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Effect of pollution due to human activities at Naka dam Benue State, Nigeria

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ABSTRACT

This study aims at determining the pollution effect of human activities at Naka dam Benue State Nigeria in order to ascertain the level of water quality of the dam. In carrying out the study, three samples each were collected from upstream, middle stream and downstream of the dam. Physico-chemical and bacteriological analysis was done to obtain parameters such as temperature (32.20 – 32.80)^{0}c, color (40.00 – 93.70) pt color, turbidity (19.90 – 35.70) NTU, suspended solids (16.30 – 27.30) mg/l, total dissolved solid (30.70 – 34.70) mg/l, total solids (48.30 – 62.00) mg/l, conductivity (71.70 – 75.30) Ns/cm, pH (6.8 – 8.4), hardness (66.70 – 86.7) mg/l, nitrates (40.5 – 56.5) mg/l, sulphates (36.70 – 40.0) mg/l, chlorides (36.00 – 44.20) mg/l, biological oxygen demand (72.30 – 80.70)

mg/l, biochemical oxygen demand (144.00 – 159.30) mg/l, $DO_{2\ (1)}$ (5.20 – 5.50), $DO_{2(5)}$ (4.30 – 5.00), E coli (53.00 – 161.70) x 10^{-5}cfu, salmonella typhi (0.30 – 3.30) x 10^{-5}cfu, and vibro chlorella (0 x 10^{-5}) cfu. It was observed that the water was highly polluted in comparison with world health organization standard (WHO) and not suitable for drinking. Hence human activities around the dam should be monitored properly.

Keywords: Pollution, Naka Dam, water quality, pyhsico-chemical parameter, Bacteriological parameters

1. INTRODUCTION

Damming of water has long become a means of making available water for different purposes. But the problem usually encountered in this regard is ensuring that the quality of water is adequate for the purpose of drinking. UNEP (2012) in their report stated that the deterioration in the quality and quantity of water does not only have impact on the availability of clean and safe drinking water but also on the population living downstream as well as the aquatic ecosystem. According to figures issued by the World Health Organization (WHO, 2006), an average of fifty thousand (50,000) persons die daily from diseases associated with contaminated water. This is just a glimpse of how much potable water is needed for consumption. Since the potability of water is paramount and the need for water has increased due to population boom, ensuring that the available water resources remain unpolluted is a great assert. There is no doubt that the introduction of chemicals and herbicides to farming activities as well as other human activities have greatly affected the quality of water expected from a body of water such as a dam especially through surface runoff. Hence, there is a need to determine the level of pollution resulting from the activities going on around the dam.

Ayobahan et al. (2014) noted that the effect of human activities trigger pollution in surface water bodies. They further explained that different anthropogenic (Human) activities can lead to different levels of pollution along a river path. Some of the major factors that may result in the different levels of pollution in a body of water are industrial effluent, soil erosion, nutrient loading and human activities such as fishing, swimming, and training of students from different schools, car washing and block making. Ratemo (2018) investigated the relationship between land use and surface water quality. The study pointed out that different land use types can led to different levels of pollution where areas with high urban domination with highly concentrated number of industries recorded significantly higher levels of pollution as compared to areas with forest domination or deserted areas. The focus of this study is to investigate the level of pollution of Naka dam resulting from human activities with reference to the socio- economic activities going on around the dam.

Figure 1 Google earth map showing Naka Dam

2. MATERIALS AND METHODS

Area of Study

Naka is the headquarters of Gwer West Local Government Area of Benue State, Nigeria. It has been known as the highest producer of Honey and Rice in the state. It has an area of 1,094 km² and a population of 122,145 at the 2006 census. Naka dam is the major source of water supply in Naka town. It was constructed in the Year 1986 by the Benue state government. The aim of constructing the Dam was to supply water to the waterworks for treatment and distribution to meet up with the water consumption per capita of the populace.

