ANALYSIS OF THE QUALITY 0F KURAFE RIVER WATER IN NASARAWA STATE NIGERIA

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Abstract

A total number of forty water samples were collected and analyzed for the physical, chemical and environmental impact assessment drainage system (Kurafe Rivers) within the study area (Nasarawa town) from the result of the chemical analyses the cations concentration are in the order of $Ca^{2+} > Mg^{2+} >$Na while that of anions are in order $Hco_3 > So4^{2+}$ > cl-. The concentration of heavy metals (Cd, Cu, Mm N, Pb, Zn, Al, Cr, Fe) were determined in the water of river Kurafe, using Agua Regia Extraction analysis. The concentration of metals in the soil samples ranges as follows (in ppm): Cd (0.05 – trace), Cu (1-8), Mn (12 -60) N_1 (Trace – 0.05), Pb (0.5 -8), Zn (0.05 – 8.00), Al (0.65 – 2.50) in %, Cr (8 – 23); Fe (0.2 – 8.73) in %, the degree of metal concentration is compare with a control sample showing slight increase from the control joint, except for some metal. The geo accumulation index order for the water is Fe> Cu > Zn > Pb > Mn > Cr > Al > Cd > N_1 > Sn, significant positive correlation was observed between and among heavy metals. Evaluation of the chemical analysis results revealed that there is subsurface transportation of contaminants from the waste into the river and shallow aquifers. The major contaminants identified are No_3^{-r}, turbidity, Ni and Cd. The high conductivity and TDS values recorded in some location indicates surface water pollution or contamination and due to the level of contamination the water is uncertified for domestic uses, on the other hand, the water is good for irrigation purpose. It is therefore strongly recommended that refuse dump, and mechanical workshop effluent should not be overlooked before their discharge into the river Kurafe.

Introduction

The ever increasing number of people that have no access to safe, clean water and good sanitary services continue to be a matter of great concern to the World Health Organization (WHO).The development of water resources was more or less relatively limited to bigger cities and metropolis while the major sources of water supply for the rural populace are hand dug well and streams. The majority of which are highly more reliable during the rainy seasons.

In the recent past, effort has been geared towards assessment, exploration and exploitation of water resources in Nigeria by agencies such as Directorate of Food Road and Rural Infrastructure (DFFRI), National Rural Water Scheme (NRWS scheme), Petroleum Trust Fund (PTF-Assisted) water projects, most of these projects/programmed focused only on exploration and exploitation of the groundwater. Information with respect to water resources quality is generally lacking. A complete appraisal of available water in any area is commonly accomplished when aspects of the water quality are included (Techobanoglus

et.al., 1977; Mark et al 1980; Adelekan and Sangodoyin 1987; Amusa 1993; Abua 1996; Singh and Hasnain 1999; Onianwa and Fakayode 2000; WHO, 2004).

A recent survey by World Health Organization (2004) revealed that, in developing countries in 1970, only 40% of the people in rural area had access to safe water supplies. The prevalence of water-borne diseases is therefore the end results of water supply sanitation. Diarrhea is endemic throughout the developing countries and is the major courses of infant mortality. Cholera, typhoid fever and different intestinal parasites also affects hundred of million of people. Studies estimate that the provision of safe water and basic sanitation will reduce the incidence of diarrhea by 50%, Cholera by 90%, sleeping sickness 80% and guinea worm infection by 100% (Mark et al 1980; Amusa 1993; Abua 1996; Singh and Hasnain 1999; WHO, 2004).

The unsanitary conditions due to indiscriminate disposal of untreated domestic effluents in the city, town and villages have created an untold environmental nuisance in developing countries of the world. Human activities as a result of pollution have degraded aesthetic integrity of environment and have invariably exposed the lives of people living in such vicinity to serious health hazards. These areas are heavily polluted, creating an ecological distress.

