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Quality Assessment of Oji River Surface Water Samples: Implications for Aquaculture Operation

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ABSTRACT
This study was carried out to ascertain the suitability of the Oji River surface water resources for aquaculture purposes. Physico-chemical analyses were carried out on water samples collected from three different points along the river course representing the upper, middle and lower courses. The water samples were analyzed for Temperature, pH, Conductivity, Turbidity, Chlorides, Alkalinity, Total Hardness, Nitrate, Sulphates, Phosphates, Total Dissolved Solids, and Total Suspended Solids. The Temperature values of the surface water samples ranged from 27^0c to 28^0c. The pH values ranged from 5.40 to 5.60. The Electrical conductivity values ranged from 60.60 to 63.63 μScm^{-1}. The Turbidity values ranged from 0.60 to 0.76 NTU. The Chlorides values ranged from 5.60 to 6.80 mg/L. The Alkalinity values ranged from 2.80 to 4.00 mg/L. The Total Hardness values ranged from 8.00 to 10.40mg/L. The Nitrates values ranged from 0.17 to 0.69 mg/L. The Sulphates values ranged from 5.51 to 6.20 mg/L. The Total dissolved solids values ranged from 985 to 1240 mg/L. The Total suspended solids values ranged from 1000 to 1260 mg/L. The results of the analyzed water parameters indicated that the values obtained for most of the samples were within the acceptable ranges for aquaculture operations and that only a few samples were outside the acceptable ranges though their effects can be corrected. The outcomes of the analyses showed that Oji River area council and environs have great potentiality for aquaculture development.
Keywords: Aqua operation, Surface-water and Physico-chemical parameters**.**

INTRODUCTION

The global development of aquaculture is on a swift rise as a result of increasing pressure on its products and limited production potential of marine and inland capture fisheries (Aniebone, V.O., Mohammed, R., Nwamba, E.E., and Abe, O.B, 2018). Supplies coming from inland and coastal water sources are not sufficient. Basically, fish production beside aquaculture (fish farming) is from artisanal and industrial fisheries. Artisanal fishery refers to the harvesting or capturing of fishes from natural water bodies such as rivers, streams, lakes, lagoons, coastal water bodies, and ponds by small scale fisher folks using both traditional and modern fishing gears (Okwu et al., 2011). The industrial fisheries are a higher and mechanized level of fish production, which depends on the use of trawling vessels for fishing and shrimping in the territorial and offshore waters (Dada, 2003). It refers to the industrial fishing in inshore and offshore water of the seas. Aquaculture, to which fish farming belongs, is the commercial rearing of fish in conditions where all basic means of production can be controlled within their respective limitations and from which farmers target to get maximum financial gains (Tunde et al., 2015). Aquaculture is

defined as the rearing of aquatic organisms under controlled or semi-controlled environments for the social and economic benefits of mankind and livestock (Rouhani & Britz, 2004; Nandi et al., 2014). The aquatic organisms that could be reared include fish, insects, bivalves and pearls, mollusks, crustaceans, and aquatic plants, while the controlled environments include ponds, cages, pens, and raceways (Tunde et al., 2015). This present study is on water quality assessment from Oji River water body for aquaculture production. In aquaculture two things are very crucial: water sources are matched to aquaculture products. What comes first, the water or the fish? Usually, aquaculture projects come from one of two situations (Michael & Colt, 2000). Often someone has knowledge about a species that they are hoping to culture and needs to find a site with a source of water to fit the species or has a site with an available water source and is looking for a suitable species to culture. Water source and species selection are closely linked. Water is the most important element for aquaculture production therefore in selecting a site, the source of water and its suitability ought to be considered as water quality determines the ultimate success or failure of an aquaculture operation. Water embodies certain physico - chemical substances that determine its quality. These substances can be harmful to both human and aquatic organisms when taken in excess or beyond the specified range. Poor water quality may impair the development, growth or quality of fish products by tainting their flavor or causing bioaccumulation due to high concentration of some elements or toxic substances. A knowledgeable aquaculturist should consider the physico-chemical state of the water source for the intended aquaculture project. According to Arabi et al. (2011), the two main categories of water supply for aquaculture purposes are subsurface and surface water. Ground water often differs substantially from surface water in their characteristics. Subsurface water is commonly considered the most desirable water source for aquaculture because it is usually consistent in quantity and quality and free from toxic pollutants and contamination with predator or parasitic living organisms (Arabi et al., 2011). However, subsurface water can be contaminated if there is incidence of waste water intrusion into the underlying aquifers. The objective of this present study is to carry out quality assessment of Oji River surface water sources for aquaculture (fish farming) purpose. Oji River local council area and environs share both urban, peri-urban and village settings. There are numerous riparian communities along the Oji River water course from the source to the mouth.

