academicJournals

Vol. 9(5), pp. 385-389, May 2015
DOI: 10.5897/AJEST2014.1786
Article Number: 09C3DD852127
ISSN 1996-0786

African Journal of Environmental Science and Technology

Full Length Research Paper

Assessment of effluents discharged from textiles industries in selected villages in Kaduna State, Nigeria

Mohammed Ahmed Emigilati[1]*, Ibrahim Ishiaku[2], Badaru Yahaya Usman[1], Garba Inuwa Kuta[1] and Kudu Dangana[3]

[1]Department of Geography, Federal University of Technology Minna, Niger State Nigeria.
[2]Department of Geography, Federal University Birnin-Kebbi, Kebbi State, Nigeria.
[3]Department of Geography, IBBU Lapai, Niger State Nigeria.

Received 4 September, 2014; Accepted 18 March, 2015

A major serious source of pollution is the industrial effluent discharge by the process industries into the water bodies. Industrial effluent consists of water with varieties of potentially harmful substances. The study analysed the public health effects of effluents discharged from Kaduna textile industry into the waters of river Kaduna. Physicochemical qualities of effluents at the downstream were assessed. Parameters measured include pH, temperature, electrical conductivity, depth, turbidity, biological oxygen demand (BOD), dissolved oxygen, chemical oxygen demand, nitrate, sulphate, acidity, alkalinity, organic matter and carbon levels and these were simultaneously monitored in the river using standard methods. Unacceptable, high levels of the parameters were observed in the four sampling points during the study period and are severally outside the compliance levels of the Federal Environmental Protection Agency (FEPA) Guidelines and World Health Organization (WHO) tolerance limits for domestic uses. The study recommend the need for the intervention of appropriate regulatory agencies to ensure production of high quality treated final effluents by wastewater treatment facilities in selected villages of Kaduna

Key words: Pollution, textile industry, industrial effluent and water quality.

INTRODUCTION

The water we drink is essential ingredient for our wellbeing and a healthy life but unfortunately, polluted water and air are common throughout the world (European Public Health Alliance, 2009). All people, whatever their stages of development, social and economic condition, have the right to have access to drinking-water in quantities and of a quality equal to their basic needs (WHO, 2004). Over the last three decades, there has been increasing global concern over the public health impacts attributed to water pollution, in particular, the global burden of disease. It is estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to water pollution. Most of these water pollution-related diseases are however not easily detected most especially in developing countries and may be acquired during childhood and manifested later in adulthood. The discharge of

*Corresponding author. E-mail: m.emigilati@futminna.edu.ng. Tel: +2347032950192.

industrial effluent into water bodies is one of the main causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these industries lack liquid and solid waste regulations and proper disposal facilities, including the harmful waste. Such waste may be infectious, toxic or radioactive (WHO, 2004).

Industrial pollution is one of the problems presently facing Kaduna State in Nigeria due to concentration of textile manufacturing industries. The industries together with municipal effluents ultimately polluted water in the river. The water pollution may infect our food in addition to groundwater contamination when used to irrigate crops and this poses great risks to public health.

In an attempt to contribute to the understanding of the nature of the problems, this study undertook a comparative analysis of textile industries effluent discharge in Kundende, Rigasa, Nasarawa and Kakuri in relation to acceptable limit of world health organisation in Kaduna State, Nigeria.

Statement of problems

A major serious source of pollution is the industrial effluent discharge by the process industries into the water bodies. Industrial effluent consists of water with varieties of potentially harmful substances. The wastewater is a by-product of utilized portable water (domestic wastewater) or industrial process water (industrial wastewater). In the process industries, water could be used as coolant, process water and raw material, etc. It is also used in purification of either the raw materials or finished products. In the process of usage, industrial water becomes polluted and contaminated with various substances it comes in contact with. The discharge of such wastewater or industrial effluents into water bodies such as streams, rivers, lakes, seas, oceans or farmland, etc., could be hazardous to man, aquatic lives, plants and every other living things that derive their water from the polluted sources (Dix, 1981). Effluent discharge from industries, especially from textile industries in Kaduna town has been on the increase on daily basis. Its effective management has constantly been a problem to the industrialists, the community and the government of Kaduna. Adverse effect of these to human health, biodiversity and agricultural farmlands are now eminent. The question that readily comes to mind is how consumable are surrounding rivers in relation to world health organization standard. It is therefore significant in environmental management and decision making to assess and evaluate the magnitude of negative impact.