Polluted streams by industrial effluents has seen studied at different times and places by several (Klien, 1967; Adoni, 1975; Trivedig 1980; Oluwande et al, 1983; Malle, 1990; Agarwal (1983). Adepelumi et al (2001) studied groundwater contamination in basement complex areas with respect to distribution and concentrations of chromium (Cr), Cadmium (Cd), Lead (Pb), Zinc (Zn), and Copper (Cu) issuing from sewage disposal. The impacts of heavy metals on plants, animals and man have been investigated (Doudoroff and Katz, 1973). The toxicity of various salts of zinc on a number of fish species have been demonstrated (Mckee and Wolf, 1973; Pikering and Henderson, 1974) and found out that they have effects on the health of those that consume them.

In the recent time, it is clearly noticed that the number of people visiting hospital in Nasarawa town, has increased as a result of water-borne diseases, which they contracted through the use of unhygienic water from different sources especially river kurafe, which flows from the South Eastern part to North Western part of the town joining River Benue tributaries. In this respect the hospital management board and resident doctors confirmed that they treated patients with typhoid fever, diahorea, stomach constipation, skin rashes and ring worm.

Statement of Problem

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The unsanitary conditions due to indiscriminate disposal of untreated domestic effluents from the surrounding area and adjacent village have been creating an untold environmental nuisance. Pollutants from the river area degrade the aesthetic integrity of environment and have invariably exposed the lives of people living in such vicinity to serious health hazards. These areas are heavily polluted, creating an ecological distress. The discharge from their domestic water related activities and raw effluents from the micro industries such as rice mill flow into the river. Yet people are using the water from the river for domestic activities like washing, cooking and drinking purposes.

The first modern water supply scheme in Nasarawa became fully operational in 1981 when the construction of the Tammah reservoirs on River Kurafe was completed. Despite this, there is still the problem of inadequate pipe-borne water supply, which has led to the reliance of some household in Nasarawa on surface water and hand-dug wells.

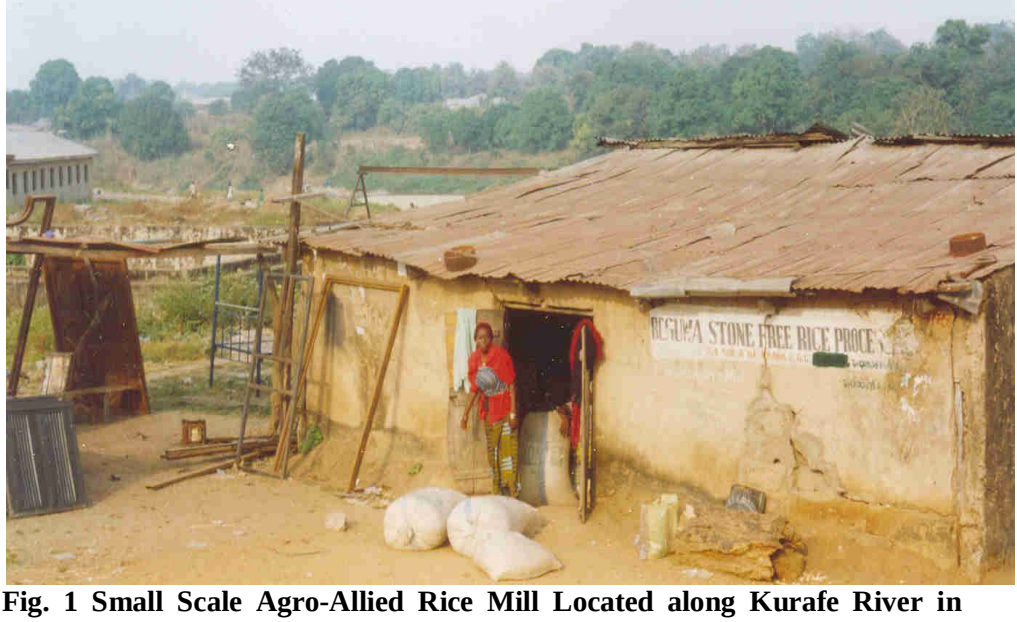

Fig. 1 Small Scale Agro-Allied Rice Mill Located along Kurafe River in Nasarawa Town

