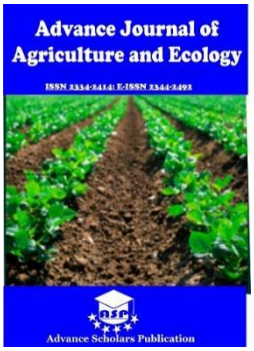
Advance Journal of Agriculture and Ecology
Adv. J. Agric. & Eco.
Volume: 8; Issue: 4
April-2023
ISSN 2334-2414
E-ISSN 2344-2492
Impact Factor: 5.39
Advance Scholars Publication
Published by International Institute of Advance Scholars Development
https://aspjournals.org/Journals/index.php/ajae/index



ASSESSMENT OF WATER QUALITY PARAMETERS OF THE COASTAL WATERS OF RIVERS STATE, NIGERIA

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Keywords:
Coastal waters, water quality, physico-chemical parameters, Rivers State, Nigeria

Abstract
The study was conducted to determine some important physical and chemical parameters following mass fish kills in the coastal waters of Rivers State, Nigeria. Three locations were selected because they were among the affected areas. The measured parameters were water temperature, salinity, pH, dissolved oxygen (DO), alkalinity, nitrate (NO_3–), nitrite (NO_2 –), phosphate (PO_4), and sulphate (SO_4). Results revealed that the monthly mean values ranged from 26.90 to 33.3°C for temperature, 6.13 to 7.44 for pH, 15.01 to 18.61 mg/l for salinity, 49.2 mg/l to 69.2 mg/l for alkalinity, and 5.32 to 8.58 mg/l for dissolved oxygen. Further results revealed that nitrite and nitrate concentrations ranged from 0.51 to 0.69 mg/l and 0.57 to 1.13 mg/l, respectively. The ranges of phosphate and sulphate were 0.31–0.46 mg/l and 3.4–4.51 mg/l, respectively. The statistical analysis of the measured physicochemical parameters revealed significant seasonal fluctuations for temperature, DO, salinity, pH, alkalinity, nitrate, and PO_4 ($p<0.05$). There was a strong positive and significant correlation between temperature and nitrate (0.927, $p<0.01$) and sulphate ($r = 0.894$, $p<0.05$). Also, there was a strong positive and significant correlation between pH and sulphate ($r = 0.898$, $p<0.05$). Nitrite and phosphate have a strong positive relationship ($r = 0.993$, $p< 0.01$). Generally, all the measured parameters were either within or slightly above the permissible limits obtainable in the marine environment.

Introduction

Coastal waters are among the most productive regions of the oceans. About 90 percent of global fishery activity occurs in coastal waters, and the greatest numbers of fish, shellfish, and seafood in general are caught here. However, coastal waters are particularly susceptible to pollution where they receive the outflow of streams and rivers in lagoons or estuaries. Aside from outright fish kills and other dramatic effects, pollution causes pervasive and continuous degradation that is evidenced by the gradual disappearance of fish and shellfish or a general decline in the natural carrying capacity of the system (Clark, 1992).

Masses of dead and dying fish of the family Sciaenidae were reported in various locations along the coastal waters of the Niger Delta in the last week of March 2020 in Nigeria. The region is considered as one of the most oil impacted region in the world due to poor regulated oil activities (UNEP, 2011). Fill kills are events that occur occasionally in the coastal waters of the Niger Delta region, particularly in oil producing areas. This recent event of mass mortality was not confined to the oil producing area but spread to other parts of the region.

Numerous causes of mass fish mortalities in natural water resources were reported in many parts of the world. Mass fish kills in rivers, lakes, estuaries, and

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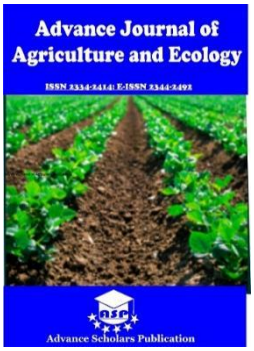

coastal waters are typically caused by abrupt changes in environmental parameters such as salinity, temperature, pH, and dissolved oxygen (DO), as well as the introduction of chemicals, toxicants, or pollutants, toxic algal blooms, or pathogens (Eissa et al., 2013). In many cases, the primary reasons attributed to mass fish kills are natural and anthropogenic hypoxia (Ram et al., 2014).