Aim and objectives

The aim of this study was to assess the quality of effluents discharge in river Kaduna in comparison with WHO accepted limit. In specific, the objectives are: To compare the quantity of pollutants in the water with the acceptable limits of WHO; to assess the rate at which chemical related effluents discharged from the industry affect the quality of water.

RESEARCH METHODOLOGY

Study area

Kaduna is the capital of Kaduna State. It has always been the seat of government right from the time of colonial rule in Nigeria. It was the capital of then, northern religion when the country was divided into twelve (12) states; it became the capital of the emergent north central state. Kaduna was first developed as an army encampment and later grew to become a cosmopolitan city. The city, located on the Kaduna River, is a trade centre

Kaduna occupies an approximate total land area of 3,080 km^2 and also has an estimated population in the 1991 census of about 711,155. The recent 2006 population census estimated Kaduna as 1,458, 900. The river Kaduna takes it source from the Kujama hills in the Jos plateau and flows for 210 km before reaching Kaduna town. It crosses the city dividing it into north and south area. Beyond Kaduna, the river flows about 100 km into the Shiroro dam areas. The river is joined on its course by three tributaries which include river SarkiPawa, Tubo/Damari and Dinya, the Shiroro. It continues to flow for 200 km and finally discharges into the river Niger on the Northern shores of Pategi (Figure 1).

The entire study was designed to involve three different stages which included:

1. Preliminary studies: it involved collection of reports and preparation of maps.
2. Field work which involved collection of water samples.
3. Analysis and report writing: it involved laboratory analysis of sample.

In the first stage, reconnaissance and a pilot survey was conducted before the definition and mapping of the study area. Thereafter, the sampling strategies/procedures were designed with the required instruments of investigation. At the data collection stage, all the selected villages were identified and water sample collected. This was followed by data analysis stage, where data collated were summarized and presented including composite water sample test from laboratory analysis where the following parameters were tested: temperature, dissolved oxygen, turbidity, conductivity, total dissolved solid, pH, fluoride (F), manganese (Mn^+), ammonia (NH_3), nitrate (NO_3^{-2}), sulphate (SO_4^{-2}), nitrite (NO_2^-), sodium (Na^+), Potassium (K^+), alkalinity, calcium, chloride (Cl^-), magnesium (Mg^{2+}), bicarbonate and carbonate ($CO^3{}_2$). The data collected from the sources of water segments established within the villages were subjected to one-way analysis of variance (ANOVA). ANOVA was also used to test for existence of significant variation between groups of water quality parameters and among the four designated sources of water.

Quantity of pollutants in the water and acceptable limits of National Standard and WHO

In comparing the quantity of pollutants in the water with the acceptable limits of National Standard and WHO, the selection of parameters and the determination of maximum allowable limits were computed and shown in Table 1 taking into consideration the WHO guidelines for domestic water quality.