MATERIALS AND METHODS

Study Areas

The study area is located within latitudes 6^0 31′ 30″N and longitudes 7^0 44′ 0″ E. The Oji River is the trunk stream in Oji River Drainage Basin in Enugu State southeastern Nigeria (Figure 1). The river has its source from the famous Enugu-Awgu escarpment. The presence of a north-south trending cuesta or escarpment that crosses Enugu State creates major surface and ground water divides for the two great drainage basins of Cross River and Anambra River east and west of the escarpment respectively. Oji River and its tributaries flow westwards into Mamu and Anambra river basins passing through various types of land uses from its source down to its confluence with Mamu River in Anambra state. The area lies within the humid tropical rainforest belt of Nigeria (Iloeje, 1979; Balogun, 2005) with partially deforested northern parts turning into derived Savanna grassland and has a tropical savanna climate (Koppen: Aw). This area is characterized by relatively warm temperature days of 27^0C to 32^0C and moderately cool nights of 17^0C to 28^0C. The area experiences two main distinct seasons, namely the dry season and rainy season. The soils underlying the study area are of sedimentary origin with sandstones and shales as the two dominant parent materials. The study area shows undulating relief with a high central zone, which lies over 370m above mean sea level. Some isolated peaks may reach over 580m. The landforms are categorized into cuesta, plains and lowland landscapes. The cuesta comprises the Nsukka - Okigwe cuesta, the Enugu and Awgu escarpments and the Udi - Nsukka plateau (Akamigbo, 1987). The geology of the study area can be broadly classified into shapes, false-beddded sandstones and coal measures (Akamigbo, 1887). The study basin, the Oji River Basin is underlain by three lithostratigraphic units. These are: Imo Shale, Nsukka Formation, and Ajalli Sandstone.