The continuous anthropogenic input of pollutants into the aquatic environment constitutes a potential threat to natural ecosystems because of its direct effect on water quality as well as aquatic organisms. Fish, like all of God's creation, can only thrive in their enabling environment, the waters, and good water quality is essential to sustaining the life of the organisms. Water quality generally depends on ecosystem circumstances and is assessed according to its physical and chemical properties (Kamboj and Kamboj, 2019). This water quality assessment can provide information on whether the quality of the water can threaten the utilization of marine biota. Water quality is the foundation of healthy marine ecosystems, and degradation of water quality, habitat, or a combination of both can have severe consequences for fisheries and associated ecosystems (Karr, 1981). These physicochemical variables, alone or in combination, impose different morphological and physiological stresses on fish, impairing their health and eventually leading to death (Adams et al., 1993). In order to assess the cause of the mass fish kill incident of sciaenid species, surface physico-chemical characteristics and nutrients content were assessed after the mortality.

Materials and Methods

The coastline in Nigeria stretches on 853 km, along nine states: Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Lagos, Ogun, Ondo and Rivers. Rivers State is bounded on the South by the Atlantic Ocean to the North by Imo, Abia and Anambra States. It also shares boundaries with Bayelsa and Akwa Ibom towards the West. It is located at the Niger Delta area of the South-South geopolitical zone and lies at latitudes 4°45¹N, longitude 6°55¹ E. Its topography ranges from flat plains, with a network of rivers to tributaries. The environment has two seasons; the dry and the wet seasons, the dry season is from November to March and the rainy season is from April to October with an annual rainfall of about 1000 mm. the study area is located between longitude 5° 10' N and latitude 4° 55" and 4° 60' E (Figure 1). The surface water samples were collected from three points, namely, Amaiari (S1), Mbisu (S2), and Oyorokoto (S3), located in Bonny and Adoni Local Government Areas along the 300 km coastal line of Rivers State and the Atlantic shoreline across the area referred to as the "Gulf of Guinea." They were purposively selected because they were in the affected areas.

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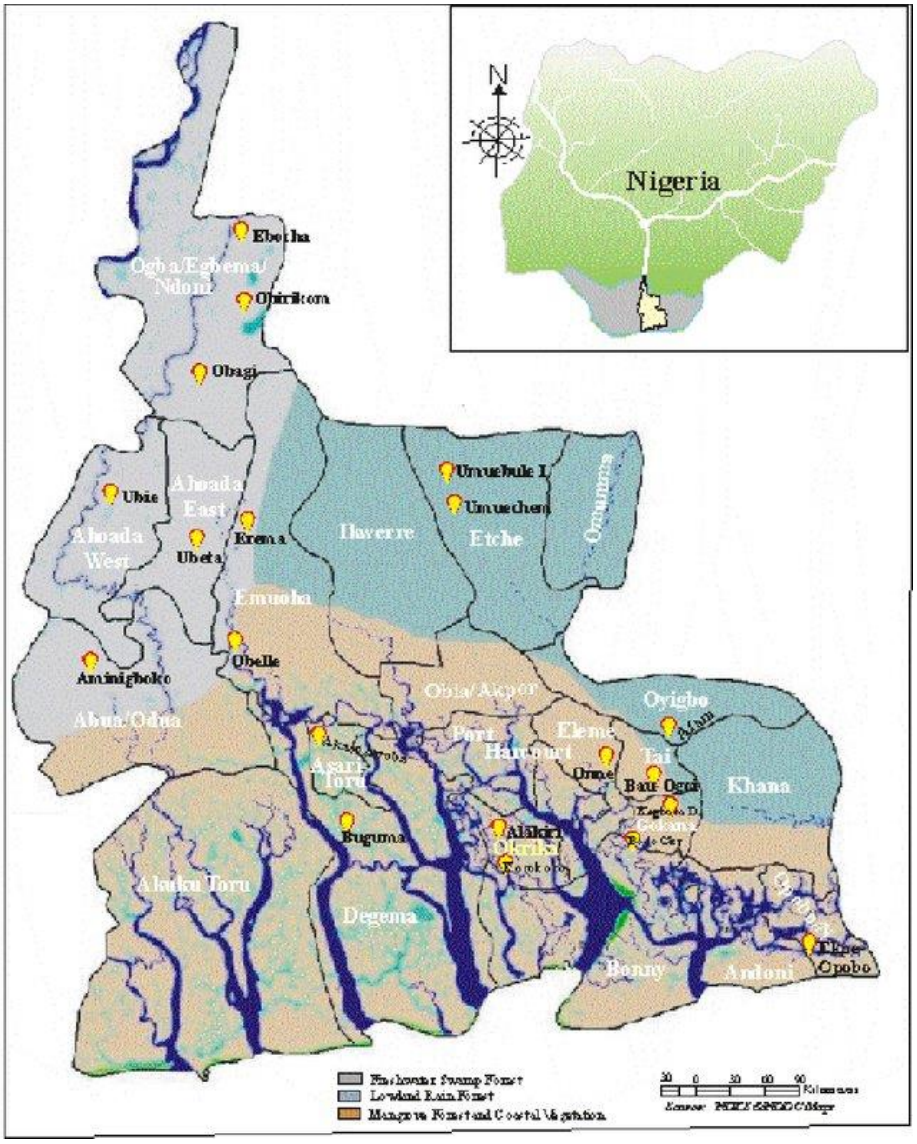

