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ASSESSMENT OF WATER QUALITY USING PHYSICOCHEMICAL PARAMETERS AS AN INDICATORS OF RIVER MATAN FADA, ARGUNGU

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ABSTRACT

Water is one of the most important natural resources needed for the survival of all living organisms on earth. The water quality of River Matan Fada was assessed using physicochemical parameters as indicators from February to July 2023. Physicochemical parameters like pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), turbidity, conductivity, nitrate, and phosphate were measured on the monthly basis using standard methods. Statistical analysis showed no significant difference in physicochemical parameters among sampling points ($p>0.05$), but significant differences existed among months ($p< 0.05$). Furthermore, Post Hoc analysis was carried out in order to reveal the actual point where the differences lie. Overall, River Matan Fada was described as slightly polluted due to minimal chemical and organic pollutant concentrations at various points. There is need for a lengthy research work and continuous monitoring of this River since the water is being used for various purpose especially domestic and recreational.

Keywords: Physicochemical parameters, Matan Fada, Pollution, Monitoring and Water quality

1.0 INTRODUCTION

WATER is one of the most important natural resources needed for the survival of all living organisms on earth (WHO 2023). It plays a vital role in maintaining aquatic ecosystem and human health in general. Water, an essential requirement for all forms of life, need protection from pollution which otherwise pose a threat to human life. Environmental conditions such as salinity, oxygen, temperature and nutrients affect the composition, distribution and growth of its biota (Swami *et al.,* 2000).

Matan Fada River is an important source of freshwater to the surrounding communities; it is popularly known for irrigation farming, fishing, and recreational activities. Presumably, the river has been under environmental stress resulting from human's detrimental activities. Detrimental changes to surface water quality of a river can affect other bodies of water, a sensitive issue of environmental concern (Hanna and Shekha, 2015). Water quality refers to the chemical, physical and biological characteristics of water (Diersing and Nancy, 2009). It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need (Johnson *et al.,* 1997). Therefore, the overall process of evaluation of the physical, chemical and biological nature of water in relation to natural quality, human effects and intended uses, particularly which may affect human health and the health of aquatic organism is refers to as water quality assessment (Chapman, 1992).

Physicochemical and micro-biological parameters of water indicate the safety of potable water and their analysis is essential for public health and pollution studies (APHA 1999). The significance of water to human and other biological systems cannot be over emphasized, and there are numerous scientific and economic facts that, water shortage or its pollution can cause severe decrease in productivity and deaths of living species (Garba *et al.,* 2008; 2010). Reports by Food and Agricultural Organization of USA revealed that in African countries,

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particularly Nigeria, water related diseases had been interfering with basic human development (FAO, 2007). The common sources of water that are available to local communities in Nigeria are fast being severed by a number of anthropogenic factors, of which pollution remain the most dominant problem (Adakole and Annune, 2003). The introduction of sewage and organic matter into water bodies increases their pathogenicity and restricts recreational access to these water bodies, while also increasing the risk of human and animal mortality resulting from oral exposure to gastrointestinal and digestive disease-causing pathogens such as viral gastroenteritis, coliform, salmonella, and vibrio cholerae (Lin *et al.,* 2022). Understanding and monitoring the integrity of water bodies globally is an overriding goal for environmental stakeholders as this plays central role in administering regulations, policies, and pollution mitigation or prevention approaches (Chapman and Sullivan 2022). It's based on this background this research aimed to investigate the level of pollution using physicochemical parameters as an indicator for assessing the integrity of River Matan Fadan in Argungu.

2.0 MATERIALS AND METHODS

2.1 STUDY AREA

The study area represents a naturally occurring lotic freshwater at Argungu known as Mata Fada River (Figure 1). River Matan Fada is located at Argungu, in Kebbi State which lies in the Sudan savannah zone of Northern Nigeria on latitude 12°45'N and longitude 4°32'E. Rainy season last from April/May to October while the dry season lasts from November to April. River Matan Fada is approximately 35 km west from Birnin Kebbi town along Sokoto Birnin Kebbi road and about 1km from Argungu town. The River is the major source of water for various domestic and agricultural (such as irrigation and fisheries) activities.