The catchment area was inspected to observe the land use and socio-economic activities going on around the dam after which water samples were collected for laboratory analysis. The dam was stratified into three zones namely; upstream, midstream and downstream. Water samples were taken from these zones by paddling in a locally constructed canoe through these points. Collection of water samples was done in the morning between 8am and 9am. Theses samples were collected using Grab sample technique as outlined in the Standard Methods for the Examination of Water and Wastewater, sections 9221B and 9221F, respectively (APHA, 2015). Samples were collected into clean 1 litre plastic bottles and were stored in an ice box of about 4ºC and were taken to the laboratory within three hours for analysis. Water samples were collected by lowering pre- cleaned plastic bottles into the bottom of the water body, 30 cm deep, and allowed to over flow before withdrawing. Thus, Nine (9) samples of water were collected from the dam, three (3) from upstream, three (3) from downstream and three (3) from midstream. The Parameters investigated were those that indicated effects of human socio-economic activities on water quality.

3. RESULTS AND DISCUSSION

Drinking water quality should be suitable for human consumption over a life time of consumption. When a guideline value is exceeded, the cause should be investigated and corrective actions taken. Table 1 shows the result of water quality parameters of Naka dam in comparison with WHO standard for drinking water.

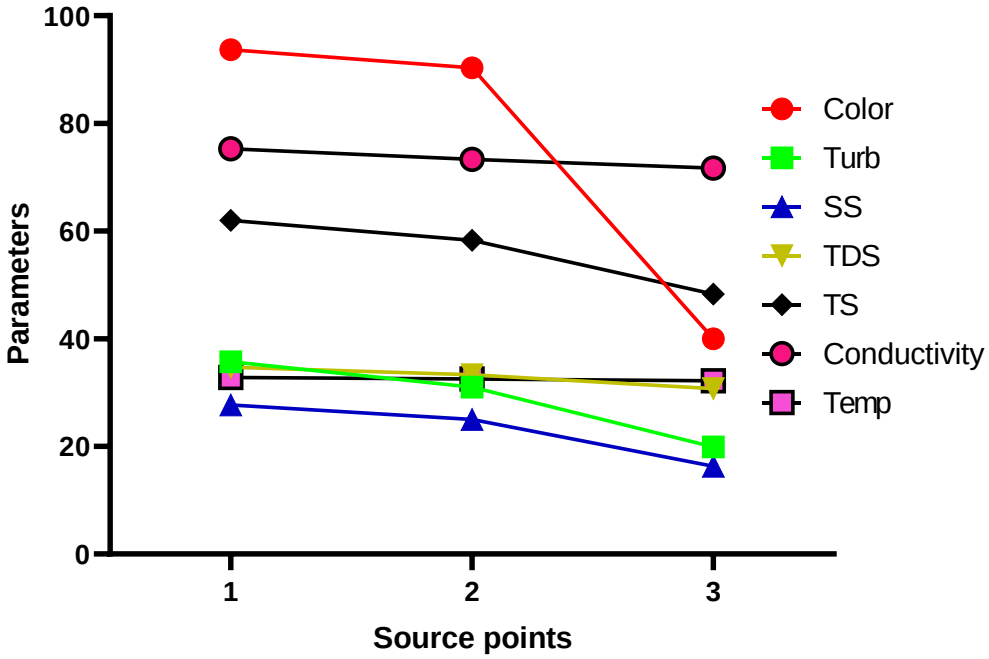
Table 1 Result of the Physico-chemical and bacteriological parameters of Naka dam in comparison with World Health Organization Standards