Figure 1: Map of Rivers State showing its Coastal Location

Water sampling and analysis

Water samples for the physicochemical analysis were collected on monthly between January and December 2022, every two weeks basis from each station. Sampling was done during the morning hours, water samples were collected in polyethylene bottles, closed bottle was dipped at a depth of 0.5 to 0.7 m using 250 ml sampling bottles and transported in ice-chest to the laboratory for analysis. The measurement and analysis of water samples have been performed according to standard methods. In situ field measurements such as pH, salinity, temperature, and dissolved oxygen (DO) were measured by using YSI multi-parameter water quality instrument. The other water quality parameters, such as nitrate (mg/l), nitrate (mg/l),

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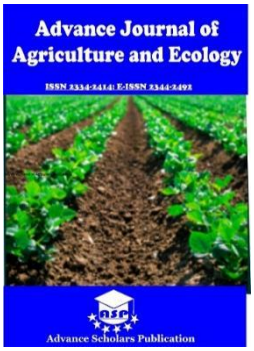

phosphate (mg/l) and sulphate (mg/l) were analyzed at the laboratory according to the standard procedures (APHA, 2017).

Data Analysis

The obtained physicochemical parameters data were analyzed using the descriptive and inferential statistics.

Results

The mean monthly water quality parameters taken at affected sites in Rivers State coastal waters (Table 1). The water temperature was uniformly high with slight variation from month to month as a result of the tropical nature of the study area. The water temperature varied from 26.90°C recorded in June to 33.3°C recorded in March. The mean monthly pH values ranged from 6.13 to 7.44, with the minimum and maximum values recorded in July and March, respectively. The mean monthly salinity values ranged from 15.01 to 18.61 mg/l as recorded in June and January, respectively. The dissolved oxygen ranged from 5.32 to 8.58 mg/l, with the maximum values recorded in June and the minimum values recorded in January. The alkalinity of the water samples ranged from 49.2 mg/l in June to 69.2 mg/l in January. Nitrite and nitrate concentrations ranged from 0.51 to 0.69 mg/l and 0.57 to 1.13 mg/l, respectively. Phosphate values varied from 0.31 to 0.46 mg/l as recorded in June and February, respectively. Sulphate values varied from 3.41 to 4.51 mg/l, with the highest mean value recorded in December and the lowest in April.