Fig. 2. Sand Escavation Along Kurafe River in Nasarawa Town

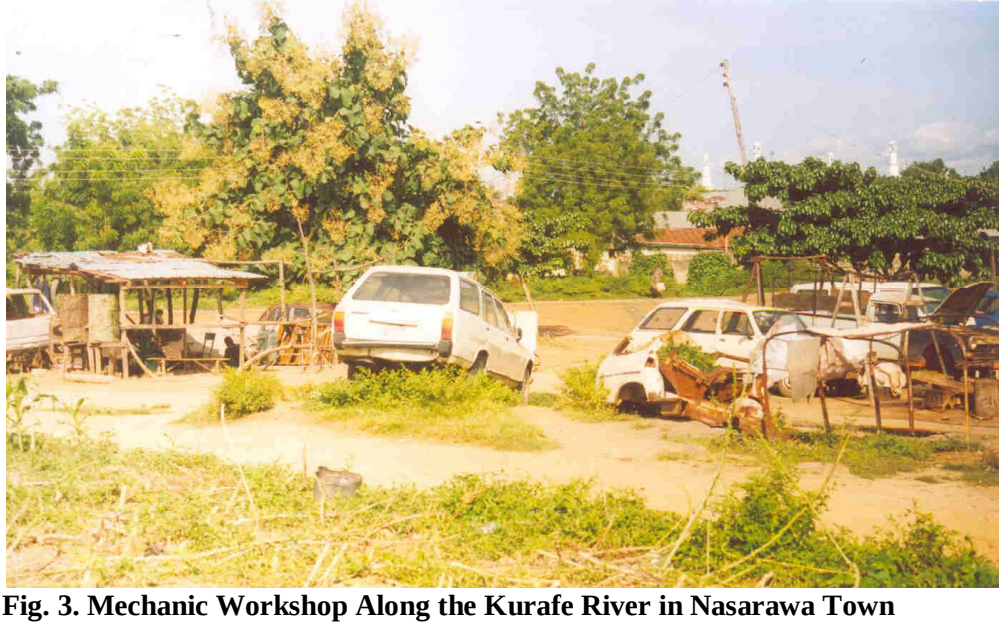

Fig. 3. Mechanic Workshop Along the Kurafe River in Nasarawa Town

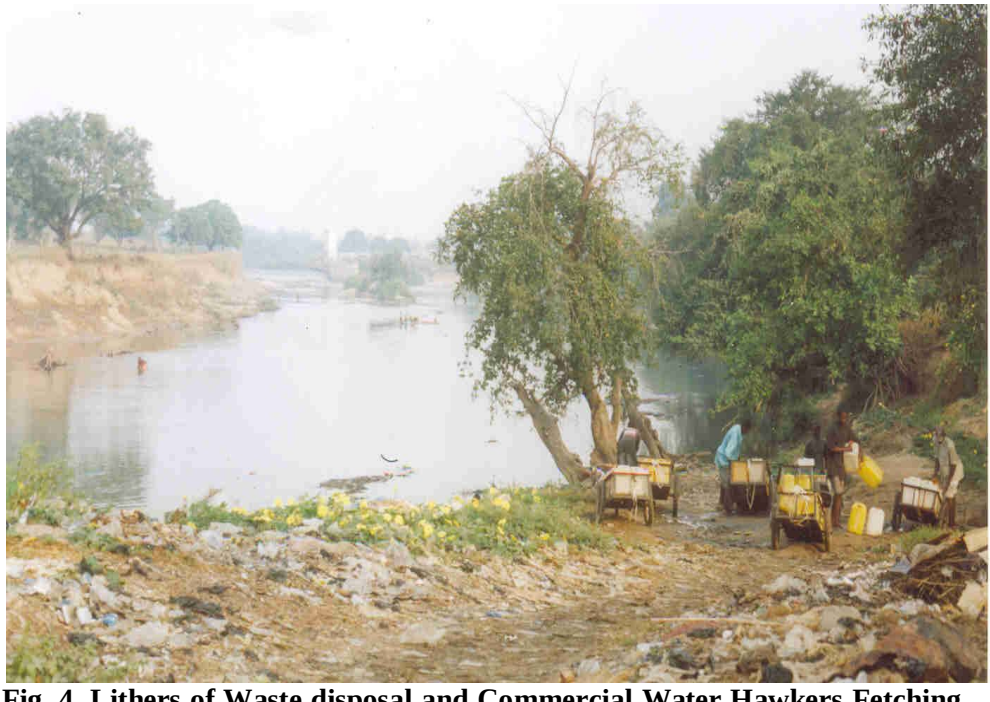

Fig. 4. Lithers of Waste disposal and Commercial Water Hawkers Fetching Water from River Kurafe

However, the increase in the urbanization, population and lack of regular pipe-borne water has made rive Kurafe a refuge and survival rest for the majority of people in Nasarawa town. The refuse dumping in the town cannot be organized and well manage, resulting in health and environmental hazards. Thus, the focus of this research work is to determine the chemical components and quality of water from river Kurafe in Nasarawa town and also to establish the level of environmental contamination or pollution as related to bad sanitary practices and waste disposal within the town.

Aim and Objectives

The purpose of this investigation is essentially to establish the chemical composition and toxicity level of the river water, the degree of river pollution and the effects on the inhabitants living in the study areas. To achieve the above aim the following objectives have been set:

1. Assessing the hydro chemical character and quality of river water within Nasarawa town
2. Establish the level of environmental contamination or pollution as related to sanitary practices within the town.
3. Establishing a benchmark from the results with which to predict likelihood health hazards.
4. to come up with the recommendation that will help in solving pollution problems and improving the quality of water.

Method

Nasarawa, the study area is located south west of Nasarawa State, bounded by latitude 7^0 50' and 9^0 30'N and longitude 6^0 50' and 9^0 45'E and shares boundaries with Keffi and Karu Local Government Areas to the north, Toto on the south west, Benue State on the south and Doma Local Government Area stands on its eastern border. The population of the study area as projected from 1991 to 1999 is put at 90,898; its landmass is about 5743.84 square kilometer having a population density of 16.