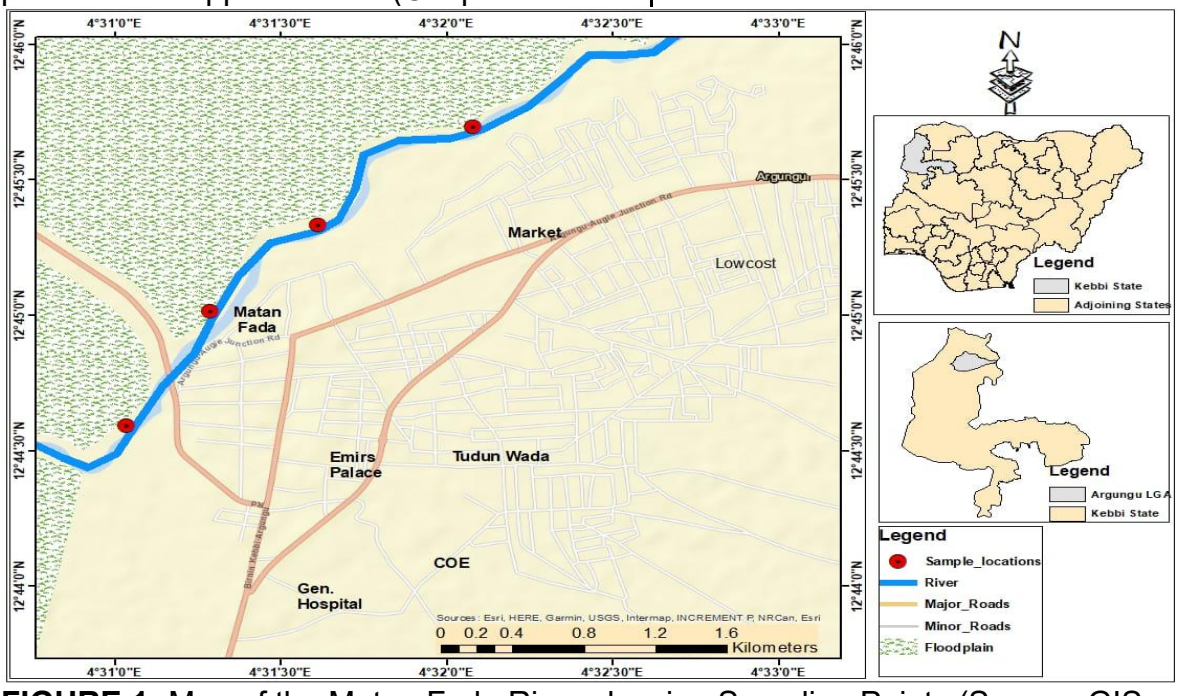

FIGURE 1: Map of the Matan Fada River showing Sampling Points (Source: GIS Geography Department Usmanu Danfodiyo University, Sokoto, 2022).

2.2 SAMPLING POINTS

Four (4) sampling points A, B, C and D were selected for the study base on the differences in their anthropogenic activities. GPS 12 model (GARMIN, USA) was used in taking the global position of the points.

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SAMPLING POINT A is located on Lat. 12º44'42 N and Long. 4º31'10E which is 1km away from the water source. This is regarded as the inlet of the river. Water is being used for irrigation and human activities such as washing and bathing.

SAMPLING POINT B is located on Lat. 12º44'50N and Long. 4º31'13E and is 500m away from sampling point A. Many activities are taking place at this point such as fishing, laundry activities (washing and bathing), irrigation and intake of water for drinking purposes.

SAMPLING POINT C is 500m away from sampling point B located on Lat. 12º44'58N and Long. 4º31'21E. This is regarded as the midpoint of the river. No or less anthropogenic activities are taking place there. It is considered to be the deepest part of the river.

SAMPLING POINT D is also 500m away from sampling point C located on Lat. 12º45'16N and Long. 4º31'35E. This is an outlet of the river where fishing and agricultural farming activities are taking place. Washing and bathing are frequent at this sampling point.

2.3 WATER SAMPLING AND ANALYSIS

Water samples were collected from the river in 250 ml capacity sample bottles from 8-9am and was taken to the Usmanu Danfodiyo University Sokoto for physicochemical analysis. The samples were collected monthly for period of six months from February, 2023 to July, 2023. Physicochemical parameters such as Dissolved Oxygen (DO), Electrical conductivity, turbidity, pH, Biochemical oxygen demand (BOD), nitrate and phosphate were analyzed based on the standard methods for the examination of water and wastewater standard procedure set by American Public Health Association (APHA 2005) while temperature was measured in the field (measured in situ).

2.4 DATA ANALYSIS

Data obtained were computed into Microsoft Excel 2016 edition. Analysis of variance (ANOVA) using statistical package for social sciences (SPSS) version 21 was used to test for significant differences between the means of Physico-chemical parameters at 0.05 significant levels, from four sampling points.