Table 1. Mean monthly values for water quality parameters of the coastal waters Rivers State, Nigeria

Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temp (°C)	31.7	31.2	33.3	31.5	29.3	26.9	27.2	29.5	28.7	29.3	32.4	31.7
pH	7.33	7.11	7.44	6.62	6.33	6.31	6.15	6.72	6.13	6.81	7.14	7.23
DO (mg/l)	5.32	6.34	6.81	7.30	8.24	8.58	8.13	7.62	7.24	7.93	7.21	7.47
Alkalinity(mg/l)	69.2	52.1	51.8	62.1	58.9	49.4	51.3	53.4	56.1	54.1	62.6	67.3
Salinity(mg/l)	18.61	18.22	17.94	17.11	16.82	15.01	15.22	15.81	16.4	17.1	15.9	16.5
Nitrite (mg/l)	0.57	0.61	0.71	0.51	0.61	0.54	0.61	0.65	0.62	0.68	0.62	0.69
Nitrate(mg/l)	0.68	0.62	0.68	0.71	0.57	0.63	0.68	1.02	1.09	1.12	1.02	1.13
PO_4 (mg/l)	0.36	0.46	0.37	0.40	0.31	0.37	0.33	0.41	0.36	0.32	0.37	0.42
SO_4 (mg/l)	3.66	3.51	4.11	3.41	4.01	4.21	4.11	4.39	4.71	4.37	4.21	4.51

The statistical analysis of the measured physicochemical parameters revealed significant seasonal fluctuations for temperature, DO, salinity, pH, alkalinity, nitrate, and PO_4 ($p<0.05$) across all stations (Table 2). The mean temperature value recorded in the dry season was significantly higher ($p<0.05$) than in the wet season. Similar statistical values were observed for pH, alkalinity, salinity, and PO_4, with the dry season having significantly higher ($p<0.05$) than the wet season in the four parameters. Further results showed that the mean values of DO and nitrite were significantly higher in

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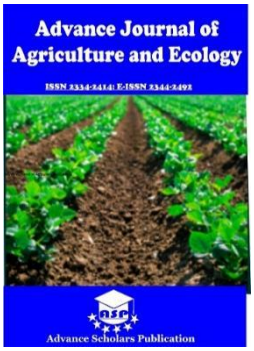

the wet season than in the dry season. There were no significant differences seasonally in the values observed for nitrite and SO4.

Table 2. Physico-chemical parameters of coastal waters for the Dry and Wet Seasons

Parameters	Dry season	Wet season
Temp (°C)	32.13± 0.37[a]	28.91± 0.13[b]
pH	7.25± 0.08[a]	6.43± 0.06[b]
Dissolve Oxygen (mg/l)	6.63± 0.11[b]	7.86± 0.29[a]
Alkalinity (mg/l	60.64± 0.13[a]	55.04± 0.18[b]
Salinity (mg/l	17.43± 0.26[a]	16.20± 0.03[b]
Nitrite (mg/l)	0.65± 0.16[b]	0.76± 0.05[a]
Nitrate (mg/l)	0.83± 0.20	0.83± 0.08
PO_4 (mg/l)	0.39± 0.63[a]	0.36± 0.14[b]
SO_4 (mg/l)	4.04± 0.07	4.17± 0.32

Correlation is significant at the 0.05 level

Figures 2 and 3 depict variations in the physicochemical parameters in the three sampling stations. The average pH in station 1 ranged from 5.11 to 7.47, in station 2 from 5.11 to 8.48, and in station 3 from 5.02 to 8.48. The highest pH was found at station 3 with a mean value of 7.55 and the lowest at station 1 with a mean value of 6.67. The average DO ranged from 4.678 to 8.43 mg/l with a mean value of 7.32 in station 1, 5.63 to 8.92 mg/l in station 2, and 5.02 to 8.48 mg/L in station 3. The highest DO was found at Station 2 with a mean value of 7.48 mg/l and the lowest at Station 1 with a mean value of 7.32 mg/l.

The average nitrite in station 1 ranged from 0.24 to 0.71 mg/l; in station 2, it ranged from 0.21 to 0.71 mg/l; and in station 3, it ranged from 0.34 to 0.61 mg/l. The highest nitrite value was found at station 2, with a mean value of 0.67 mg/l, and the lowest at station 3. The average nitrate in station 1 ranged from 0.68 to 1.83 mg/l; in station 2, it ranged from 1.16 to 1.69 mg/l; and in station 3, it ranged from 1.09 to 1.89 mg/l. The highest nitrate value of 1.74 mg/l was found at station 3, and the lowest at station 2, with a mean value of 1.51 mg/l. The average sulphate in station 1 ranged from 2.67 to 5.01 mg/l; in station 2, it ranged from 2.61 to 4.87 mg/L; and in station 3, it ranged from 4.00 to 4.89 mg/l. The highest sulphate value of 4.33 mg/L was found at Station 1 and the lowest value of 3.65 mg/l at Station 2.