Water samples were collected in the month of February during the pick of dry season. A total number of 40 water samples were collected for hydrochemical analysis of drainage system within the study area (Nasarawa Town) Sample were collected in 2 litres plastic containers which are adequately washed and rinsed for sampling. About 1 litre of each of the samples collected was filtered and the volumes were used for the analysis of cation with acidified (HNO3) to prevent the metal from adhering to the wall of containers. For further preservation purposes, the entire samples collected were refrigerated before eventual analysis. The sampling points are the bathing area, washing area, waste disposal, agro-factory and mechanic workshop areas. And a control point was located 1000metres away from the areas of human activities.

All the analyses were evaluated in the laboratory in lieu to American Public Health Association (1989) standard methods for examination of water and soils. The physio-chemical properties analyzed are: Conductivity, total dissolved solid; total suspend solids; turbidity; Cl^-, So_2^{-4}, Co_2^{-3} HCo^{-3} $N0^{-3}$, Po_2^{-4} oil and grease, total organic carbon, Pb^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Na^+, CA^{2+}, Mg^{2+}, K^+, Mn^{2+} and Zn^{2+} constituents were determined. The determination of each parameter in the water samples follows the same procedure.

Table 1.0: Acceptable Standard for Major Substances

Substance	Undesirable effect	Highest desirable level	Maximum Permissible level
Copper	Astringent taste, corrosion of pipe, fittings and utensils	0.05mg/l	1.5mg/l
Iron (Fe)	Taste discoloration; and growth of iron bacteria; turbidity	0.1mg/l	1.0mg/l
Magnessium (Mg)	Hardness, taste gastrointestinal irritation in the presence of Sulfate	> 30mg/l	150mg/l
Manganese (Mn)	Taste; discoloration	0.05mg/l	0.5mg/l
Zinc (Zn)	Astringent taste; opalescence	5.0mg/l	15mg/l
Total Hardness	Excessive scale formation	2mEq/^{ab} (100mg/$CaCo_3$)	10mEq/^{ab} (100mg/$CaCo_3$)
Calcium	Excessive scale formation	75mg/l	200mg/l
Lead (Pb)	Plumbism; Highly toxic	-	0.05mg/l
Arsenic (As)	Human Cancer	-	0.01mg/l
Cadmium (Cd)	It affects metabolism	-	TJV 0.0Mg/l
Silver (Ag)	Upon chronic ingestion causes	-	MAC 50Mg/l