3.0 RESULTS

The results of the monthly mean of physicochemical parameters of River Matan Fada are presented in the Table 1. The results obtained from all the four sampling points have shown that the monthly pH value in all the sampling points ranged from 6.8-8.0. Monthly water temperature in all the sampling points ranged from 24°C - 25.9°C. Concentration of dissolved oxygen (DO) varied from 2.5mg/L - 4.9mg/L with the highest recorded in July and the least in the months of February and March. Biochemical oxygen demand (BOD) ranged from 1.3mg/L – 2.7mg/L in all the sampling points. Similarly, for Turbidity, the monthly values ranged from 3.2 NTU – 8.6 NTU in all the sampling points. The highest mean monthly value of turbidity was recorded in the month of July with 8.2 NTU while the lowest mean value of turbidity was seen in February with 3.2 NTU (Table 1). Monthly conductivity values in all the sampling point ranged from 523µs/cm - 650µs/cm. The highest mean monthly value for conductivity was recorded in July with 650µs/cm and the least mean value was seen in the month of March with 523µs/cm. The concentration of nitrate in all the sampling points varied from 1.0mg/L – 3.3mg/L. The monthly concentration of phosphate in all the sampling points differed from 0.1mg/L – 1.7mg/L.

However, Table 2 shows the mean of physicochemical parameters of River Matan Fada based on the four (4) sampling locations. The mean of pH ranges from 7.5-7.8. The highest mean value of pH was recorded at sampling location C and D with 7.8Mg/L and the lowest value was recorded at sampling location A and B with 7.5Mg/L. Water temperature was recorded highest at

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sampling location D with 25.3°C and the lowest mean value was obtained at sampling location A, B and C respectively with 24.7°C. Sampling location A also recorded the highest mean value of Dissolved Oxygen 3.8Mg/L and the lowest value was recorded at sampling location D with 3.4Mg/L. The concentration of Biochemical Oxygen Demand ranges from 6.1-1.9Mg/L. The highest mean value was obtained from sampling location A with 6.1Mg/L and the lowest value was recorded at sampling location D with 1.9Mg/L.

In addition, the mean of Conductivity ranged from 528-635 µs/cm. The highest mean value was recorded at sampling location D with 635µs/cm and the lowest was recorded at location C with 528µs/cm. For Turbidity, the mean values ranged from 6.2-5.4NTU. The lowest mean value was recorded at sampling location D with 5.4NTU and the highest value was recorded at sampling location B with 6.2NTU. The mean concentration of Nitrate varied from 1.2-1.7Mg/L. Sampling location D was recorded with the highest mean value of Nitrate concentration with 1.7Mg/L and the lowest was recorded at location A with 1.2Mg/L. The mean value of Phosphate ranged from 0.2-0.9Mg/L. The highest mean concentration of Phosphate was recorded at sampling location D with 0.9Mg/L and the lowest was recorded at sampling location C with 0.2Mg/L (Table 2).

Results from the ANOVA revealed that there was no significant difference between the physicochemical parameters within the sampling points ($P > 0.05$), however, there was significant difference between the parameters within the months ($P < 0.05$). The Post Hoc analysis further shows that, at point A, BOD concentration (M=2.15, SD=1.02) significantly differ from that of point B BOD concentration (M=1.54, SD=0.37), Conductivity concentration at A (M=598.33, SD=51.62) significantly differ from that of point C (M=527.50, SD=57.14), and lastly, Phosphate concentration at C (M=0.22, SD=0.22) significantly differ from that of point D (M=0.88, SD=0.91).

4.0 DISCUSION

The result of pH revealed that there was a slight increase in value of pH in the early month of rainy season and low pH was observed during dry season. This may be due to the washing of refused dumped alongside the river bank in to the river during the rainy season. The mean value of pH indicated that the water was slightly alkaline. The values are within the permissible limit prescribed by WHO (2024) and this is also in agreement with the EPA (2022). The water temperature of the study area was relatively low, though slightly below the optimal range (24-30°C). The low temperature recorded during this period may be due to the cool dry North-East trade winds (harmattan) effects. Similar report was given by with findings from Rahman *et al.* (2023) in Bangladesh. The concentration of DO indicates that it was low during dry season and high during rainy season. According to Pontius *et al.* (1999), decrease in DO during dry season is attributed to the decrease in the water level and flow rate into the water body. Biological Oxygen Demand was found to be high during rainy season. Findings of this study also showed that the mean value of turbidity recorded from the river exceed the permissible limit set by WHO and EPA. High turbidity lower light penetration, hindering photosynthetic oxygen generation. Suspended particulates may provide shelter for organisms like bacteria, parasites, and organic residues that increase microbial oxygen demand (Okoro *et al.,* 2022). For human health, turbidity higher turbidity can signify unsafe microbial levels (FAO, 2022). The result of conductivity reveals that higher conductivity was recorded during rainy season than in the dry season. The higher electrical conductivity observed during rainy season may be attributed to an increase in nitrate and phosphate because of the surface water run-off from the farmland as a result of the application of fertilizer. This agrees with