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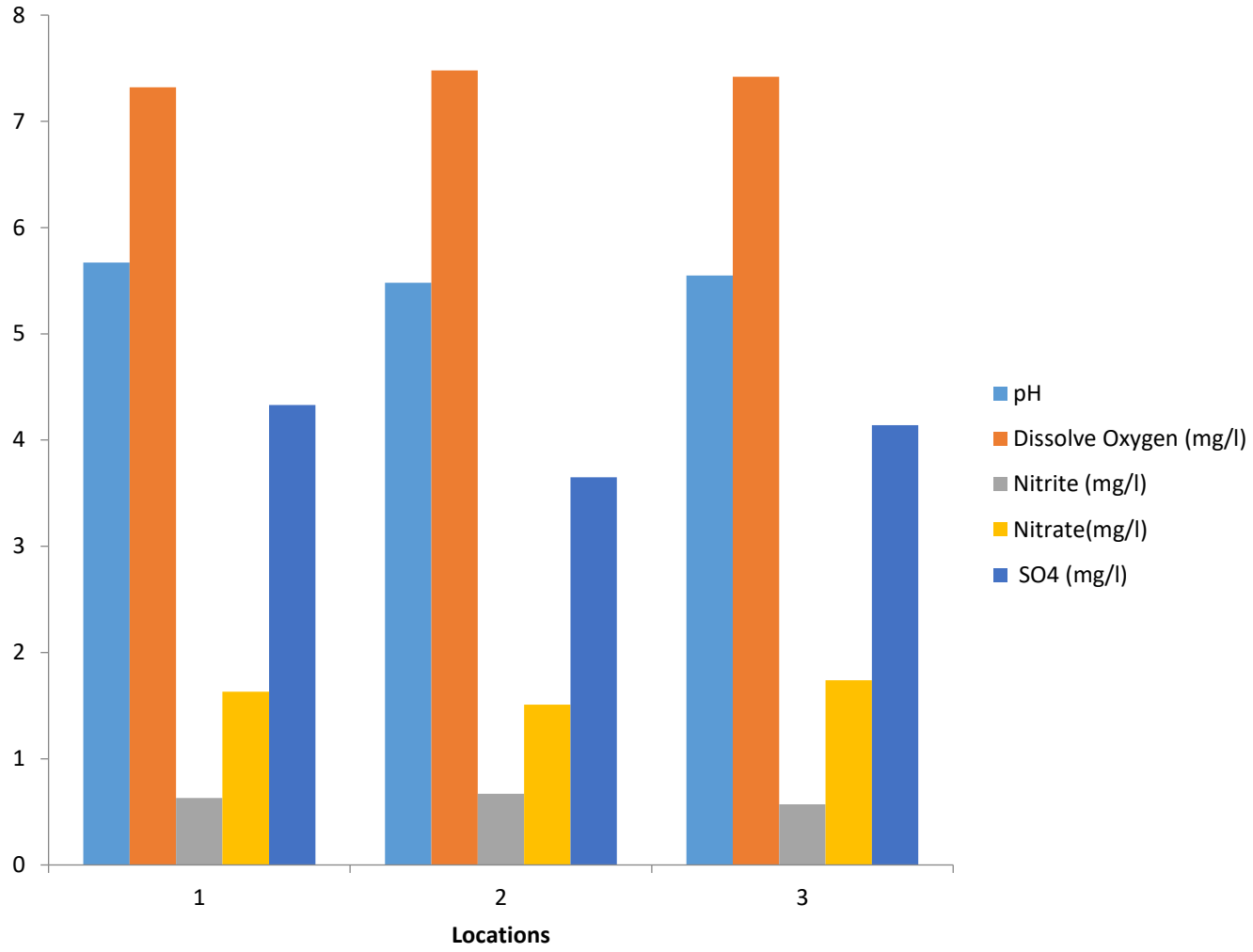