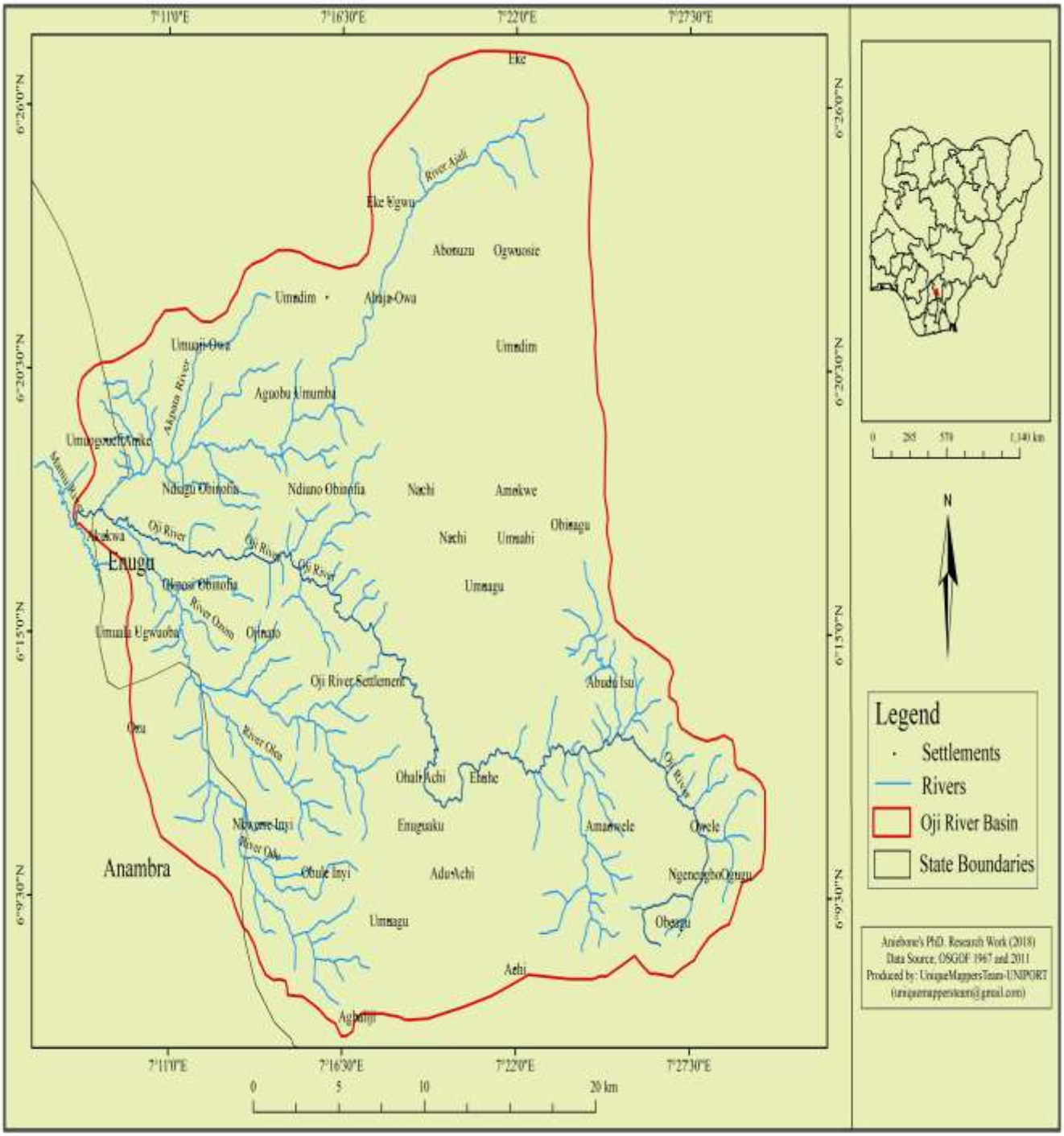

Figure 1: Oji River basin showing the riparian communities

Sampling

Surface water samples for this study were collected from three different locations representing the upper, middle and lower courses of the Oji River (Figures 2).These are represented by P1, P2 and P3.