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the findings of Kaur *et al.* (2023) and Otieno *et al.* (2021) in India and Kenya relate high EC to agricultural runoff and domestic wastewater infiltration. For humans, excessive TDS can impart undesirable taste and may contribute to hypertension and renal stress due to elevated sodium and chloride ions (EPA, 2022). The concentration of Nitrates was also higher in the rainy season than in the dry season. The higher nitrates concentration during the rainy season may be due to run-off from farmland into the river as a result of the application of fertilizers from the catchment areas, as reported by Kemdirim (2000) from sediment during decomposition of organic matter. This is also in accordance with the work of Dike *et al.* (2003) on the Jakara River of Kano. Similarly, low concentration of phosphate was observed during the dry season and high concentrations during the rainy season. The high concentration of phosphate during the rainy season could be due to increased surface water runoff from agricultural land, resulting from the application of fertilizer and the discharge of domestic waste. Manure and fertilizers application in agricultural croplands, lawns, and gardens have been as being observed to be potential sources of Cd, Cu, Pb, and Zn runoff into water bodies. Furthermore, nitrogenous fertilizers have particularly been reported to have effect on the solubility and availability of these metals (Wei *et al.* 2020; Xu *et al.* 2020). Leachate from landfills has been reported to contain high concentrations of toxic metals and nitrogen compounds. Agricultural fertilizers, pesticides, and manures are other potential sources of these contaminants (Li *et al.* 2020a, b; Panagos *et al.* 2018).

TABLE 1: MONTHLY MEAN VARIATION IN PHYSICOCHEMICAL PARAMETERS OF RIVER MATAN FADA

	Physico-chemical parameters							
Month	pH	Temperature (ºC)	D.O (mg/L)	B.O.D (mg/L)	Turbidity (NTU)	Conductivity (µs/cm)	Nitrate (mg/L)	Phosphate (mg/L)
February	7.9±0.44	24.0±0.59	2.5±0.17	1.3±0.14	3.2±1.48	542±45.84	1.0±0.37	0.1±0.11
March	8.0±0.86	24.5±0.47	2.5±0.27	1.3±0.18	3.4±1.38	523±54.03	1.1±0.12	0.1±0.13
April	7.5±0.32	24.5±0.3	2.9±0.45	1.5±0.44	4.2±1.21	588±53.52	0.6±0.15	0.2±0.14
May	6.8±0.46	25.7±0.59	3.5±0.21	1.7±0.30	7.1±0.97	590±38.51	1.8±0.40	0.3±0.20
June	8.0±0.33	25.8±0.83	4.5±0.31	2.3±0.24	5.4±3.15	625±52.13	2.0±0.43	0.7±0.22
July	7.5±0.45	25.9±0.85	4.6±1.15	2.7±0.87	8.6±4.97	650±52.92	3.3±0.74	1.7±0.90

Footnote: DO: Dissolved oxygen, BOD: Biochemical oxygen demand

TABLE 2: MEANS OF PHYSICOCHEMICAL PARAMETERS AT SAMPLING LOCATIONS OF RIVER MATAN FADA

	Physico-chemical parameters							
Locations	Ph	Temperature (◦C)	DO (Mg/L)	BOD (Mg/L)	Turbidity (NTU)	Conductivity (µs/cm)	Nitrates (Mg/L)	Phosphate (Mg/L)
A	7.5±0.77	24.7±0.78	3.8±1.40	6.1±3.69	1.9±1.03	598±51.64	1.2±0.40	0.7±0.71
B	7.5±0.56	24.7±0.97	3.2±0.62	1.5±0.37	6.2±4.34	584±59.33	1.6±1.00	0.4±0.40
C	7.8±0.64	24.7±1.01	3.2±1.04	1.6±0.51	3.5±4.3	528±57.14	1.3±0.72	0.2±0.22
D	7.8±0.65	25.3±0.91	3.4±0.83	1.9±0.54	5.4±1.74	635±44.98	1.7±1.14	0.9±0.91

Footnote: DO: Dissolved oxygen, BOD: Biochemical oxygen demand

5.0 CONCLUSION

The data obtained from the research study indicated that pH, temperature, conductivity, dissolve oxygen and biochemical oxygen demand all lies within the standard limit of good water quality set for freshwater according to EPA and WHO while Turbidity recorded exceed the minimum standard values limits set by EPA and WHO. However, nitrate and phosphate fall below the minimum standard limits, therefore, the water at Matan Fada River is of good quality and anthropogenic (activities) within the river had little effect on the general condition of the river. Overall, River Matan Fada was described as slightly polluted due to minimal chemical and organic pollutant concentrations at various points.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

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