (using gravitmetry) and suspended solids (by finding the difference between TS and DS).

Results of his analysis showed that water quality deteriorated as one moved along the river from the north to the south as anticipated. His results also showed that the most extreme conditions of water pollution were from samples which originated from Kakuri and Makera drains for most of the parameters monitored. These he attributed to the high concentration of industries in these areas.

The state of water quality deterioration in River Kaduna, particularly through industrial pollution, has necessitates studies and subsequent design of remedial programmes aimed at monitoring waste generation and disposal methods in industries, and it is with this view that the authorities of the Kaduna Environmental Agency (KEPA) prepared some guidelines called "Policy directives on industrial waste pollution control in Kaduna State" in 1995.

To plan against water pollution, however, requires that adequate knowledge of spatial variation in the level of stream water pollution is acquired. Such knowledge can provide good indication of the level and nature of pollution and thus draw particular attention to the need for preventing discharge of particular pollutants into the stream. It appears, however, that for most rivers, such an approach is not being widely accepted in stream water quality monitoring. Hence, this study intends to advance such an understanding using Kaduna urban area which drains into Kaduna river, as a case study.

Material and Methods

For the purpose of this study, five (5) zones of waste discharge into the Kaduna River have been recognized, according to their capacity, intensity and type of waste they carry. They are:

- 1.Kawo -heavy Agricultural discharges.
- 2.Stadium -high domestic and light agricultural discharges.
- 3.Makera -relatively high industrial and low agricultural discharges.
- 4.Bye-pass -Bridge-heavy industrial discharges.
- 5Kudenda -low industrial discharges.

Samples were collected from the midstream where reasonable mixing between water and discharged effluent are thought to be occurring, immediately

after the point where a drain is discharged. To collect samples, 1000, 500 and 250 plastic bottles were used, as recommended in the standard methods for water and waste water analysis 15th edition 1980, published by American Public Health Association (Washington DC U.S.A). The bottles were submerged to about 5cm below the water surface and inclined against the direction of flow, caps were screwed on while the filled bottles remained submerged.

standard laboratory analysis were conducted, for instance Dissolved oxygen (DO) was measured using the yellow spring instrument (YSI) NO. 57 portable D.O. meter. A corning EEL digital PH Meter was used for pH determination, while conductivity was measured by means of Beckman laboratory conductivity meter. Chemical Oxygen Demand was determined by the acidified dichromate method.

Descriptive statistics (mean, standard deviation and standard error of the mean were calculated for each water parameter determined for each of the five water sampling stations. This is to enable us offer a good descriptive account of the special variation in water quality of the river. Student's T-test was subsequently used to further assess the significance of variation in the quality parameters determined between pairs of sampling stations. This is to enable us identify the main spatial location that vary significantly amongst the five sampling stations.

Result and Discussion

Table 1 below presents the observed values for the 19 parameters tested in the water quality carried out for each of the five sampling zones.

The PH values in the various sampling points range in value from 38.69 to 191.18 indicating that the stream water quality varies from strongly acidic to weakly basic. At Kawo and stadium, the water is weakly acidic and at Bye-pass-Bridge and Kudendan the water is weakly basic while in the Makera area the water is strongly acidic. This goes to show that mixed agricultural, residential and commercial land use promote weak acidic conditions. A combination of mixed light to medium industrial, residential and agricultural land uses promote slight alkaline conditions. It can be said therefore, that it is only at areas of mixed heavy industrial and light agricultural land uses that the PH level is altered extremely. This means that attempts at controlling deterioration in the level of River Kaduna should be concentrated around the activities going on the Makera land use zone

The value of EC varies substantially among the five zones. But, like the PH, Makera zones has values that are extremely above those of other stations by over 100% followed by areas of mixed light to medium industrial and Agricultural land uses which promote very low levels of EC in the area.

Unlike PH and EC, areas of mixed Residential/Commercial/Agricultural land uses types promote comparatively high DO values and those of the mixed industrial Agricultural. Residential land use group promote medium DO levels. Those of industrial land use types only promote the lowest levels. This means, the major source of effluent into the river is human activities concentrated within the commercial/residential/Agricultural land use zones.

