

# Assessment of the Physicochemical Quality of Challawa Gorge Dam Kano, Nigeria

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## ABSTRACT

Water and sediment samples were collected from Challawa Gorge dam during the wet and dry seasons and analyzed for some physicochemical parameters, heavy metals (Cd, Cr, Mn, Pb, Zn) and minerals (Na and K) using Atomic Absorption Spectrophotometric and Flame Photometric techniques. The results showed the following ranges of the physicochemical parameters; pH (7.78±1.1 to 7.82±0.2), Conductivity (45.0±3.2 µs/cm to 65.8±0.2 µs/cm), Nitrates (1.59±0.18 mg/l to 2.03±1.5mg/l), Dissolved oxygen (6.3± 0.5 mg/l to 15.3± 1.45mg/l), Total dissolved solids (34.1±2.4 mg/l to 36.0±3.7 mg/l) and chlorides (3.47±0.36 mg/l to 10.72±0.57mg/l). Variations in concentrations of the heavy metals ranged from 0.01± 0.001 mg/l to 1.41± 0.13 mg/l in water and 1.64 mg/kg to 51.0mg/kg in sediment, while sodium and potassium ranged from 7.65±0.28 mg/l to 11.32±8.62mg/l in water and 50.16±17.92 mg/kg to 144.19±12.09mg/kg in sediment. The levels of all the tested parameters in water were within the WHO and SON standards for drinking water and fishing activities and may not pose immediate health effects on human. However, the high levels of heavy metals in the sediment samples can lead to bioaccumulation and long term adverse effects on the aquatic lives and humans. Therefore continuous monitoring of the heavy metal contents in the Dam and sediment is recommended to safeguard aquatic and human lives.

## INTRODUCTION

Surface and ground water contamination, air pollution, solid waste dumps and general environmental degradation, including the loss of land aquatic resources, are the major environmental problems caused by industrialization in Nigeria. Improper disposal of untreated industrial wastes has resulted in colored, murky, odorous and unwholesome surface waters, fish kills and a loss of recreational amenities. A significant proportion of the population still rely on surface waters for drinking, washing, fishing and swimming while industries

use water of acceptable quality for processing<sup>1</sup>.

The extent of deterioration in water quality is related to the retention time of the reservoir; its storage capacity in relation to the amount of water flowing into it. Dams are being polluted by indiscriminate disposal of sewage, industrial wastes and human activities<sup>2</sup>. Different regulations have been made to protect the marine environment in Nigeria but yielded poor results in the control of indiscriminate dumping of effluents into water bodies. Studies have shown that high levels of some heavy metals such as

lead, copper, zinc, nickel, chromium, cadmium, and iron are present in most Nigerian rivers<sup>3,4</sup>.

The importance of protecting fresh water fisheries and aquatic lives led to the assessment of their water quality requirements, in terms of physicochemical parameters such as pH, temperature, dissolve oxygen, alkalinity, hardness, conductivity and total dissolved solids. These factors serve as basis for the richness or otherwise of biological productivity of any aquatic environment<sup>5</sup>. Water quality parameters also provide the basis for judging the suitability of water for irrigation, drinking, bathing, fishing and industrial processes.

Furthermore, the pollution of aquatic environment has become a worldwide problem in recent years, because of their toxic effects on living organisms. Among environmental pollutants, heavy metals are of particular concern, due to their potential toxic effects and bioaccumulation ability in the ecosystem<sup>6</sup>.

This study was aimed at determining the physicochemical properties and heavy metals contents of the water and sediment of Challawa Gorge dam in order to assess the suitability of the water for drinking, fishing and agricultural activities. The study is expected to serve as a baseline for monitoring and tracking changes in the water quality of the dam.

## MATERIALS AND METHODS

### *Study Area*

The Challawa Gorge Dam is located on latitude 11° 44' 34" and longitude 8° 1' 2" in Kano State Nigeria. It is a major reservoir on the Challawa River, built in 1990-1992 with a full storage capacity of 904,000,000m<sup>3</sup> and a direct catchment area of 3857km<sup>2</sup>.<sup>7</sup>

### *Sample Collection*

Water and sediment samples were collected from five different locations within the dam on weekly basis during the rainy and dry seasons (March 2012-September 2012). Collection and preservation of samples were done based on procedures described by<sup>8</sup>.

### *Sample Analysis*

Dissolved oxygen of the water sample was measured with a DO meter Jenway model 9071 and heavy metal contents of the water and sediment samples were determined using Atomic Absorption Spectrophotometer (Shimadzu Model AA 6880). All other physicochemical analysis of water samples were determined using Wagtech Physicochemical Water Analysis kit (Model CP 1000).

