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PHYSICO – CHEMICAL AND MICROBIAL ANALYSES OF RIVER KOGUM USE FOR DRINKING, SWIMMING AND IRRIGATION AT KAFANCHAN TOWN

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Abstract

The study examined the water quality of river Kagum with the view to establish the suitability of the river for drinking, swimming and irrigation purposes. The water samples were collected using Grab method from the river at six points. The water samples were analysed for Turbidity, Electrical Conductivity, Calcium, Chloride, Nitrate, Sulphate, and Bicarbonate Alkalinity. Total hardness, Total Dissolved Solids and Ammonia were determined using Standard method. Silica, Copper, Cobalt, Chromium, Iron, Lead and Manganese were determined using Atomic Absorption Spectrophotometer. Biological Oxygen Demand and Chemical Oxygen Demand were determined using Azide modification of Winkler's method. Temperature probe and pH meter for Temperatures and pH respectively. Bacteria count was determined using Chamber method. Results obtained from the laboratory analysis were compared with the permissive standards of World Health Organization (WHO). The results show that mostof the parameters observed were highly concentrated above the recommended permissible limit set by Who. This revealed that the Kagum River had become contaminated by the waste from the town, fertilizers from farms, vegetation decay and animal dung discharged into it. This makes the river not suitable for human uses. For sustainable management of the water resource, it is recommended thatJema'a Local Government Area should involve in sanitation programmes and propagate these through environmental education throughout the communities around the river catchments to prevent pollution of water bodies and consequent transmission of water-related diseases. Farmers should be assisted in fertilizer application by agricultural extension officers to avoid the incidence of high nutrient loads in surface waters.

Keywords: *Water Quality, Contamination, Domestic uses, Microbial and Coliform.*

Background to the Study

The continuous increase in human population and the demand for freshwater has become a major source of concern for many countries of the world particularly the developing countries (Don Mc Cuthean,Penner, Berston, and Adesiyin,Hinrichson (2003). To avoid the crisis, such countries must conserve water, pollute less, and manage supply and slow population growth. The state at which water exists, either as solid, liquid or gas in terms of quality, sometimes depends on human activities like agricultural practices, level of sanitation and such natural factors as the source of the water itself and its geological origin (Williams, 2007).Water quality is negated through pollution from factories, power plants, sewage treatment plants, underground coal mines, oil wells, runoff from farmlands and other sources (Williams, 2007).For polluted water to be made suitable for human consumption or use, the pollutants have to be removed through treatment (Manual of Instruction for Water Treatment Plant Operations, 2002). It further stated that the chemical, biological and physical qualities of water can interfere with its intended uses: whether it is for in-stream, commercial or developmental use, they all have their desired limits.

Kafanchan is mostly inhabited by farmers that are involved in both wet and dry season farming. The water for irrigation during the dry season comes from the river Kagum. The river also serves as a source for bathing, swimming, washing of household utensils, fishing for the communities around Kafanchan town. Eziashi (2000) noted that most surface waters in Nigeria have coliform counts of above 0 in 100millilitres of water. Therefore, the need for the assessment of the quality of our rivers becomes very necessary to enable them meet up the desired of World Health Organization Standard.

The Study Problem

Throughout the world the provision of safe drinking water and that meets in-stream and off-stream use standards are essential requirements. Standard Organization of Nigeria asserts that water quality for in-stream and off-stream uses should be free from microbiological, chemical and physical contamination. According to Hutton (2003), the basic requirements for drinking water are that should be free from pathogenic organism, containing no compounds that have an adverse effect or in the long terms on human health, low turbidity and little colour, have no compounds that cause an offensive taste or smell and not staining clothes washed in it .The inhabitant of the study area uses the river for farming. Herbicides, pesticides, chemical and organic fertilizers in agricultural practices are thereby certainly introducing chemicals into the water as a result of surface run-offs and leaching. Water from river used to irrigate farmlands washes soil particles and chemicals applied to crops back into the water bodies. Wastes from households, markets and other commercial activities are also discharged into the river, thereby polluting the river. The river is a source of drinking water for man and animals, bathing/swimming and irrigation. This places the inhabitants at the risk of using polluted water. Because of these uses, water quality analysis of the river is important to control infections that are water borne that can influence negatively human and animal populations. From the search of literatures, it shows that no attempt has however been made to assess the water quality of river Kagum for in-stream and off-stream uses. Therefore, an assessment of the quality for this study is quite necessary.

Aim and Objectives

The aim of the paper is to determine the extent to which the river Kogum meets the quality standard for in-stream and off-stream uses.
The specific objectives therefore are:

1. To identify the present in-stream and off-stream uses of river Kogum
2. To determine the water quality of the river Kogum
3. To investigate the suitability of the river for usefulness to human livelihood.