Characteristics	WHO	Present Study
Temperature (ºC)	25	32.5
Color (pt color)	15	74.7
Turbidity (NTU)	25	28.9
Suspended solid (mg/l)	-	22.9
Total solid (mg/l)	-	56.2
Total dissolved solid (mg/l)	500	32.9
Conductivity (N_s/cm)	1000	74.1
pH	6.5 - 8.5	6.8
Hardness (mg/l)	200	75.6
Nitrate (mg/l)	10	48.6
Sulphate (mg/l)	-	41.8
Chlorides (mg/l)	250	40.2
BOD (mg/l)	-	77.4
COD (mg/l)	-	154
$DO_{2(1)}$ (mg/l)	7.5	5.37
$DO_{2(5)}$ (mg/l)	-	4.70
Salmoneiha Typhi (cfu)	-	1.77×10^{-5}
E coli (cfu)	-	101.7×10^{-5}
Vibro chlorella (cfu)	-	0.0×10^{-5}

Physical parameters

Figure 1 presents the results of physical parameters of the water from Naka dam. The results of parameters such as temperature, color, Suspended solids, Total dissolved solids, Total solids, Conductivity, and Turbidity were captured in Figure 1. The values of

temperature were within the range of 32.2 - 32.8 ^{0}C. The higher value was obtained at the upper stream while the lower temperature value was noticed at the lower stream.



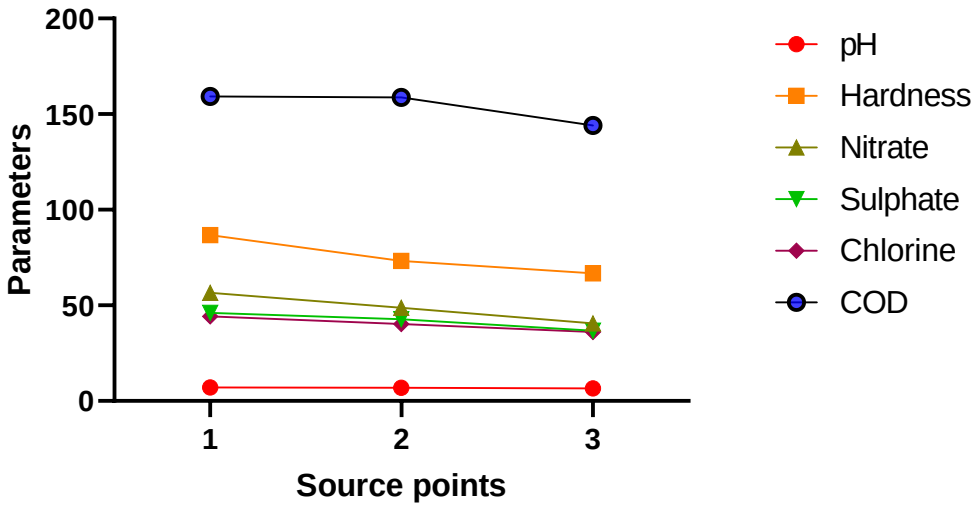
Note: 1, 2, and 3 represents Upstream, Midstream, and downstream respectively

Figure 1 Results of physical parameters of the water quality from Naka dam

The values of color were within the range of 40.00 – 93.7 Pt. The higher value was noticed at the upstream of the dam while the lower value occurred downstream. This improvement in clarity from upstream to downstream was as a result of settling. The highest level desirable for color in drinking water is 5mg/l and the minimum permissible level is 500mg/l. Hence, the values were within the maximum permissible level of 500mg/l. The measure of light deflected by un-dissolved particles present in water is attributed to the level of turbidity of that water (Ratemo, 2018). The measured values of turbidity were within the range of 19.90 – 35.7 NTU, signifying a considerable amount of light obstruction. The leading cause of the turbidity of the water from Naka dam is the impact from local brick making around the dam. The values of suspended solids were within the range 16.30 – 27.30 mg/l. All the values are below the maximum permissible level of 500 mg/l given by World Health Organization for drinking water. The level of suspended solids in surface water is usually influenced by the nature of activities (mostly anthropogenic) going on around the dam. From Figure 1 above, the values of dissolved solids ranges from 30.70 – 34.70 mg/l. This may be due to natural/ self purification. All the values are below the maximum permissible level of 1200 mg/l as given by World Health Organization for drinking water. Total Solids had values within the range of 48.3 – 62 mg/l. All the values were below the highest level desirable and maximum permissible level of 500mg/l and 1500mg/l respectively as given by World Health Organization for drinking water. The values of the conductivity measured are within the range of 71.70 – 75.30 Ns/cm. The levels of conductivity are often times affected by the concentration of dissolved solids in the water (Aho et al., 2018). The values of conductivity were below the highest desirable level of 1250 Ns/cm as given by World Health Organization for drinking water.