WHO, (2004) Acceptable standard

Results and Discussion

In other to determine the quality of the water of the river, control point is created away from the human intervention and this control point is situated at the upper stream of the river, which is 1000 meters away from the point of domestic activities on the water body of Kurafe river. Beside this control point results of samples were also compared with set standards by WHO.

Physiochemical Analysis of Kurafe River

As mentioned above, various physio – chemical parameters are discussed in this chapter and they are: -

Temperature (0^0C).

The temperature of the used or polluted water varies from 24^0C to 27^0C with waste disposal area having 27^0C and the control point is having the temperature of 24^0C. (Table 4.1).

pH: The mean pH of the used water falls to the level of alkalinity because of domestic activities carried out along the river channel, made use of soap and detergent, which made the water to be amorphous and milky with the released of

$Na^{+}Co_3^{-}$ ion and $CaHCo_3^{-}$ into the water body, control site has pH of 7.8 which is almost neutral, while pH of Agro factory area is 11.0, which is the highest, followed by mechanic workshop area (10.7), waste disposal 9.0 and washing/bathing area has a mean pH of 8.7 respectively (Table 4.1).
Based on Ezeigbo (1989) classification the analysed water of Kurafe river in Nasarawa town is alkaline in nature. The value is not within the range stipulated by World Health Organization standard of drinking water (see Table 4.0).

Total Dissolved Solid (mg/1^{-1}): The average amount of Total Dissolved Solid varies from 800 in the control area to 13,200 in the waste disposal area (Table 4.1).

This means that waste disposal area has the highest level of total solid pollutant, which is injurious to health (World Health Standard 2004).

Conductivity: the electric conductivity of the various elements in the used water at different point of define activities, varies from 0.13 (control point) to 4.04 (waste disposal) with washing area having (2.45); bathing (2.65) etc. which means that the leachate of the sewage area involves in a lot of anaerobic chemical reaction. The values recorded were below the World Health Organisation limit for drinking water.

Biochemical Oxygen Demand (BOD): This is very high with river water that got in contact with the leachate of water disposal dump site. The amount of BOD at this point is 564.5, followed by bathing area (502) and washing (500) area of the river. Control point has 0.5 (Table 2), which makes the area less polluted. In some area, their concentration were below permissible level (e.g. the control area)

Chemical Oxygen Demand (COD): The river water that has a contact with the agro factory has 1300 COD, waste disposal has 5060 COD, mechanical area has 3820, washing/bathing has 602 and lastly control area has 0.72 COD. From these results it is assumed that the rate of pollution is very high at two points along the river channel, these areas are: the dump site area that have contact with the river and the mechanic area, that dispose various petrol-chemical matter into the river (Table 2).

Oxygen Demand (DO): In regards to various domestic and industrial activities along the river Kurafe the amount of oxygenated water is very low, however, mechanic area recorded the least DO which is 1.37 and control point.

Table 2: Physical Analysis of Kurafe River In Nasarawa Town

L oc. Pt.	Te mp oC	Ph	Tot. TDS mg/I^{-1}	Hardne ss mg/I	Gr s Kg	Tur. NTV	Cond . os/c m	BODs mg^{0}2/I^{-1}	COD mg02/I^{-1}	DO mg02/I^{-1}
Washing area	24	8.7	1326	300	40 7	66	2.45	500	602	2.11
Bathing area	24	8.7	1320	278	28 2	48	2.65	502	602	2.11
Waste Disposal	27	9	1320 0	382	12 67	25	4.04	564.5	5060	2.36
Agro Fac.	26	11	8025	146	77 0	23	3.2	400.7	1300	1.98
Mech. Point	26	10.7	1240	125	12 11	37	1.69	436.6	3820	1.37
Control Point	24	7.8	800	102	22	3	0.13	0.5	0.72	2.08
WHO STD. 2004	-	6.9 - 9.26.	500	500	-	10	-	-	-	-