Literature Review

Water Quality Standards

Throughout the world the provision of safe water and water that meets commercial standards are essential requirements. Unfortunately, the process of analysing and monitoring a water supply can be costly and time consuming (Lund 2001).ELE International Ltd (2001), defined water quality by Physical, Chemical and Microbiological parameters while United State Environmental Protection Agency (2004), asserts that water quality standards are the foundation of the water quality – based control programme mandated by the clean water act, the electronic version of November of 27, 2002. Water quality standards define the goals for a water body by designating its uses and establishing provisions to protect water quality from pollutants. In biological or microbiological contamination micro-organisms are found in the water while in physical contamination, foreign bodies like wood, grass dissolved and solid soil particles are found in chemical contamination, the presence of dissolved toxic chemical like carbon and sulphates and others are common in the water.

According to Hutton (2003), the basic requirements for drinking water are that it should be free from pathogenic (disease causing) organism, containing no compounds that have an adverse effect, acute or in the long terms, on human health, fairly clear (i.e. low turbidity, little colour), not saline, containing no compounds that cause an offensive taste or smell and not causing corrosion or encrustation of the water supply system nor staining clothes washed in it or food cooked in it The expected water quality standard for a given body of water will therefore depend on its intended use. Thus, the water quality standard for drinking water will not be the same for that of recreation or other uses. The quality of water is not what is visible to the eye but those things the eye in its nakedness cannot see. This has made the use of the scientific method a necessity in water quality analysis this helps to monitor the health of the ecosystem and the entire environment. For water quality standard for drinking water references are made to the World Health Organization (WHO) standard for drinking water, Federal Environmental Agency (FEPA) and others.

Running water including streams and rivers, according to Miller (2004), recover rapidly from degradable oxygen – demanding wastes and excess heat on the stream pollutant load and water flow rate that could be affected by draught, damming or diversion for agricultural and industrial usages. The non – degradable wastes are left to accumulate or build up in the stream water. Adverse changes in water temperature can influence aquatic life and can cause complete migration. Lund (2001), observed that fish and wild fowls can tolerate slight changes in water temperature. For recreation, Lund (2001), recommended that the water temperature should not exceed 300c. The river is also used for swimming and bathing. Arms (2000) recommended coliform count for swimming to be 200 colonies per 100milliters.

The Study Area

River Kogum (locally call river Wonderful) is a tributary of River Gurara located at the Southwest of the Jos plateau. River Kogum took it source from the Jos plateau at the Kagoro pediment and flows through Kafanchan town, crosses Kafanchan-Abuja road and eventually discharges it water into river Gurara (Ishaya and Abaje, 2008). The river flows throughout the year but it volume reduces during the dry season and increases in volume during rainy season. KafanchanTown where the study was carried outis situated in Jema'a Local Government Area of Kaduna State, located between latitude 90 10' and 90 30'N and longitude 80 00' and 80 30'E. Kafanchan Town has a population of 278,735 (FRN, 2006). It has four wards, namely: Maigizo, Kafanchan 'A', Kafanchan 'B', and Takau (Ishaya and Abaje, 2008). The area has a climate with two distinct seasons, a wet season and a dry Season. Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1800 mm, and the mean monthly temperature is 250C, while the relative humidity is about 62%. The main type of soil is the Ferruginous tropical soil which is related to the climate, vegetation and the topography of the area. The relief is relatively flat and undulating and it influences the drainage pattern of the area (Ishaya and Abaje, 2008).

Methodology

The data for the study were obtained from the analysis of the selected water parameters: these include: pH, temperature, total suspended solid, turbidity, dissolved solid, chlorine, sulphate, nitrate, iron, magnesium BOD, COD, Coliform count, total hardness, calcium and lead. The water samples were collected using Grab method from the river wonderful at six points. The first sample was collected at the waterfall point upstream and the remaining five samples were collected downstream at a distance of two kilometres each. The water samples were collected using 25litres plastic containers and each sample was labelled. The samples were taken to National Water Instituted Mando Kaduna within one hour for analysis. All samples were stored in an ice box at 40c and transported immediately to the Kaduna State Water Board (KSWB) for analysis.

