WATER QUALITY ASSESSMENT OF KAKURI-MAKERA RIVER FOR IRRIGATION

[1]Yunana Mba Abui, [2]Siaka S. G, [3]Simon, S. & [4]Nale, B. Y.
Dept. of Environmental Management,
Kaduna State University School of Agric.
Technology Samaru Kataf Campus, Nuhu Bamalli Politechnic

Abstract
The study examined the water quality of Kakuri-Makera River with the view to determine the quality of the water, investigate the toxicity level of the stream and examine the suitability of the stream for irrigation activities. Water samples were collected at three sampling points along the stream. One sample was taken at Kurmin Gwari upstream, and at downstream, one sample was taken at downstream. The parameter determined were Temperature, pH, Total Dissolved Solids, Nitrate, Sulphate, Total Dissolved Oxygen, COD, BOD using Standard Method. The metal parameters such as Silica, Iron, Lead, Manganese, Cobalt and copper were determined using Absorption Spectrophotometer (UNICAM, model, SOLAAR 969). The results of the analyses show that most of the parameters observed were highly concentrated above the recommended permissible limit set by WHO. This revealed that the river of Kakuri-Makera had become contaminated by the effluents discharged into it and is not suitable for irrigation. For sustainable management of the water resource, it is recommended that the state assembly should involve sanitation programmes. Government should assist in Earth dam's construction to provide water for irrigation in the area. Proper and adequate treatment of the effluents to a safety level before it is discharged by the company in order to save water body from further pollution. The prepared guidelines and standards from WHO relating to water pollution control should be strictly adhered to.

Keywords: *Water Quality, Suitability, Parameters, Concentration and Contamination.*

Background to the Study

The face of irrigation agriculture is changing with respect to water quality and quantity. In the past, neither irrigators nor agricultural crop adviser had to give much consideration to either the supply or the quality of irrigation water supplies of good quality water, well-matched to crop irrigation were plentiful, generally uncontested and not necessary closely monitored or regulated (Bauder at el 2008). The growing competition for and accountability of the use of water have contributed to increasing scruting about just how water is used, how much water is available to the public for non-agricultural uses, and what practices impact the quality of our nation's water resources correspondingly irrigators in many watersheds and irrigation distracted have had to face and respond with changing practices to increasing scruting about how to best manage available water resources. Long with that has come growing attention to the quality of water available for irrigation (Schafor, 20003).

With the ever increasing demand on irrigation water supply, farmlands are frequently faced with utilization of poor quality irrigation water (Alemtselaye, 2002). The application of poor quality irrigation water can reduce the yield of farmlands. Water quality for agricultural purpose is determined on the basis of the effect of water on the quality and the field of the crops, as well as the effect on the characteristic changes in the soil (FAO, 2005). According to Richardson (2004) that the qualities of irrigation water that deserve consideration include the salt content, the presence and abundance of macro and micro-nutrients and trace elements, the alkalinity, acidity and hardness of the water under some circumstances the suspended sediment concentration bacterial content and temperature of irrigation water may also deserve attention.

The Study of the Problem

The mixture of the industrial plant effluents of the Kakuri-Makera textiles factories, abattoir, brewery and steel product industry and domestic wastewater are discharged into the river. Farmers used the river to irrigate their farmlands in order to grow different crops like vegetables, fruits, sugar cane, carrot, pepper.

According to FAO, (2005), water quality for agricultural purpose is determined on the basis of the effect of water on the quality and the field of the crops, as well as the effect on the characteristic changes in the soil. Kalu Woreda Agricultural Office, (2007), observed the decline in the quality of crops as well as the increasing trend of devastation of the immediate environment and the health of the inhabitant of Kakuri-Makera areas. Effluents released by the textiles, abattoirs, breweries and household domestic waste are characterized by the presence of large quantities of pollutants. Due to the ineffectiveness of purification systems wastewaters may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the consumers from these agricultural products.

Several investigations have shown positive correlation between the pollution and the quantity of the crops as well as the health of the inhabitant, but no in-depth study has been conducted on the water quality of the stream in relation to irrigation in the area.

There is therefore the need to take an in-depth study on the quality of the river that is likely to affect the production and health of the agricultural product of the area.

Aim and Objectives

The aim of the paper is to examine the water quality of Kakuri-Makera River for irrigation.