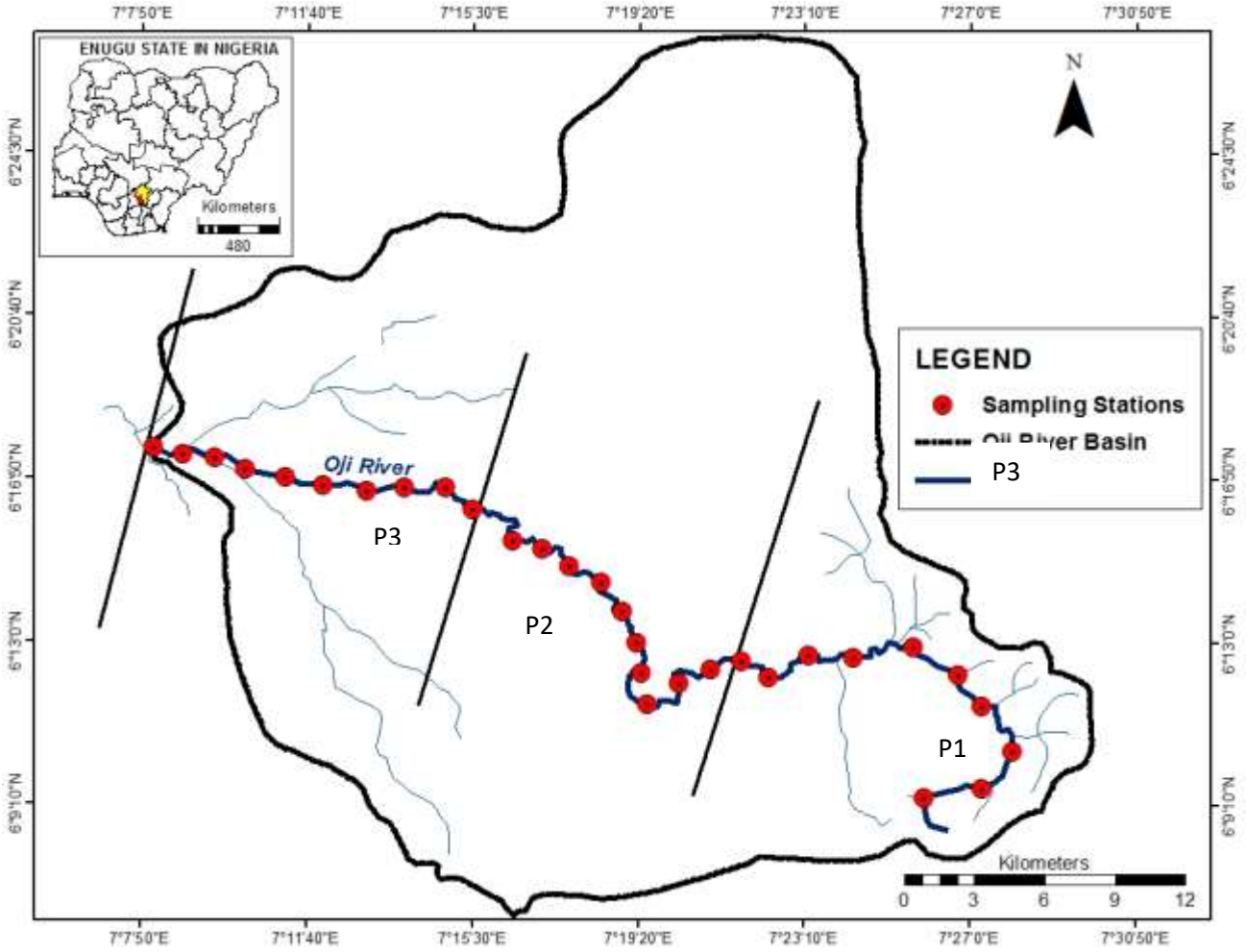

Figure 2: Oji River channel showing Sampling points (P1, P2, and P3 are the water sampling points)

The surface water samples were collected in high density polyethylene bottles prewashed with 1 N hydrochloric acid followed by distilled water and then rinsed two to three times with the sampling water. The collected water samples were transferred to the Plant Anatomy and Physiology Research laboratory at the University of Port Harcourt for further analysis and kept at 5 °C. The samples were filtered using 0.45 µm cellulose membrane before the analysis. The water samples were analyzed for Temperature, pH, Conductivity, Turbidity, Chlorides, Alkalinity, Total Hardness, Nitrate, Sulphates, Phosphates, Total Dissolved Solids, and Total Suspended Solids (Table 1). Turbidity was measured with a HACP 400P turbidimeter Temperature of the groundwater samples was determined using a common mercury thermometer, pH of all the samples were determined directly at the sources with pH meter. Hardness was

analyzed by titration with EDTA. The sampling and preservation procedures and analytical methodologies followed the criteria adopted by the APHA (1995).

Table 1. Physico-Chemical Data From The Three Sampling Points

	OJI RIVER								
Variable	P1	P2	P3	MAX	MIN	MEAN	SD	WHO Standard, 1993	Desirable range of water for freshwater fish culture (Chapman, 1996)
Temperature °C	28	27	27	28	27	27.3	0.58	-	24-32^{0}C
Ph	5.40	5.60	5.50	5.60	5.40	5.50	0,1	6.8	6.5-8.5
Conductivity µScm^{-1}	63.50	61.80	60.60	63.50	60.60	61.97	1.46	1.01µScm	<1500 µScm^{-1}
Turbidity NTU	0.72	0.76	0.60	0.76	0,60	0.69	0.08	-	40-80 NTU
Chlorides mg/L	6.80	5.60	5.60	6.80	5.60	6.00	0.69		
Alkalinity	4.00	3.60	2.80	4.00	2.80	3.47	0.61	200mg/l	50-400mgL
Total Hardness mg/L	10.40	8.40	8.00	10.40	8.00	8.93	1.29	100mg/l	50-400mg/L
Nitrates mg/L	0.17	0,62	0,69	0.69	0.17	0.49	0.28	10mg/l	0-3mg/L
Sulphates mg/L	6.20	6.20	5.51	6.20	5.51	5.97	0.40	0.02	< 0.1mg/L
Phosphates mg/L	0,54	0.30	0,32	0.54	0.30	0.39	0.13		
TDS mg/L	1240	1010	985	1240	985	1078	141	500mg/l	80mg/L or less
TSS mg/L	1260	1120	1000	1260	1000	1127	130	10mg/l	80mg/L or less

RESULTS AND DISCUSSION

The results of the physico-chemical parameters as depicted in Table 1 show that the Temperature values for the surface water samples range from 27^{0}c to 28^{0}c with mean of 27.3^{0}c and a standard deviation of 0.58. The highest value of 28^{0}c was recorded at P1 and 27^{0}c were recorded at P2 and P3 respectively. Temperature affects the development and growth of fish more than any other single factor. Each species has optimal growth and reproduction temperature ranges. The temperature values fall within the desirable range required for fish culture in the tropics.

The pH values range from 5.40 to 5.60 with mean of 5.50 and a standard deviation of 0.1 for the surface water samples. P2 has the highest pH value of 5.60 while P1 has the least pH value of 5.40. pH, the negative logarithm of hydrogen-ions concentration – a way to measure acidity. It is the scale used and is from 0 to 14, where lower number reflects higher acidity & the higher number reflects higher alkalinity. Acid death point is around 4, alkaline death point is about 11 pH. Toxicity of ammonia to fish increases with an increase in pH. The acceptable range for aquaculture is between 6.5 to 8.5. The EU sets protection limit of 6 to 9 for fisheries and aquatic life (Chapman, 1996). The values are below the acceptable range for fish culture. This implies that treatments should be carried out to make the water source beneficial.