The water samples were analysed for Turbidity using a HACH 2100 P Turbid meter. Electrical Conductivity was determined with Cybersan 510 conductivity meter. Calcium was determined using EDTA titration. Chloride was determined with Argent metric titration. Nitrate was determined using Dionex-80 ion analyser, Sulphate, Bicarbonate and Alkalinity was determined with strong acid titration method. Total hardness, Total Dissolved Solids and Ammonia were determined using Standard method. Silica, Copper, Cobalt, Chromium, Iron, Lead and Manganese were determined using Atomic Absorption Spectrophotometer. Biological Oxygen Demand and Chemical Oxygen Demand were determined using Azide modification of Winkler's method. Temperatures and pH of the water samples were taken in-situ using a temperature probe and portable pH meter respectively. The bacteria count was determined using Heber chamber method .For the In-stream and Off-stream, one set of structured questionnaire was designed to source information from the farmers, fishermen and other users of the river Kagum for In-stream and Off-Stream uses. Variables on which data were collected include the respondent's characteristic, the activities spectrum of the communities and the possible problem(s) encounter at when using the water.

One hundred and fifty (150) copies of the questionnaire were administered to the benefiting communities as follows: 39 to Bakin Kogi, 35 to Aduan 1, 40 to aduan 2 and 36 to an

The descriptive statistical analysis involved the use of table and percentages were used for the study.

Results

Respondents Usage of River Kagum

The section explains the respondent's usage of river Kagum. The results of the data collected from questionnaire show that 34.67% of the respondents use the river for bathing and washing, 10.67% of the respondents use the river for irrigation farming, 10% of the respondents use it for feeding their animal, 6.66% of the respondents use it for building and molding of blocks and 3.33% of the respondents use the river for drinking. The study proof that the river serve as source of washing, bathing, irrigation, feeding of animals, building, molding of blocks and drinking. These uses were observed where the river flow is very close to the river

Table 1: Respondent’s uses of river Kagum.

Uses of River Kagum	No. of Respondents	Percentage
Drinking	05	3.33
Bathing	52	34.67
Washing	52	34.67
Industrial Activities	0	0.00
Irrigation	16	10.67
Building/Block making	10	6.66
Feeding of Animal	15	10.00
Total	150	100

Physical-chemical parameters of Water Sample of Kagum River
From the dry season and the rainy season results on table 1 and 2, the river water was found to be acidic. The pH of the river was at the range of 6.4 – 6.8 even at upstream against the WHO stipulated standard of 6.5 – 8.5 for drinking and domestic purposes

The water temperatures during the dry and wet season ranged from 210c to 23oC respectively. These values are within the temperature ranges of WHO standard of 300c.
Turbidity values of the river during the dry season ranges from 21.5NTU to 49.4 NTU while that of the rainy season remain constant from 21.1NTU upstream to 11.5NTU downstream. These values grossly exceeded the acceptable limit of WHO standard of 0-5NTU. This results show that the river Kagum was highly turbid.
Total Dissolved Solids values ranged from 80mg/l to 180mg/l in the dry season and 80mg/l at the point A and B upstream and drastically reduced to 40mg/l at point C and D downstream at the rainy season. These values were high compared with WHO guideline value of 40mg/1.

Colour is an important physical property of water because of its implications for water supply, and the need to reduce it to acceptable levels by water treatment is highly recommended. Increase in the colour of water in reservoirs results in increases in treatment cost. Colour varied between 78.9–107 Hz. These values are above 15 Hz which is WHO recommended limit for no risk. Colour in natural water usually results from the leaching of organic materials and is primarily the result of dissolved and colloidal humus substances, primarily humic and fulvic acids. Colour is also strongly influenced by the presence of iron and other metals, either as natural impurities or as corrosion products. Highly coloured water may be due to decaying vegetation.

The results shown in Table 1 and 2 indicate that the river Kagum water is highly hard. The values obtained in the water samples at dry season and rainy season were high above the standard limit of WHO of 0.1mg/l and 0,20mg/l of calcium and magnesium respectively. In the dry season samples of CA+, the values range between 0.30mg/l – 1.95mg/l and rainy season the values ranges from 0.3mg/l – 1.95mg/l. For ma+, the dry season values range from 0.30mg/l – 8.94mg/l and 0.49mg/l – 1-70mg/l. The results indicate that the values obtained are above the permissible limit of WHO standard. Based on water hardness classification by Kunin (2002), the hardness is a function of the geology of the area with which the surface water is associated.

The results of Sulphite, Ammonia and Chlorine water samples were observed to be high above the permissible of WHO (table 1 and 2) in both the dry and rainy season. The values of the dry season samples ranged from 7.09mg/l – 24.87mg/l, 1.2mg/l – 2.4mg/l and 7.09 – 28.36mg/l for Sulphate, Ammonia and Chlorine respectively. For the rainy season, the values of Sulphate ranged from 20.1mg/l – 65.0mg/l, Ammonia ranged from 1.2mg/l – 2.5mg/l and 7.09mg/l – 28.36mg/l for Chlorine. This indicates that a large quantity of fertilizer and animal wastes discharge into the river that pollutes it.