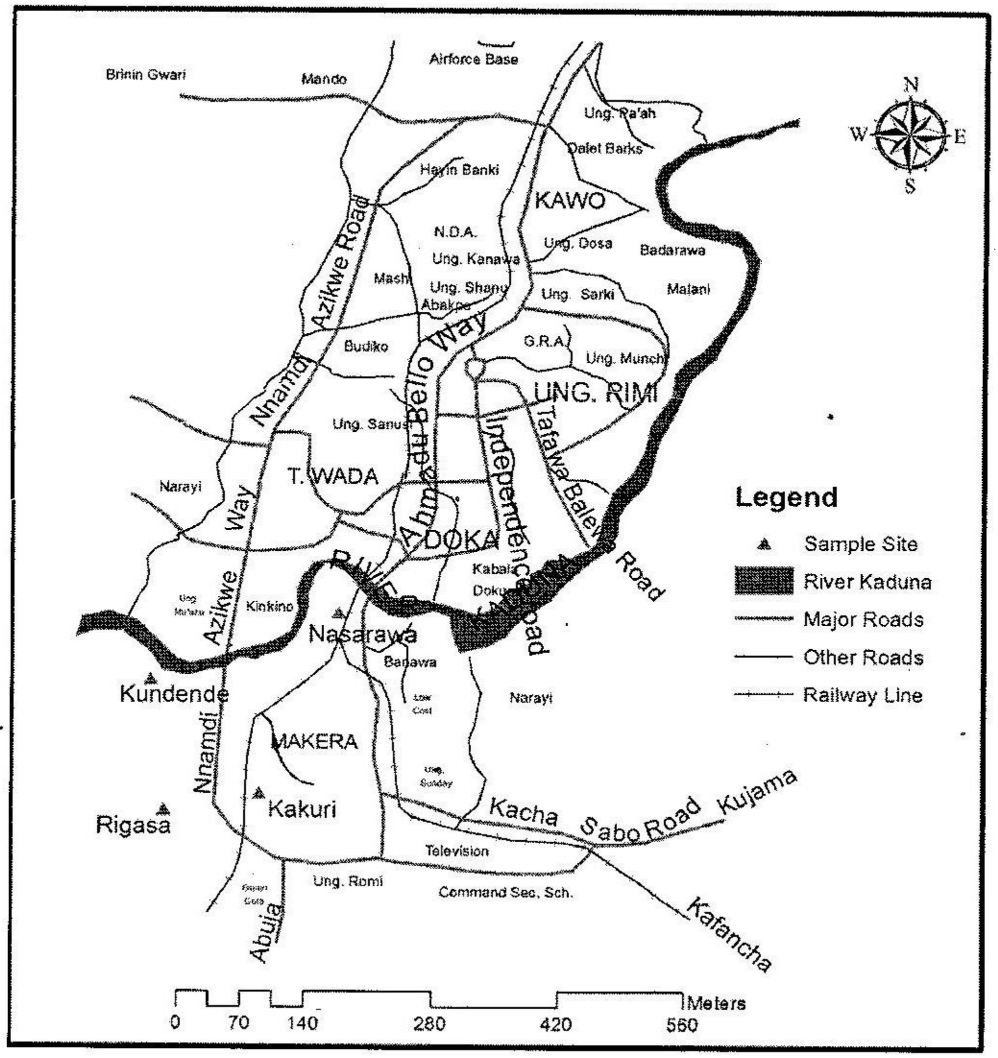

Figure 1. Map of Kaduna showing water sample collection site.

In comparing the quantity of pollutants in the water, certain parameters were considered based on WHO standard. The selection of parameters and the determination of maximum allowable limits were conducted by taking into consideration the WHO guidelines for domestic water quality. However, water of higher quality may be required for some special purposes such as renal dialysis and cleaning of contact lenses, or for certain purposes in food production and pharmaceutical use.

Water samples were collected from Kundende, Rigasa, Kakuri and Nasarawa. The laboratory test was conducted by Federal Ministry of Water Resources Regional Water Quality Laboratory Minna, Niger State, Nigeria. Bacteriological tests were used to determine if water is bacteriologically safe for human consumption. This was based on detection of coliform bacteria, a group of microorganisms recognized as indicators of pollution from human or animal wastes. Coliform bacteria are found in the intestinal tracts and faecal discharges of humans and all warm-blooded animals. Bacteriological test were performed on drinking water by contacting the local health department to obtain the specially prepared bottles and instructions for taking a water sample.

Chemical tests on calcium, magnesium, sodium, chloride, sulphate, nitrate, potassium, fluoride concentration in the samples were determined using an atomic absorption spectrophotometer (AAS) to identify impurities and other dissolved substances that affect water used for domestic purposes. Water begins to decrease in palatability when the amounts of minerals, that is, dissolved salts, exceed 500 to 1,000 ppm, but this depends on the nature of the minerals. Most testing laboratories report quantities of chemical substances by weight in volumetric units such as milligrams per litra (mg/L).

RESULTS AND DISCUSSION

Chemical related effluents discharged from the industry

Water samples collected at the downstream of discharge point were subject to analysis, the mean ± standard

Table 1. Comparison of the quantity of pollutants in the water with the acceptable limits of National Standard and WHO.