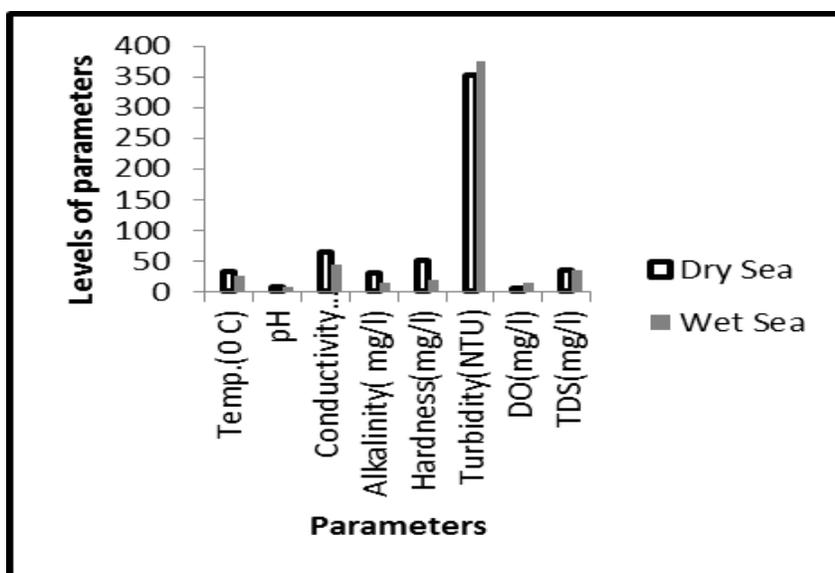
## RESULTS AND DISCUSSION

The mean seasonal variations of the physicochemical parameters in water are shown in Figures 1 and 2 while Figure 3 shows the mean seasonal variations of the

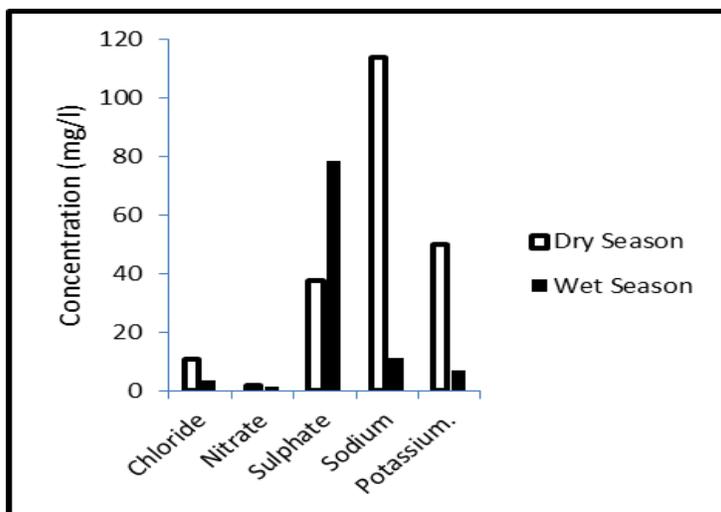
heavy metals in the water and sediment samples.

The water temperature was high during the dry season ( $33.6 \pm 0.8^{\circ}\text{C}$ ) when compared to  $26.9 \pm 1.5^{\circ}\text{C}$  recorded during the wet season. There is no guideline value for temperature, however temperature affects the levels of other parameters such as conductivity and DO.

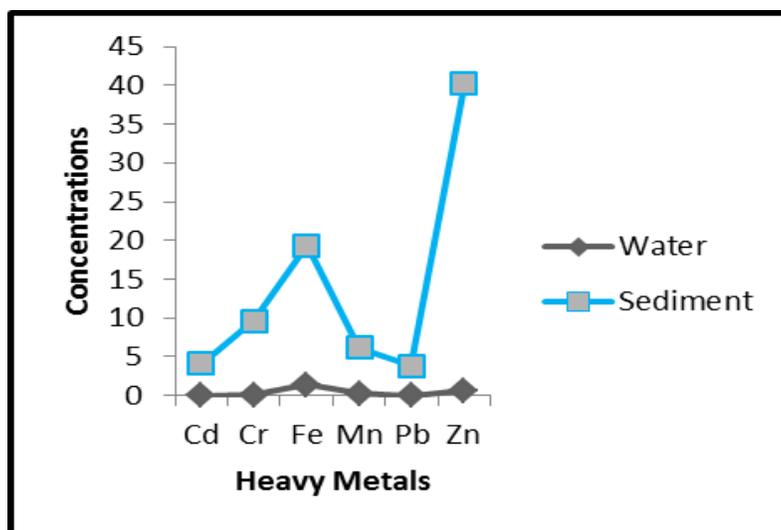
The mean values of pH of the water ranged from  $7.78 \pm 1.1$  for wet to  $7.82 \pm 0.2$  for the dry seasons (Fig. 1). An acceptable pH for domestic and irrigation purposes is between 6.5-8.5 and 5.5-8.5 respectively. High or low pH values in a river affects aquatic lives and alter toxicity of other pollutants<sup>9</sup>.