The COD and BOD of the water samples of the river were observed to be higher than the acceptable limit of the WHO standard of 40mg/l and 10mg/l respectively. The values of these parameters as observed during the dry season ranged from 120mg/l – 292mg/l of COD and 3mg/l – 15mg/l of BOD. The rainy season values of the parameters ranged from 92mg/l – 142mg/l of COD and 2mg/l – 6mg/l of BOD.

Trace metal Parameters of Water Sample of River Kagum

The concentrations of Iron (Fe) in the water samples of the dry season ranged from 0.45mg/l to 3.617mg/l and that of the rainy season ranged from 0.841mg/l – 9.931mg/l. the results show that all the water sample points exceeded the acceptable level of WHO of 0.3 mgl/1. The levels of Lead in the dry season water samples of river Kagum varied between 0.044mg/l – 0.29mg/l and the rainy season value ranged from 0.20mg/l – 0.85mg/l. All the level obtained indicates that the river values of Lead is higher above the acceptable limit of WHO guideline for domestic water supply of 0.01mgl/1, hence, adverse effects from domestic use are expected.

Microbial water quality of River Kagum

The results obtained for the microbial analysis are shown in Fig.1 and 2. The values of the coliforms both in the dry and the rainy reasons are higher than the acceptable limit of WHO standard of the values obtained in the dry season ranged from 76mg/l – 299mg/l and the rainy season values ranged from 120mg/l – 279mg/l. Historical data indicated that the microbial water quality of the river Kagum is poor.

Table 1: Results of the Dry Season Surface Water Sample of River Kagum

PARAMETERS	A1	A2	B1	B2	B3	WHO STANDARD
pH	6.8	7.1	6.9	6.8	6.4	6.5 – 8.5
Temperature	21	21	21	21	21	30^0c
Colour	246.0	142.0	206.0	243.0	243.0	15
Turbidity	21.5	21.5	21.5	24.1	49.4	0 – 5
Total Dissolved Solids	160	80.0	160	90	120	40
Suspended Solid	320	51	290	250	315	30
Sulphate	7.09	7.09	7.09	7.09	24.87	0.5
Nitrate	4.01	3.21	3.21	2.40	34.00	50
Ammonia	1.22	2.2	2.3	2.3	2.4	0.5
Chlorine	7.09	7.09	7.09	7.09	28.36	0.2
Calcium	0.50	1.95	0.50	0.30	1.60	0.1
Magnesium	1.95	8.94	1.70	1.55	3.00	0.20
Iron	3.617	0.078	3.224	0.451	ND	0.3
Lead	0.044	0.0780	0.075	0.29	ND	0.01
COD	120	224	292	253	142	40
BOD	4	3	9	15	8	10
Coliform	284	76	216	297	299	200

Table 2: Results of the Rainy Season surface water samples of river Kagum

PARAMETERS	A1	A2	B1	B2	B3	WHO STANDARD
pH	7.1	6.8	6.8	6.8	6.8	6.5 – 8.5
Temperature	23	23	23	23	23	30^0c
Colour	550	550	451	550	550	15
Turbidity mg/l	21.1	12.1	12.1	11.5	12.0	0 – 5
Total Dissolved Solids	80.0	80.0	40.0	40.0	40.0	40
Suspended Solid	0.025	0.04	0.130	0.060	0.25	30
Sulphate	20.1	40.0	65.0	32.0	29.0	0.5
Nitrate	1.0	1.0	3.0	1.1	1.2	50
Ammonia	1.2	2.2	2.3	2.3	2.4	0.5
Chlorine	7.09	7.09	7.09	7.09	28.36	0.2
Ca^2+ Hardness	0.50	1.95	0.50	0.30	1.60	0.1
Mg^2+ Hardness	1.22	1.70	0.73	0.49	1.46	0.20
Iron	3.532	0.841	9.931	1.025	2.410	0.3
Lead	0.36	0.85	0.061	0.025	0.69	0.01
COD	92	105	107	140	142	40
BOD	2	3	5	6	6	10
Coliform	200	110	120	263	274	200

Discussion of Findings

Based on the results, the pH of the river water would adversely affect its use for domestic and recreational purposes, and the aquatic ecosystem. The well buffered nature of the river water can be attributed to the fact that, normally, running waters are influenced by the nature of deposits over which they flow (Williams, 2007). It was observed that river Kagum was highly turbid. Soil erosion and runoff from the catchments could be the source of high turbidity in the river water. The excessive turbidity in water causes problems with water purification processes such as flocculation and filtration, which may increase treatment cost (Williams, 2007). Elevated turbid water is often associated with the possibility of micro-biological contamination as high turbidity makes it difficult to disinfect water properly (Eziashi, 2000). The levels of turbidity recorded in this study were much higher than those reported by Eziashi, (2000).