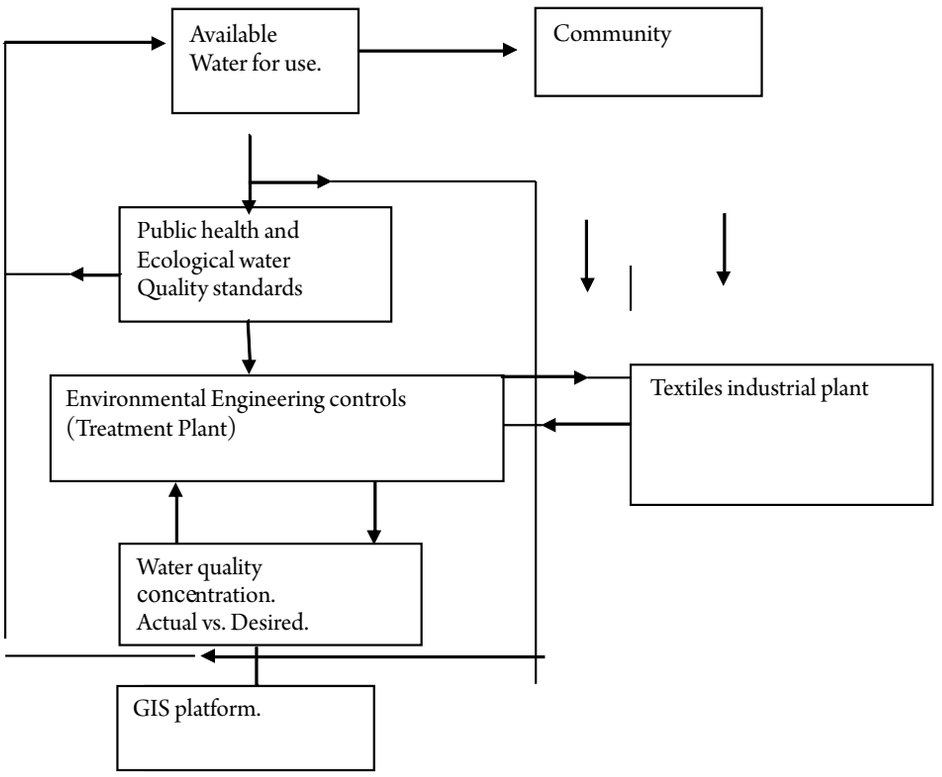
The study therefore attempts:

1. To determine the quality of the Kakuri-Makera river.
2. To investigate the toxicity level of the Kakuri-Makera river and
3. To examine the suitability of the river for irrigation activities.

Conceptual Framework

The study was guided by Thomann's model of water quality engineering. Thomann and Mueller (2007) observed that water quality management problems can be controlled by means of assignment of allowable discharges to a water body, so that designated water use and quality standards are met. There are several components to the problem of water quality namely; determination of desired water use standards, water quality standards, and comparison between desired and the actual quality, sources of pollution and control measures. Working from the premise that uncontrolled discharge of wastewater into a river system lowers its water quality, the model was modified and adapted for this study as illustrated in Figure 1.

Figure 1: Conceptual framework (Adapted from Thorman and Mueller, (2007)



Source: Thorman and Mueller, (2007)

The Area of Study

Kakuri-Makeri stream is tributary of river Kaduna and it lies between latitude 100 18' and 100 30'N and Longitude 70 15' and 45' (BLSK, 2010). The river rises from Kurmin Gwari hill and tanverses Kakuri and Makera town (hence the name) and discharges it water into river Kaduna at Nasarawa down Quarters. The stream flows throughout the year, but its volume reduces during the dry season. The river serves as sink for the industrial and household domestic effluents.