Chemical parameters

Figure 2 presents the results of chemical parameters of the water from Naka dam. The results of parameters such as pH, Hardness, Nitrate, Sulphate, Chlorine, Chemical oxygen demand (COD) were captured in Figure 2. The pH values as presented in Figure 2 ranges from 6.60 – 7.0 with the upper and middle stream values within World Health Organization standard for drinking water of 6.80 – 8.40 while the lower stream value obtained fell below the standard. The reduction in the value of pH at the lower stream is an obvious indication that the water around that region is slightly acidic. This level of acidity may be influenced by the level of farming activities around the dam which often time requires the use of chemical for the weeding and improving harvest yields.



Note: 1, 2, and 3 represents Upstream, Midstream, and downstream respectively

Figure 2 Results of Chemical Parameters of the water Quality from Naka Dam

As presented in Figure 2 above, the values of hardness in the various parts of the dam were within the range of 66.70 – 86.7 mg/l. The highest value was obtained at the upper stream while the lowest value was obtained downstream. The concentration of total hardness is said to decrease as water flows downstream, implying that the level of calcium and magnesium as well as polyvalent metallic ions in the water is higher upstream than downstream. This influence may be attributed to the process of weathering or natural geological processes (Ratemo, 2018). All the values obtained fell below the highest desirable level stipulated by World Health Organization (2011). Figure 2 above presents the values of nitrate content in the various segments of the dam which are found to be within the range of 40.50 – 56.50 mg/l with the highest and lowest in the upstream and downstream respectively. The values of middle and lower stream are below the highest desirable level of 45 mg/l for drinking water as given by World Health Organization (2011). The values of sulphates measured are within 36.70 – 46.0 mg/l with the highest and lowest values in the upper and lower stream respectively. All values are above both the highest desirable level of 200 mg/l and maximum permissible level of 400mg/l as specified by World Health Organization (2011). Figure 2 above shows the amount of chloride present in the water samples collected for the various segments of the dam. The values are within the range of 36.0 – 44.20 mg/l. The highest value was found at the upper stream and the lowest value at the lowest stream. All the values are below both the highest desirable level and the maximum permissible level of 200 mg/l and 600 mg/l respectively. As shown in Figure 2, the values of the COD are within the range of 144.00 – 159.30 mg/l with the upper and lower stream having the highest and lowest values respectively. This indicates that all the sampling locations recorded COD levels that are higher than the recommended maximum standard of 100 mg/l according to the WHO (2011).

Bacteriological parameters

Figure 3 presents the results of Bacteriological parameters of the water from Naka dam. The results of parameters such as $DO_{2\ (1)}$, $DO_{2\ (5)}$, E coli, Salmonella typhi, and Vibrio cholera were captured in Figure 3. Figure 3 presents the mean value of $DO_{2\ (1)}$ are represented in the figure above. The values recorded for the different source points were within the range of 5.20 – 5.50 mg/l with the highest value in the lower stream and the lowest value upstream. The implication is that the water upstream is more harmful to aquatic life than the water downstream. All the values obtained were above World Health Organization standard for drinking water of 0 to 5.