As observed in the results (tabe 1 and 2), river Kagum has high Total Dissolved Solid which make river not suitable for drinking. According to McCutheon et al. (2003), the palatability of water with TDS level less than 40mg/l is generally considered to be good whereas water with TDS greater than 40mg/l becomes increasingly unpalatable. The research find out that river Kagum content a high concentration of Sulphite, Ammonia and Chlorine. It is apparent that the dominance of these parameters could be due to the large amount of domestic wastes being discharged into the river waters. Studies conducted by Mc Cutheon et al. (2003) on characteristics of fresh water and coastal ecosystems in Ghana also confirmed similar observation. The results of trace metal analysis in the water are presented in Table 3. Trace metals have been referred to as common pollutants, which are widely distributed in the environment with sources mainly from the weathering of minerals and soils (Mc Cutheon et al. 2003). However, the level of these metals in the environment has increased tremendously in the past decades as a result of inputs from human activities (McCutheon et al. 2003).

Total and faecal coliforms pollution was widespread, and the entire river basin as sampled is not suitable for domestic use without treatment. For agricultural purposes there is a possibility of contamination from vegetables and other crops eaten in their raw state. The results suggest that the general sanitary qualities of the water source, as indicated by total coliforms counts, were unacceptable. For water to be considered as no risk to human health, the faecal coliforms counts/100 ml should be zero (WHO, 2000). These results have indicated faecal pollution of the water sources, and imply that these water sources pose a serious health risk to consumers. The poor microbiological quality might be due to contamination caused by human activities and livestock. It is a common practice for people living along the river catchment to discharge their domestic and agricultural wastes as well as human excreta/wastes into rivers. In addition to using the river as a source of drinking water people use the source for bathing, washing of clothes and for recreational purposes such as swimming. Wild and domestic animals seeking drinking water can also contaminate the water through direct defecation and urination. The microbial count was higher in well water close to refuse disposal site as compared to well water far away but both microbial counts are lower than that of river water. Generally, underground water is believed to be the purest known (WHO, 2000) () because of the purification properties of the soil however, it can also be contaminated. Groundwater are found to be contaminated due to improper construction, shallowness, animal wastes, proximity to toilet facilities, sewage, refuse dump sites, and various human activities around the well (Bitton, 1994). The presumed reason for contamination of well water accounts for why the microbial load of well water close to refuse disposal site have higher microbial count than the one far away from refuse disposal site. Environmental Protection Agency (EPA) establishes heterotrophic plate count as a primary standard, which are based on health considerations. Accordingly, the total coliform count for all samples were exceedingly high the WHO maximum contamination level (MCL) for coliform bacteria in drinking water of zero total coliform per 100ml of water (EPA, 2003). The high coliform count obtained in the samples may be an indication that the water sources are fiscally contaminated (EPA, 2003). None of the water samples complies with WHO standard for coliform in water. According to WHO standard, every water sample that has coliform must be analysed for either fiscal coliforms or E. coli (EPA, 2003) with a view to ascertaining contamination with human or animal waste and possibly pathogenic bacteria or organism, such as Guardia and Cryptosporidium may be present (EPA, 2003).

Conclusion/Recommendation

The findings show that effluents from pesticides, fertilizers, domestic and sewage is highly loaded with contaminant that pose an environmental risk to the receiving river Kagum. Hence, the water borne diseases are due to improper disposal of refuse, contamination of water by sewage, surface runoff, therefore programmes must be organized to educate the general populace on the proper disposal of refuse, treatment of sewage and the need to purify our water to make it fit for drinking because the associable organisms are of public health significance being implicated in one form of infection or the other.

River Kagum is used for a variety of purposes such as drinking, fishing, irrigation and other domestic purposes without prior treatment. For sustainable management of the water resource, the inhabitant of Kafanchan should evolve sanitation programmes and propagate these through environmental education throughout the communities in the river catchments to prevent pollution of water bodies and consequent transmission of water-related diseases. Farmers should be assisted in fertilizer application by agricultural extension officers of the Ministry of Food and Agriculture to avoid the incidence of high nutrient loads in surface waters. Since farmers in the basin use considerable volumes of pesticides, nematicides, fungicides and herbicides to control a variety of pests and diseases, pesticide, residue analysis must be carried out to enhance better management of these agrochemicals.

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