Table 3 Chemical Properties of Anion in Kurafe River Nasarawa Town

L oc. Pt.	Mg mg/I	P mg/I	Na mg/I	K mg/I	Mn mg/I	AI mg/I	Ca mg/I
Washing area	2.52	3.18	2.1	3.7	0.28	0.2	0.02
Bathing area	2.33	2.45	2.2	3.7	0.21	0.2	0.02
Waste Disposal	3.42	7.19	4.2	4.2	0.35	1.92	0.05
Agro Fac.	2.38	11.34	3.7	3.8	0.32	1.8	0.11
Mech. Point	0.23	0.45	3.4	4.4	0.01	2.11	0.08
Control point.	6	0.61	1.7	3.5	0.61	N.D.	19.2
WHO STD. 2004	150	0.5	200		0.05	-	200
FEPA STD.							

Table 4 Chemical Properties of Metals and Heavy Metals In Kurafe River, Nasarawa Town

L oc. Pt.	Fe mg/I	Cu mg/I	Pb mg/I	Zn mg/I	Chromiu n.mg/I	Cad. mg/I	Nic. mg/I	Hg. mg/I	Ti mg/I	U mg/I	Mo mg/I	Sb mg/I	S mg/I
Washing area	3.32	2	0.08	0.12	0.002	0.001	N.D.	N.D.	0.037	0.07	0.01	N.D.	2
Bathing area	3.32	0.18	0.08	0.11	N.D.	N.D.	N.D.	N.D.	0.038	0.07	0.01	N.D.	2
Waste Disposal	3.85	0.3	5.2	0.22	0.038	0.013	0.022	0.005	0.113	0.1	0.077	0.139	18.23
Agro Fac.	3.4	0.05	0.15	0.12	0.001	0.001	0.001	N.D.	0.097	0.05	0.017	0.06	10
Mech. Point	4.8	0.22	3.9	0.14	0.036	0.013	0.019	N.D.	0.136	0.35	0.15	0.074	6.458
Control Point	3.1	0.02	0.01	0.08	N.D.	N.D.	N.D.	N.D.	N.D.	0.023	N.D.	0.14	0.11
WHO STD. 1984	0.3	-	0.05	5	0.01	0.01	0.1	0.01	0.01	0.01	0.5	0.01	-
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With highest, which is 2.08 (Table 2). The amount recorded in all the area is less than the permissible amount for any drinkable water (WHO, 2004). Therefore the water is not fit for human consumption.

Hardness: The hardness in term of Ca and Mg ranges between 4.99 and 35.5 mg/1(see Table 2). Based on the classification scheme used by Heath (1987). Hardness of water is determined by the amount of $Ca^{2+}HCo_3^{--}$ in the water and this is called "Alum". Water leachate of waste disposal area of the river has the highest Hardness of 382, washing area 300, bathing area 278, agro-factory 146 and mechanic workshop 125(Table 2). Control point has the least of the six zones which is 102 (Table 2). While pollution of surface water were assessed based on those exceeding maximum allowable limit as stipulated by regulatory agencies.

Greese (Grs/kg): the amount of greese introduce into the river channel is high within the polluted area. the leachate of the refuse area get in contact with water and released the highest amount of greese content into the water body of Kurafe, which is 1267 (Table 2) followed by mechanic workshop area which is 1211, then agro factory area of the river (770); washing area (407); the bathing area is (282), lastly control point area of the river is having the least amount of greese which is 22. The amount of oil and grease is well above the WHO stipulated maximum acceptable level in all collection points in the study areas.

Turbidity (NTV): Turbidity is measured by the rate of clarity of the water body. Good quality water has very low turbidity. The control point area of the river has 3 the turbidity, which is very low, washing/bathing has 66 and 48 turbidity respectively (Table 2), which is quite high, it shows that water body of the river in these zones is amorphous and milky always.