The pattern of COD and BOD are almost exactly the same as that of EC, with the areas associated with industrial activities contributing comparatively highly levels into the river than the other area. The similarity in pattern between EC, BOD and COD as observed here is expected since EC is known to greatly influence the levels of chemical oxygen that is demanded by aquatic lives.

The land uses associated with industrial activities maintain comparatively higher levels of TDS than the other areas. However, only at Makera are the levels extremely high. This certainly reflects the effect of discharges through industrial waste water, of several dissolvable solids in the river. Thus, even the perceived contribution of Agricultural activities to soil erosion and sediment yield is not causing significant increase in NTDS and FS in Kaduna River.

The concentration of all the metals copper, zinc, Beryllium, Sulphur, Rubidium and strontium are all comparatively higher at the two areas associated with industrial activities in urban Kaduna (ie Makera and Bye-pass – bridge). In most cases, the differences in concentration between each of these two areas and the others look apparently large. While it is not difficult to advance industrial discharges as the major cause of the observed highly elevated levels of various metals particularly a Makera where the industrial activities are comparatively higher, the levels of almost all the element determined are above the maximum permissible limit set by FEPA.

TABLE 1: RESULTS OF WATER SAMPLE ANALYSIS OF KADUNA RIVER.

PARAMETER	SAMPLING POINT	OBSERVED VALUE
PH	1	47.79
	2	53.27
	3	191.18
	4	37.35
	5	38.69
ELECTRICAL CONDUCTIVITY (EC)	1	0.04
	2	030
	3	2.26
	4	2.53
	5	0.35
DISSOLVED OXYGEN (DO) Mg/L	1	116.07
	2	99.58
	3	77.38
	4	39.66
	5	33.51
CHEMICAL OXYGEN DEMAND (COD) Mg/L	1	0.22
	2	0.55
	3	13.32
	4	6.66
	5	2.14
BIO-CHEMICAL OXYGEN DEMAND (BOD) Mg/L	1	0.83

	2	0.54
	3	154.7
	4	108.33
	5	21.01
POTASSIUM (K) PPM/Mg/L	1	16.71
	2	23.67
	3	79.89
	4	76.70
	5	36.61
CALCIUM (Ca) Mg/L	1	6.72
	2	23.71
	3	35.20
	4	31.80
	5	37.53
MANGANESE (Mn) Mg/L	1	7.33
	2	15.00
	3	63.51
	4	29.85
	5	26.93
IRON (Fe) Mg/L	1	74.83
	2	93.87
	3	283.34
	4	194.40
	5	141.61
NICKEL (Ni) Mg/L	1	465.01

	2	740.83
	3	6250.01
	4	1835.30
	5	730.22
COPPER (Cu) Mg/L	1	727.01
	2	1815.60
	3	2754.20
	4	2579.31
	5	2110.32
ZINC (Zn)	1	1264.59
	2	1616.91
	3	4012.33
	4	3125.01
	5	2927.92
BERRYLYIUM (Br) Mg/L	1	87111.02
	2	11854.36
	3	18055.55
	4	17105.20
	5	15250.74
SULPHUR (S) Mg/L	1	-
	2	-
	3	77.56
	4	26.62
	5	84.89
RIBIDIUM (Rb) Mg/L	1	-

	2	-
	3	5803.51
	4	2321.40
	5	-
STRONTIUM (Sr) Mg/L	1	26.00
	2	20.92
	3	108.30
	4	26.08
	5	21.62

Conclusion and Recommendations.

The water quality study of River Kaduna has brought to the fore some important concerns that were muted by research works like (Farouk,1987 and Rognerard 1993; Wright 1970) which indicated the presence of several heavy metals in high concentration to cause contamination to biotic species of flora and fauna that abound in the river and at its riparian. The other parameters monitored such as the oxygen characteristics of the water in terms of COB, BOD and DO are all indicating toxicity above the threshold that can be purified by the river.

There is the urgent need the environmental Agency to mount a serious pollution control measure to check the excesses of especially the identified sources that are responsible for the disposal of untreated waste into the river. It is also recommended that community workers and non- governmental bodies be active in enlightenment campaigns that will alert members of the public to the harm being caused to this important ecosystem.

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