The climate of the area is part of the tropical wet and dry climate of Nigeria. The wet season begins in April and ends in October, though there is fluctuation Sahara desert in November to March. The annual rainfall is about 1140mm to 1204mm and has the annual average temperatures of about 26.40c (Kareem and Mbason, 2010). The area is located in the slightly thicker wooded vegetation of the north guinea savannah. The activities such as overgrazing, bush burning, over cropping, tree felling for fuelwood have generally modified the vegetation to wooded shrub like-vegetation. The vegetation comprises of transitional woodland, with species like Daniela, Oliverii, vitex, Domana, Diospyros, Mespiloformus, Khaye, Grandifohala and albizia Africana. The area is noted for having large quantities of fuelwood and consumers of wood all year round. The inhabitants of these towns used the river for irrigation of their crops (like vegetables, sugar cane and maize) during the dry season

Methodology

Three sampling points were chosen along the river based on the accessibility. These were Kurmin Gwari, Kakuri and Makera. Each point was sampled on 17th may 2013 at the interval of 6km distance from each point. Surface water samples for analyses were collected mid-stream using Grab method. The collection was done at the depth of 20 - 30cm directly into clean 1 litre plastic bottles. Temperatures and pH

of the water samples were taken in-situ using a temperature probe and portable pH meter respectively. 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 analyzed for Turbidity using a HACH 2100 P Turbidimeter. Electrical Conductivity was determined with Cybersan 510 conductivity meter. Calcium was determined using EDTA titration. Chloride was determined with Argentometric titration. Nitrate was determined using Dionex-80 ion analyzer, Sulphate, Bicarbonate and Alkalinity was determined with strong acid titration method. Total hardness, Total Dissolved Solids and Ammonia were determined using Standard method. Silica, Cupper, 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

Results

Results of the samples parameters determined were compared with the World Health Organization (WHO) tolerable levels allow for wastewater.

The Results of Physical Parameters of the Water Samples along Kakuri-Makera River

The results from the water sample analyses show that the pH of the Kakuri-Makera river were found to be 5.4 at Kurmin Gwari and 6.00 at Kakuri and Makera below the acceptable limit of WHO standard of 6.5 – 8.5. This indicates that the stream water is acidic in nature due to the industrial and domestic effluents discharged into it.

The values of the temperatures at the three water sampling points were above the acceptable limit of 300c. At Kurmin Gwari the value of the temperatures was 350c, at Kakuri, it was 360c and at Makera the temperature was 450c. This increased of the temperatures could be attributed to the influence of the effluents flowing into the stream.

The turbidity values of the water samples at the three points were above the acceptable limit stipulated by WHO. There was a decrease of the value at Makera to 79.40NTU while the other stations recorded 264NTU and 297NTU respectively. The Electrical Conductivity of the stream is low compare to the standard set by WHO permissible limit of 1000mg/l. at Kurmin Gawri, the conductivity was 64mg/l, at Kakuri it was 61.10mg/l and at Makera downstream, it goes down to 48.60mg/l. this therefore, the parameter does not give cause for concern and make the water suitable for crop consumtion.

Parameters	Kurmin Gwari	Kakuri	Makera	WHO STANDARD
Temperatures (0c)	35	36	45	30
Turbidity (mg/l)	264	297.00	79.40	0 – 5NTU
Ph	5.4	6.00	6.00	6.5 – 8.5
Electrical Conductivity (mg/l)	64	61.10	48.60	1000

The Results of Chemical Parameters of the Water Samples along Kakuri-Makera River

The concentration of Sulphate and Nitrate in the water samples of the river at the three sampling points is above the WHO tolerance limit of 0.1mg/l. the high concentration of these parameters at Kakuri is due to the animal waste released at the abattoir into the stream. Going by the FEPA standard, these results exhibited pollution tendency (Santschi, 2001). The level of sulphate in the sampling point's ranges from 20.1mg/l, 40.0mg/l and 27.0mg/l revealed the presence of high sulphate concentration. The high concentration of nitrate at the three sampling points, especially at Kakuri where the value is 40.0mg/l is due to the human and animal waste from abattoirs and domestic released into the river

The results of the Total Dissolved Oxygen (TDO) at the three sampling points showed that Kurmin Gwari had an average TDO value of 3.0mg/l, 3.05mg/l at Kakuri and 24.30mg/l. the increased in the concentration of Total Dissolved Oxygen might be attributed to the effluents discharge from the textile industries and the domestic household within the area which contain high concentration of organic matter and nutrients that lead to decrease in Total Dissolve Oxygen values as a result of increased microbial activity occurring during the degradation of organic matter.