Chemical Properties of Anion in Kurafe

Sodium (Na^+ ion): generally the amount of Na+ with the various activities of usage in the river is low and this has been expressed and shown in Table 3 Waste and refuse dump area zone (3.4); bathing (2.2) and washing (2.1).

Potassium (K^+ ion) like Na, the actual amount in water is relatively low because of its high electro-negativity, which means that the reactive activities with other salts and elements are very high. Mechanic point has the highest with 4.4., followed by washing and bathing areas 3.7 respectively Leachate (Waste and refuse disposal) in contact with water body of the river, which is 4.5 and control point area has the least 3.5. (Table 3).

Calcium Ca^{2+} ion is a divalent element which forms part of the salt in the water body. Quality water needs low calcium salt. The highest amount is observed at the control point, (19.2), then lowest at the washing/bathing area of the river (0.02) respectively (Table 3). The alteration of the Ca^{2+} may affect the skin ligament, which can further lead to skin raches

Magnesium (Mg^{2+} ion) like calcium, magnesium is a divalent element which forms the salt of the "Alum" it is needed in a small quantity for good quality of water. Control point area has the proportional amount of 6 followed by waste disposal (3.42); then washing zone (2.52) and the least is measured at mechanic area which is 0.23 that has contact with the Kurafe river (Table 3).

Manganese (Mn^{2+}) generally the amount of this element is low in the river, with highest amount recorded in the control point (1000meters away) (0.61) and lowest at mechanic area of the river (0.01) (Table 3). The level of Mn^{2+} is above W.H.O (2004) maximum allowable amount in surface water.

Iron (Fe^{2+}ion). The amount of ion in the river is quite low, even as various activities are being carried out within the water body of the river. The highest amount can be found at the water body of the river that has contact with the waste from mechanic workshop (4.8) while the lowest is recorded in the control point zone, (3.1). The level of iron (Fe) is above the W.H.O (2004) maximum allowable amount in surface water Table 4).

Chemical Properties of Metals and Heavy Metals in Kurafe River

Copper (Cu^{2+} ion) copper is a micro-element that exist in water as trace element. At certain level they are dangerous to health and inimical to casinogenic disease. The leachate of the waste disposal has the highest (0.3); followed by the mechanic area (0.22) and control point which is situated 1000meters away at the upper stream is having the lowest amount which is 0.02 Table 4). The level of Cu^{2+} is above the W.H.O (2004) maximum allowable amount in surface water.

Zinc (Zn^{2+} ion). It is a traceable element in water, and the amount of Zn in 100ml of water is traceable. However as observed and measured along with the

various activities performed in the river, the amount is very low. River water in contact with waste disposal leachate has the highest amount of 0.22 and control area has the lowest of 0.08 Table 4. The level of Zinc is below W.H.O (2004) maximum allowable amount in surface water.

Lead (Pb). The presence of lead metal in water is very dangerous and casinogenic, quality has very low amount of lead, however leachate of the waste disposal contributed an average mean of 5.2 mg/1^{-} of lead into Kurafe river, Nasarawa town, while the control point has 0.0/mg/1^{-1} of lead (Table 4), it shows that the water body around the leachate of refuse waste disposal area is highly polluted with lead metal. Likewise the mechanic point with 3.9 when compared with WHO standard of 0.05.

Chromium, Cadmium Nickel and Mercury: - All these metals are traceable or very low amount in Kurafe river only nickel metal recorded the highest amount in the refuse waste disposal area because of the high presence of lead (0.022), while chromium is very high at leachate area of the waste disposal (0.038) and mechanic area (0.036) (Table 4).