Figure 2 Physicochemical parameters of coastal waters from three stations in Rivers State, Nigeria

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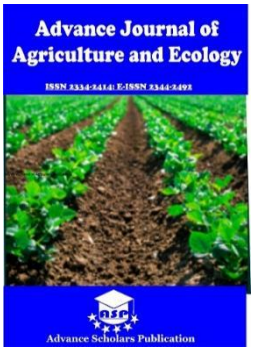

The temperature in station 1 ranged from 26.1 to 31.3 °C; in station 2, it ranged from 24.2 to 33.1 °C; and in station 3, it ranged from 24.0 to 34.5 °C. The highest temperature value of 28.14 °C was found at Station 3 and the lowest at Station 2, with a mean value of 26.90 °C. The average alkalinity in station 1 ranged from 49.14 to 69.16 mg//; in station 2, it ranged from 52.6 to 59.16 mg/L; and in station 3, it ranged from 53.47 to 68.64 mg/l. The highest alkalinity was found at Station 3 with a mean value of 54.4 mg/l, and the lowest value of 52.73 mg/l was recorded at Station 1. The average salinity in station 1 ranged from 15.60 to 21.01 mg/l; in station 2, it ranged from 13.91 to 20.11 mg/l; and in station 3, it ranged from 15.41 to 19.88 mg/L. Station 1 had the highest salinity value of 18.37 mg/l, while station 3 had the lowest value of 16.25 mg/l.

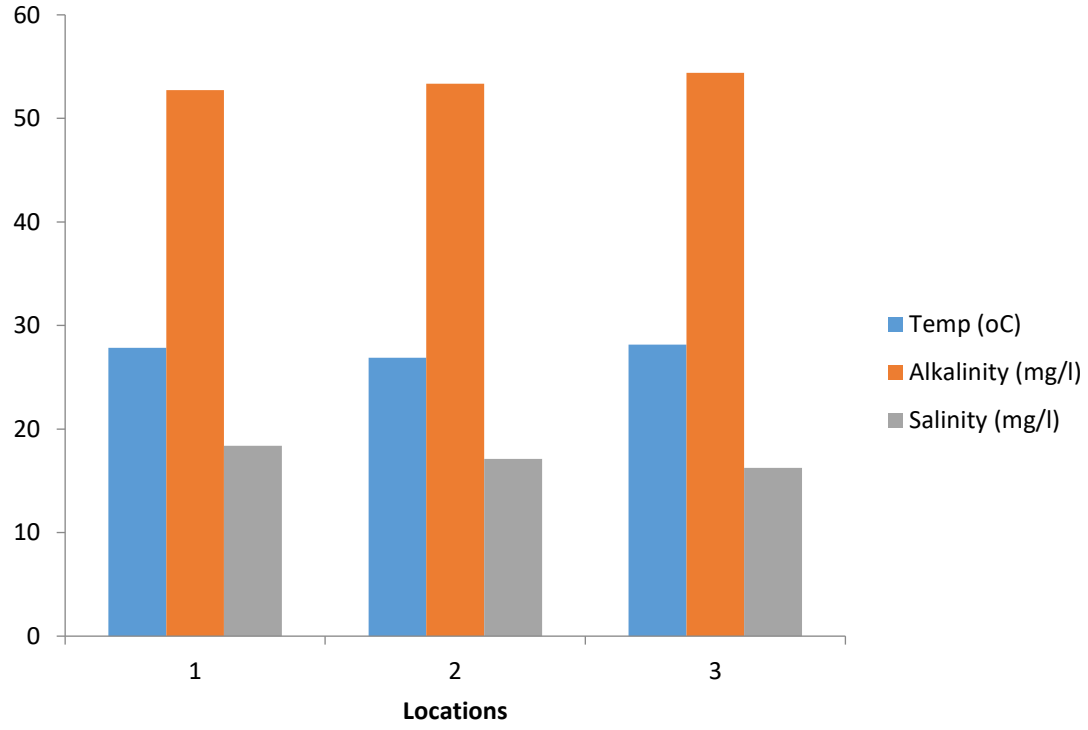

Figure 3. Physicochemical parameters of coastal waters from three stations in Rivers State, Nigeria