As evident the levels of the metal parameters in the water samples were much higher with the exception Iron, manganese, Cadmium and Chromium which values are within the permissible limit of 0.1mg/l of FEPA standard. Lead has a range of 1.2mg/l at Kurmin Gwari sampling point, 1.16mg/l and 1.60mg/l at Kakuri and Makera respectively, Cobalt has values of 0.11mg/l at Kurmin Gwari, 1.03mg/l at Kakuri and 0.45mg/l at Makera and Copper have values of 0.34mg/l at Kakuri and 2.34mg/l at Makera. Each parameter had values comparably higher than the acceptable limits set by WHO. These metal elements could have come from emissions from the use of gasoline engines and generating plants. The results in the table indicate that the alkaline, the bicarbonates and ammonia were not dictated in the samples of the river.

Table 2: Results of Chemical Parameters of the Water Samples along Kakuri-Makera River

Parameters	Kurmin Gwari	Kakuri	Makera	WHO STANDARD
Total Dissolved Oxygen (mg/l)	3.0	3.05	24.30	500
Chloride (mg/l)	Nil	Nil	Nil	250
Bicarbonate alkaline (mg/l)	Nil	Nil	Nil	0.1
Carbonate Alkaline (mg/l)	Nil	Nil	Nil	0.1
Total Alkaline (mg/l)	Nil	Nil	Nil	0.1
Total Hardness (mg/l)	144	184.00	230.00	150
Iron (mg/l)	0.94	0.90	0.59	0.3
Sulphate (mg/l)	20.1	40.0	27.0	0.1
Silica (mg/l)	2.0	1.48	33.5	0.1
Calcium (mg/l)	180.12	180.00	206.00	0.1
Nitrate (mg/l)	1.0	3.0	1.1	0.1
Ammonia (mg/l)	Nil	Nil	Nil	0.5
Manganese (mg/l)	0.12	0.15	0.19	0.2
Lead (mg/l)	1.2	1.16	1.60	0.2
Cadmium (mg/l)	Nil	-0.08	-1.41	0.01
Chromium (mg/l)	Nil	-1.13	-0.23	0.1
Cobalt (mg/l)	0.11	1.03	0.47	0.05
Copper (mg/l)	0.2	0.34	2.34	0.2

The Result of Biological Parameters of the Water Samples along Kakuri-Makera River.

The values of the BOD and COD in the water of the sampling points exceed the 6mg/l and 10mg/l of WHO permissible level for irrigation water. The BOD values at Kurmin Gwari was 4mg/l, at Kakuri was 9mg/l and at Makera was 15mg/l and for COD, it was observed to be 223mg/l at Kurmin Gwari, at Kakuri was 290mg/l and at Makera sample point was 340mg/l. This high level of concentration was due to the organic contaminations entering the water body from domestic waste and industrial effluents. These organic materials eventually are broken down by bacteria, which require oxygen for decomposition process. Since there is large amount of organic matter to be broken down, the bacteria remove large quantities of dissolved oxygen from the system, thereby increasing the levels of BOD and COD.

Table 3: Results of Biological Parameters of the Water Samples along Kakuri-Makera River.

Parameters	Kurmin Gwari	Kakuri	Makera	WHO STANDARD
COD (mg/l)	223	290.00	340.0	6
BOD (mg/l)	4	9	15	10

Discussion of Findings

The results of the water samples presented above shows that the Kaukuri-Makera River had become contaminated by the effluents discharged by the industries and household waste of Kakuri and Makera industrial plant despite the closure of the textile industries for about 15years ago. The high concentration of the contaminants was due to the content of the effluents discharged. The results shows that from the upstream to the last sampling point downstream, many of the parameters measured were high above the standard observed by WHO especially in the dry season where the volume of the stream water reduces.

The stream is highly oxygen demanding. The effluents with organic solid may need to under go slow biodegradation requiring energy from the sun and in the process causing reduction in dissolved oxygen in the water body by limiting the function of the aerobic bacteria, which may results to the loss of aquatic lives and crops if been irrigated into the farmlands. The result concord to Dix (2001), that small organic solid particle makes water turbid. It has been found to reduce the effects of solar energy absorption resulting in lowering the rate of photosynthesis, reduction in plant growth and slow down natural water purification processes. Thu, the whole river ecosystem may break down to develop into water pollution.