The Electrical conductivity value in the analyzed surface water samples of Oji River ranges from 60.60 to 63.50 uScm-l with mean value of 61.97 uScm-l and a standard deviation of 1.46. P1 has the highest value of 63.50 uScm-l value while P3 has the lowest value of 60.60 uScm-l. Electrical conductivity (EC) is an indicator of the presence of ions and concentrations of dissolved components and has a direct relationship with salinity and TDS which are used for groundwater classification. The EC values in the surface water samples are within the desirable range for aquaculture practice (Table1)..

The turbidity values for the Oji River water samples range from 0.60 to 0.76 NTU with mean value of 0.69 NTU and a standard deviation of 0.08 with P1 having the highest value while P3 has the lowest

value. Studies on warm water fishes have depicted that fishes do not show any behavioral reaction until turbidity approached 20,000ppm (Gupta & Gupta, 2006). The values are normal for aquaculture production.

The Alkalinity value of the surface water samples ranges from 2.80 to 4.00 mEq/L (milliequivalent per liter) with mean value of 3.47 mEq/L and a standard deviation of 0.61. P1 has the highest value while P3 has the lowest. Alkalinity is the capacity of water to neutralize acids without an increase in pH. It consists of negatively charged bases – carbonates, bicarbonates, and hydroxides. It is expressed in equivalent concentrations of calcium carbonate. Alkalinity offers a buffering system to reduce pH swings. Alikunhi (1957) reported that in highly productive waters, the alkalinity ought to be over 100 mEq/L. However, the range of alkalinity was 0.0 - 2.0 mEq/L for low production, 20 - 40mEq/L for medium production and 40 – 90 for high production (Pandey and Shukla, 2005). The values in the surface water samples are within the desirable range for fresh water fish culture

Total hardness of the surface water samples ranges from 8.00 to 10.40 mg/L with mean value of 8.93mg/L and a standard deviation of 1.29. P1 has the highest value while P3 has the least value.

Hardness - Water hardness is similar to alkalinity but represents different measurements. It refers to the concentration of divalent cations (calcium, magnesium, and sodium). It is also expressed as the calcium carbonate equivalent concentration. Hardness may be an index of potential pond productivity. Hardness values of at least 20 ppm should be maintained for optimum growth of aquatic organisms. Low- hardness levels can be increased with the addition of ground agriculture lime.

The sulphate values from P1, P2, and P3 locations range from 5.51 to 6.0 mg/L with mean of 5.97 mg/L and a standard deviation of 0.40.

The chloride values of the surface water samples from P1, P2, and P3 sites ranged from 5.60 to 6.80mg/L with mean of 6.00 and a standard deviation of 0.69. According to Alabaster & Lloyd, (1980), chloride and chloramines as low as 4ppb of hypochlorite can be harmful to fish within four days of exposure.

The nitrate value of the Oji River surface water samples ranges from 0.17 to 0.69 mg/L with mean of 0.49 mg/L and standard deviation of 0.28. P3 has the highest value while P1 has the lowest value (Table 1). The values fall within the acceptable range and therefore good for aquaculture uses.

Total dissolved solids values from the Oji River surface water samples range from 985 to 1240mg/L with mean of 1078mg/L and standard deviation of 141. The values are outside the acceptable range for fish culture. This high values can be attributed to erosion and flooding of the river. The sample was collected in the month of June at the peak of rainy season. The water sourcing needs some corrective measures so as to be utilized.

Total suspended solids value of the surface water samples ranges from 1000 to 1260mg/L with mean of 1127mg/L and a standard deviation of 130. The values are outside the acceptable range for fish culture. This can be as result of rainy season river flooding. Nevertheless, this can be remedied by putting some measures in place.

SUMMARY AND CONCLUSION

Aquaculture, defined as the rearing of fishes and other aquatic organisms under controlled or semi-controlled environments for the social and economic benefits of mankind and livestock is an essential enterprise in our society today. One of its goals is increased fish production. Beside financial gains, fish and fishery resources intakes provide the needed proteins in our daily diets.

This research work has provided valuable information on the quality status of Oji River surface water with respect to its suitability for fish farming. It will also provide background information to the potential farmers both in Oji River local council area and other inhabitants of the Oji River drainage basin. This is because the areas share similar geology and soil types. Water quality determines the growth and general wellbeing of fish particularly in the culture system. The quality assessment of the Oji River surface water samples collected from three different points representing upper course, middle and lower course indicate that most of the parameters are within the acceptable ranges for aqua operation except for total dissolved solids, total suspended solids and one other parameter. Their high values can be attributed to intense

flooding as a result of high discharges. The problem can be tackled and corrected with careful management of the water source.

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