Concentration of Nickel, Chromium and Lead exceeded the maximum allowable W.H.O. (2004) limit in the waste disposal area investigated. Therefore the surface water of river Kurafe is polluted with Nickel, Chromium, and Lead

T_1 (Mg/1^{-1}). This metal is traceable at the control point but is moderately high within and around the water area that has contact with the refuse waste leachate which is 0.113 and mechanic workshop waste water in contact with Kurafe river is 0.136 (Table 4)

Uranium (U). This is a radio carbon metal which is very dangerous to health. The aforementioned metal is relatively high at the point of contact of the river with waste of mechanic workshop (0.35) and area of water that get in contact with waste disposal leachate (0.1). Control area has the least amount of 0.023 (Table 4). The concentration of Uranium exceeded the maximum allowable limit of WHO (2004), in the mechanic and waste disposal area investigated. Therefore the surface water of Kurafe is unsafe for domestic activities around this area investigated

Monodnium (Mo). Is another heavy metal which is traceable in Kurafe river except the mechanic workshop area (0.15), waste disposal area (0.077) and Agro factory, control point area recorded traceable amount of monodnium (Table 4). The concentration of monodnium in the mechanic and waste disposal area is higher than the stipulated maximum allowable limit in the surface water (W.H.O. 2004). However, at mechanic and waste disposal area, there is an appreciable increase in monodnium concentration. The is due to anthropogenic enrichment from leachate of sewage and mechanic effluent composed of lost compound

leachate inorganic materials and improve properties of gasoline and engine from mechanic workshop.

Sb Metal: is traceable in the washing and bathing area of the river, while leachate of the waste disposal in contact with river water recorded the highest amount (0.139) followed by mechanic workshop area of the river with 0.074 and agro factory with 0.06, control point has 0.14 of the Sb element. The presence of Sb metal exceed the WHO standard of 0.01

Selelium (S Mg/1^{-1}): Area of the river having contact with the leachate of refuse dump site recorded the highest amount with 18.23 followed by Agro-factory 10.0 and mechanic workshop area has 6.458 lastly control site recorded 0.11mg/1^{-1} (Table 4).

Aluminum (Al): The amount of aluminum metal at the various point of domestic or industrial activities is very low. Only that 2.11 is recorded at the mechanic workshop area, which was assured to be the highest, while control point area has little or no amount of aluminum (Table 3).

Phosphorous: (P). Agro-factory recorded 11.34 of phosphorus due to its contribution of the fertilizer harvest production followed by refuse/waste dumping site (7.19) however control site has the least amount (0.61) of the element from this indication it is assumed that the product being processed at the agro-factory which is close to the river is aided by P-fertilizer (Table 3).

Conclusion

From the foregoing, it has been ascertained that waste disposal and mechanic workshop effluents is the source of heavy metal enrichment (such as Fe, Zn, Al, Cu) in water samples as established.

In the light of the environmental problems and health hazards arising from indiscriminate disposal of raw effluents in the study areas, periodic environmental analysis should be implemented. Monitoring and control team should be on ground in case of exigencies while waste disposal and mechanical areas should be isolated, that is maintaining safe distance from Kurafe River and residential areas.

Recommendations

After careful studies of the result from the tables the behaviour and activities of the inhabitants, the following recommendations were drawn,

1 Proper effluent disposal plan and recovery of sewage water of various domestic purposes should be established. Community water treatment facility should be made available.

2 Stringent legislature measure and litigation procedures should be established by the environment stakeholders to curb the problem identified in the study area notably the pollution associated with the mechanic workshop and waste

dumps. Violators, of environmental regulation should be punished appropriately, including fines for polluting the environment.

3 While emphasizing the dangers of pollution, it is equally clear that one cannot stop human activities, but these must respond to clean process of the environment and reduce pollution. Therefore proper balance has to be struck between improved productivity and environmental pollution in order to preserve the aesthetic, integrity of the environment and protect mankind from avoidable health hazard and untimely death.

4 Finally, further studies are recommended to enhance the attainment of environmental quality. To this end, bio-geo-chemical analysis of the ecosystem should be carried out on flora, fauna, soil and sediments to further strengthen the finding on adverse effect of heavy metals in the study areas. Blood samples of inhabitants may be analyzed to determine the presence, nature, toxicity levels and quality status of life and likely health hazard an individual is contending with.

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