Chemical Oxygen Demand (COD) is one of the parameters in the pollutants that are highly concentrated in the wastewater of the river. This is an evidence of highly concentration of biologically resistant substances as well as organic impurities and this is not healthy for the crops. According to Schwaites, (2008), at this level it has a high acute toxic on aquatic life. It rendered the water of Kakuri-Makera unfit for human consumption and agricultural purpose. Sulphate was noticed to be highly concentrated. According to Purse glose, (2006), this is very dangerous to soils, crops and human health. The pollutants are in particulate form and when being irrigated, they sink into the soil to be taken up through the plant xylem tissue. The plant may grow stunted with broad and green leaves, but finally with low yield. These have not much direct effects on the plants but on the consumers (human beings and animals) that feed on the plants.

The water of the river was noticed to be acidic. This acidic nature tends to suggest that the acidic substances are being discharge from the industries and household effluents. This will be detrimental not only to plants but also to other elements in the soil and also an appreciable amount of micronutrients such as Zinc and Copper become toxic to plants. It was noticed that most of the trace metal parameters exceeded the permissible limit of WHO standard and are not suitable for irrigation. According to Schwaites (2008), these parameters are needed in small quantity by the plants and therefore, if apply to the soil they become harmful to the crops. Calcium in the water samples was noticed to be high above the limit set by WHO standard. This element is required in sufficiently large quantity for crops production because of the role it plays in plant growth especially during photosynthesis process.

Conclusion

From the discussion above, it is obvious that the Kakur-Makera River cannot be relied upon as good source for irrigation of agricultural crops. Truly, the river would have been of benefit to the inhabitants of Kurmin Gwara, Kakuri and Makera. But it has been found to cause environmental pollution. The discharged of the industrial plants and household effluents has significantly altered the quality of the river. It also affected the vegetation, the crops and the aquatic animals negatively. It is high time for the Federal, State Government, the industries and the household to waged war against all sources of the pollution. Continued discharge of improperly treated effluents may further compound the environmental problem to the receiving water body.

Recommendations

1. For sustainable management of the water resource, the state assembly should involve in sanitation programmes and propagates these through environmental education throughout the communities in the stream area to prevent pollution of the river.
2. Government should assist in Earth dam's construction to provide water for irrigation in the area. Proper and adequate treatment of the effluents to a safety level before it is discharged by the company in order to save water body from further pollution.
3. The prepared guidelines and standards from FEPA relating to water pollution control should be strictly adhered to.

References

Alemtselaye, R. R., (2002). "Evaluation of some metals in the industrial waste from a paint industry and their environment pollution implications". Nig.1. technol.Res., 2: 71-77.

Bauder at el, (2008). "Towards the characterization of heavy metals in dredged canal sediments and an appreciation of availability. Environ pollution", 113: 395-401

Bereau for Land and Survey Kaduna (2010). "Map of Kaduna State showing the Local Government Areas".

Dix, H. M. (2001). "Environmental pollution". J. Willey and Sons Limited. Pp 60-62

FAO, (2005). "Quality of Domestic Water Supplies". Assessment Guide, 2nd edition. Department of Water Affairs of Forestry, Department of Health and Water Research Commission, Pretoria, South Africa.

Kareem, I.A.and Mbason, O.W. (2002). "A New Geography of Nigeria". Lonman, London

Kalu Woreda Agricultural Office, (2007). "Hand book of Environmental Data and Ecological Parameters". Pergamons Press. Oxford. 1162 pp.

Purseglove, C.F. (2006). "Environmental assessment of soil". A practical Guide book for technology of Queens land press.

Richardson, G. (2004). "A survey of water quality of river Densu". WRRI Technical report, Accra Ghana: 556.114 (667). 56 pp.

Santschi, P. H, (2001). "Historical contamination of PAHs, PCBS, DDTs, and heavy metals in Mississippi River Delta, Galveeston Bay and Tampa Bay sediment cores". Mar. environ. Res., 113: 395-401.

Schafor D. (20003). "Water Quality Assessmen"t. 2nd edition EPFN Spon: London.

Schewaites, F.N. (2008). "Factors controlling the major chemistry and small lakes example from the pairie parkland of Canada". Hydrologic. Vol. 58 pp81

Thomann V. R. and Mueller A. J. (1987). "Principles of surface water modeling and control". Harper & Row, Publishers: New York.