Parameter	WHO maximum permitted level	Kundende	Kakuri	Rigasa	Nasarawa
Temperature (°C)	23.5	29.7	29.6	29.7	28.8
Dissolved oxygen (mg/l)	10	0.42	0.46	0.43	0.43
Turbidity NTU	5	0.00	0.53	0.37	4.12
Conductivity (µS/cm)	1000	753	1025	1364	637
Total Dissolved Solid (mg/L)	500	638.5	686.8	913.9	426.8
pH	8.5	6.12	7.12	8.14	5.94
Fluoride (F) (mg/L)	1.5	0.51	0.27	0.74	0.20
Manganese (Mn^+) (mg/L)	0.2	0.00	0.066	0.022	0.084
Ammonia (NH_3) (mg/L)	NM	1.09	0.72	0.48	0.48
Nitrate (NO_3^{2-}) mg/L	50	4.83	3.12	2.08	2.08
Sulphate (SO_4^{2-}) (mg/L)	100	10	3	4	2
Nitrite (NO_2^-) (mg/L)	0.2	0.00	0.045	0.00	0.02
Sodium (Na^+) (mg/L)	200	43	27	29	32
Potassium (K^+) (mg/L)	200	24.7	6.03	6.03	10.05
Alkalinity (mg/L)	200	114	45	59	34
Calcium Hardness (mg/L)	150	195.2	84.07	101.1	92.08
Magnesium Hardness (mg/L)	150	76.07	249.2	359.3	70.06
Chloride (Cl^-) (mg/L)	250	98.96	136	215.9	95.47
Calcium (Ca_2^+) (mg/L)	200	78.22	33.69	40.15	36.91
Magnesium (Mg^{2+}) (mg/L)	0.20	18.56	60.81	87.67	17.09
Bicarbonate (HCO_3) (mg/L)		114	45	59	34
Carbonate (CO_3^2) (mg/L)	0	0.0	0.0	0.0	0.0
E. coli Cfu/100 mL	0	1	0	0	0

Source: Field work, 2014.

deviations of physicochemical parameters of the water samples are presented in Table 2. The pH mean value of the downstream was 6.87 while that of the treated effluent was 6.26. There was no significant difference between the treated effluent and the downstream sections ($p<0.05$) and all within Federal Ministry of Environment Nigeria (FMEnv) permissible limit of 6.5 - 8.5.

Higher values of total suspended solids (TSS) and turbidity were measured at the discharge point (10.60 mg/l and 50.17 NTU) and lower values (4.58 mg/l and 21.65 NTU; 4.58 mg/l and 21.67 NTU) were obtained for river Kaduna downstream. There were significant differences in values obtained at the discharge point ($P<0.05$) for both TSS and turbidity. The turbidity values obtained for all the sampled communities were higher than WHO standards of 5 NTU (WHO, 2004). Excessive turbidity in water can cause problem for water purification processes such as flocculation and filtration which may increase treatment cost. High turbid waters are associated with microbial contamination (DWAF, 1988). Again, turbidity causes decrease in photosynthesis process since turbidity precludes deep penetration of light in water (Muoghalu and Omocho, 2000). Ultimately, the water receiving body is disqualified as source of water for domestic use in the community.

Total dissolved solids (TDS) measured at the discharge point was 575.15 mg/l and the value was 75.72 mg/l, showing a corresponding reduction of about 13.2 and 13.1%. This reduction may be due to several physio-chemical reactions such as sedimentation, coagulation, fixation, amongst other factors like oxidation and precipitation (Wasserman et al., 2006).

There was significant difference at the sample point ($P>0.05$) but within the FMEnv limit. The highest mean value of total hydrocarbon (THC) obtained at the point of discharge (8.81 mg/l) indicates pollution traceable to oil and gas and may be due to seasonal effects as well as surface runoffs and flooding (Fatoki et al., 2001). However, results obtained reveal that effluent treatment plant is efficient at least with regards to total hydrocarbon content (THC) treatment. The electrical conductivity at the point of discharge was 1150.41 µS/cm. This decreased markedly to 151.50 µS/cm. This correlates with higher values of exchangeable ions estimated in effluent discharge sample. Dissolved ions are responsible for electrical conductivity.