Figure 3 also presents the mean value of DO_2 (5). The values obtained for the different source points ranged from 4.30 – 5.00 mg/l, with the highest value found at midstream and the lowest value found downstream. All the values obtained were above the WHO standard for drinking water. The values of E coli were captured in Figure 3. The values obtained were within the range of 53.0 – 161.70 $x10^{-5}$ cfu with the highest values in the upper stream and the lowest value in the lower stream. All the values are above World Health Organization standard for drinking water. The value of Salmonella Typhi ranges between 0.30 – 3.30 x 10^{-5} cfu with the highest of $3.3x10^{-5}$cfu at the upper stream and the lowest values of 0.30 x 10^{-5}cfu at downstream. All values are above World Health Organization standard for drinking water. Therefore, the water is not suitable for drinking based on Salmonella Typhi content in the

water. From the Figure 3 above, vibrio cholera was not found in the water. Therefore, the water is suitable based on vibro cholera contents stipulated by World Health Organization standard for drinking water. Lastly, the values of BOD as presented in the Figure 3 gives a mean value of 77.43 mg/l and ranges from 72.30 – 80.70 mg/l. All values are above World Health Organization standard for drinking water of 50mg/l. Therefore, the water is not suitable based on Biochemical Oxide Demand content in the water.

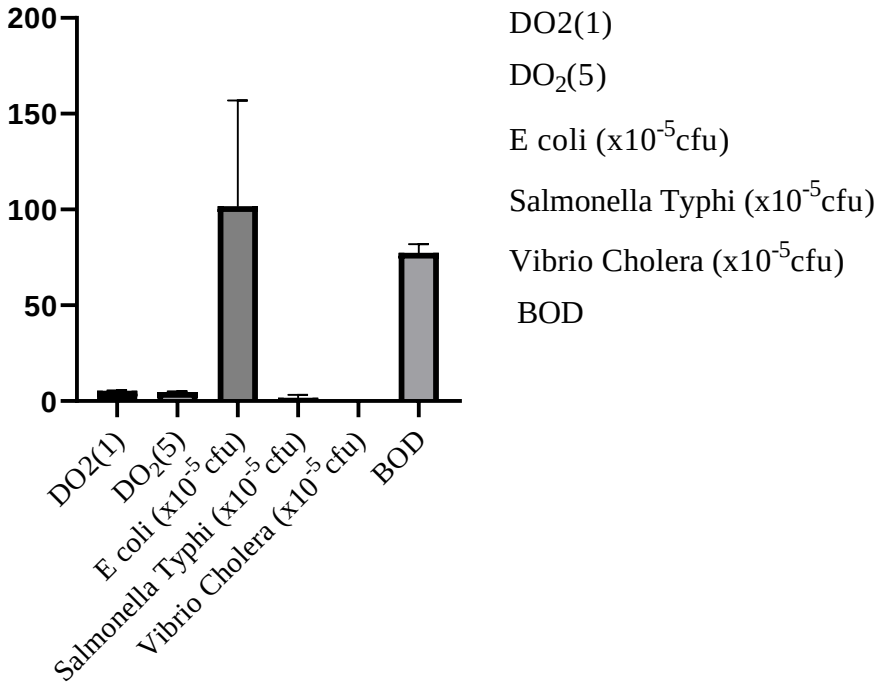


Figure 3 Results of Bacteriological Parameters of the water Quality from Naka Dam

4. CONCLUSION

The result of the physico-chemical and Bacteriological analysis revealed obviously that the water in Naka dam has been contaminated by human activities, because of the difference in concentration of the pollutants at upstream, midstream and downstream. Quite a number of the parameters obtained were higher than the acceptable stipulated by WHO. The adverse effect is that the pollutants present in the dam reduces the quality of the water in the form of preventing solar energy absorption, resulting in a lower rate of photosynthesis and subsequently slows down self purification processes. Human activities around the dam should be monitored in line with regulations stipulated by WHO and agencies like National Environmental Standards and Regulations Enforcement Agency (NESREA).

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Authors' Contributions

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This study was carried out jointly by the authors. Author JTU, designed the study and wrote the protocol and also did literature searches. Author ORE edited the manuscript, literature searches and plotting of the graphs.

Conflict of interest

None was declared.

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