**Figure 1:** Mean seasonal variations of some physicochemical parameters in water samples of Challawa Dam



**Figure 2:** Mean seasonal variations of some mineral elements and anions (mg/l) in water samples of Challawa Dam



**Figure 3:** Mean seasonal variations of heavy metals (mg/l) in water and sediment samples of Challawa Dam

Seasonal variations in electrical conductivity/total dissolved solids,

hardness and alkalinity of the water were also observed (Fig. 1), but all values were

within the WHO<sup>10</sup> acceptable limits for portable drinking water. Higher values of conductivity and alkalinity was reported in Challawa River<sup>9</sup>.

The turbidity of the dam water ranged from  $352.2 \pm 5.2$  NTU in dry season to  $374.6 \pm 50.6$  NTU in the wet season (Fig. 1) as against the WHO guideline value of 5 NTU<sup>10</sup>. This turbidity values were much higher than values reported by other researchers<sup>11,12</sup>. The general trend of turbidity, which is high in all seasons, indicates the role played by mud, algae and microorganisms in contributing to turbidity. The major effect turbidity has on humans might be simply aesthetic, but for aquatic lives, it reduces photosynthesis leading to decrease in the primary productivity upon which the fish food organisms depend leading to reduction in fish production<sup>13</sup>.

Though significant variations in DO were recorded between seasons (Fig.1) but all values obtained were within the WHO<sup>10</sup> permissible limit of greater than four (4) for domestic water supplies and stream standards for fishing<sup>13</sup>.

The concentrations of chloride and nitrate in the dam water were higher in the dry season ( $2.03 \pm 1.5$  mg/l for nitrate and  $10.72 \pm 0.57$  mg/l for chloride) compared to the levels in the wet season ( $1.59 \pm 0.18$  mg/l for nitrate and  $3.47 \pm 0.36$  mg/l for chloride). However, the mean sulphate concentrations showed a higher value ( $78.6 \pm 2.4$  mg/l) in the wet season compared to the dry season ( $37.8 \pm 0.8$  mg/l) (Fig. 2). This may be attributed to

run-off of sulphate fertilizers from nearby farmlands in to the dam.

The mean concentrations of the heavy metals in the dam sediment were higher than in the water samples (Fig. 3). This may be due to the deposition of sediment on the surface of water via aerial transport or directly supplied from the catchments through the weathering of rocks and other processes such as forest grazing lands, urban construction sites and other sources of erosion and runoff washed away from the land into water bodies. Similar seasonal variations and high concentrations of heavy metals in aqueous sediments have been reported<sup>11,14</sup>. The concentration of toxic trace elements in water sediments provides the advantage of both evaluating the quantities and qualities of the water distribution network. The concentrations of the heavy metals analyzed were all within the WHO permissible limits and NOAA<sup>15</sup> limits for sediments with the exception of Fe ( $1.35 \pm 0.06$  mg/l in water and  $19.31 \pm 5.6$  mg/kg in sediment), which exceeds the recommended value of 0.3 mg/l. High levels of soluble iron are usually associated with different anthropogenic inputs such as agricultural activities around the dam and deep bores and dams where oxygen supply is limited. Reduction of ferric ( $\text{Fe}^{3+}$ ) to ferrous ( $\text{Fe}^{2+}$ ) in the presence of organic matter might also have contributed to high levels of Fe<sup>16</sup>. The mean concentrations of Na and K confirmed their presence in the water and sediment of the dam but the

levels were low and may not cause any adverse health effects.

## CONCLUSION

The physicochemical parameters and metal levels (Cd, Cr, Fe, Mn, Pb, Zn, Na and K) determined in the water of Challawa Gorge dam seasonal variations were observed between the dry and the wet seasons. This may be attributed to reduction in the volume of water during the dry season. The parameters studied in the water and sediments with the exception of turbidity and Fe levels were found to be within the acceptable limits for drinking and fishing. Therefore, the water in Challawa Gorge dam is safe for human consumption, domestic, fishing and irrigation activities. However, monitoring of anthropogenic activities is necessary to safeguard the water quality and human lives.

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