However, the values measured for receiving water body were within the set limits. The dissolved oxygen (DO) concentration of treated effluent (4.18 mg/l) was observed to be lower than DO of the receiving water body. The lower value in treated effluent could be

Table 2. Level at which chemical related effluents discharged from the industry affect the quality of water.

Parameters	Effluent discharge	Downstream	P-value	FEPA
pH	6.2±0.04	6.87±0.01	P<0.05	6-9
Temperature (°C)	25.26±0.06	23.15±0.07	P>0.05	30
TSS (mg/l)	10.25, 10.95	4.25, 4.84		30
TDS (mg/l)	575.20, 575.10	75.53, 75.90		2000
Cond.(µS/cm)	1150, 41, 0.01	151.06, 151.80		
Turbidity(N/m)	50.10, 50.23	21.69, 21.64		
DO (mg/l)	4.17, 4.19	5.90, 5.6.05		20
BODs (mg/l)	16.22, 16.30	6.43, 6.45		10
CODs (mg/l)	58.73, 58.10	11.78, 11.38		30
TOC (mg/l)	6.26±0.00	1.39±0.23	P>0.05	NA
THC (mg/l)	8.81	2.85±0.04	P>0.05	10
Salinity (mg/l)	47.43, 40.00	47.43, 45.23		
Phenol (mg/l)	0.01±0.00	0.01±0.00	P<0.05	
Cyanide (mg/l)		0.01±0.00	P<0.050	
NH_4^+ (mg/L)	1.83±0.01	0.84±0.05	P>0.05	
NO_3^- (mg/L)	42.5, 48.1	0.23, 0.27		20
SO_2^{4-} (mg/L)	18.38, 18.45	6.34, 6.52		50
HCO_3^-	18.39, 18.34	1.12, 1.45		50
PO_3^{4-}	<0.01	<0.01		5.0
Total hardness	103.38, 103.41	37.67, 52.96	NA	

Source: Fieldwork, 2014. p>0.05 = Significant difference; P<0.05 = no significant difference FEPA = Federal Ministry of Environment; FEPA = Federal Environmental Protection Agency Guideline on Effluent Discharge 1991; N/A = not available; THC = total hydrocarbon content: TOC = total organic carbon.

attributed to the presence of degradable organic matter. Decrease in DO concentration could be attributable to breakdown of organic matter by aerobic microbes. The oxygen required for this process is taken from the surrounding water thus diminishing its total oxygen content. Odukuma and Okpokwasili (1993) reported that it may be partly due to the displacement of dissolved oxygen by dissolved solids within the effluent.

Conclusion and recommendation

A major serious source of pollution is the industrial effluent discharge by the industrial process into the water bodies. Industrial effluent consists of water with varieties of potentially harmful substances. The study revealed that water constituents in the selected communities are below the international standard of water quality. This implies that the ground and surface sources of water need to be treated before being consumed. It was concluded based on the objectives of this study that surface water in the study areas are substandard and therefore are not good for human consumption relative to the World International Standards for drinking water and similar to Simmons (1999) in Ajibade (2004) that concluded in his study that most rivers and lakes are recipients of many wastes. It is recommended that there is need to create public awareness in respect of the dangers associated with the consumption of sub-standard water; strengthen the existing water policy by ensuring adequate maintenance of water treatment plants.

Conflict of interests

The author(s) did not declare any conflict of interest.

REFERENCES

Ajibade LT (2004). Assessment of Water Quality along River Asa, Ilorin, Nigeria. Environmentalist 24:11-18.

Dix HM (1981). Environmental pollution. John Wiley & Sons, London, UK. James, D.J.G. and McDonald, J.J. (Eds.). Case studies in mathematical modelling. Stanley Thornes Publishers Ltd., Cheltenham, UK. pp. 15-17.

European Public Health Alliance (2009). Air, Water Pollution and Health Effects. Retrieved from http://www.epha.org/r/54

Odukuma LO, Okpokwasili GC (1993). Seasonal Influence on Inorganic Anion Monitoring of New Calabar River, Nigeria. Environ. Manage. 17 (4):491-496.

Simmons IG (1999), Earth, Air and Water Resources and Management in the late 20th Century, 8th edition, Edward Arnold, London

WHO(2004).www.who.int/water_sanitationhealth/publications/facts2004/en/index.html