Table 3 presents the Pearson's correlation coefficients for physical and chemical conditions at the three study stations as correlation matrices. The correlations between the physical and chemical conditions showed variability in the number of significant correlations ($p<0.05$-0.01). There was a strong positive and significant correlation between temperature and nitrate (0.927, $p<0.01$), and sulphate ($r = 0.894$, $p<0.05$). Also, there was a strong positive and significant correlation between

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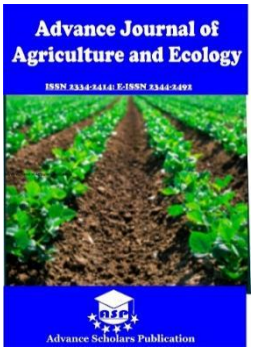

pH and sulphate (r =0.898, p<0.05). Nitrite and phosphate have a positive and significant correlation (r =.993, p 0.01). A strong and significantly negative correlation was obtained between temperature and phosphate, alkalinity, and salinity.

Table 3. Pearson correlation among the physicochemical parameters of the coastal waters of Rivers State

Parameters	Temp °C	pH	DO (mg/l)	Alkalinity (mg/l)	Salinity (mg/l)	Nitrite (mg/l)	Nitrate (mg/l)	PO_4 (mg/l)
pH	0.717							
DO (mg/l)	-0.408	-0.681						
Alkalinity (mg/l)	0.255	-0.32	0.683					
Salinity (mg/l)	-0.067	0.608	-0.695	-0.906*				
Nitrite (mg/l)	-0.52	0.117	0.115	-0.468	0.621			
Nitrate(mg/l)	0.927**	0.458	-0.177	0.556	-0.39	-0.685		
PO_4 (mg/l)	-0.926**	-0.423	0.181	-0.543	0.416	0.743	-0.993**	
SO_4 (mg/l)	0.894*	0.898*	-0.754	-0.178	0.359	-0.307	0.704	-0.697

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Discussion

Fishes generally prefer water conditions of adequate physical and chemical characteristics (Sarkar, 2018). The water temperature observed in this study was conducive and could support fisheries and aquatic life. The water temperature varied from 26.90°C recorded in June to 33.3°C recorded in March. The variations in ambient temperature followed a seasonal climatic pattern with higher temperature values observed in dry season while lower during the wet season. Temperature is in the range suitable for aquatic organisms and in line with the optimal temperature range for fish life in tropical waters is 28-32°C (Warman, 2015. In this study the mean monthly pH values ranged from 6.13 to 7.44 are within the permissible limit. Boyd and Lichtkoppler (1979) reported pH range of 6.09 - 8.45 as being ideal for supporting aquatic life including fish. The pH of water may have been affected by other chemical

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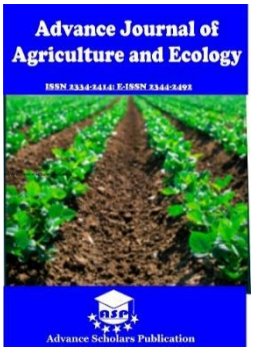

components and nutrients of the surface water. The principal component regulating ion pH in natural waters is the carbonate, which comprises CO_2, H_2CO_3, and H_2CO_3 ion (APHA, 1995). The mean monthly salinity values ranged from 15.01 to 18.61 mg/l as recorded in June and January, respectively. Decreased salinity during the rainy season might be as a result of dilution factor of intense rainfall especially during the months of June, July, August and September. The values of salinity recorded were within tolerable limits which most fish can thrive. The variation of salinity in the study sites could probably due to freshwater runoff entering the coastal waters.

Alkalinity is a measure of capacity of water to neutralize a strong acid, is a function of carbonate, hydroxide content, and includes the contributions from borates, phosphates, silicates and other bases (Qureshimatva et al., 2014). The alkalinity of the water samples ranged from 49.2 mg/l in June to 69.2 mg/l in January. Alikunhi (1957) reported that in highly productive waters, the alkalinity ought to be over 100mg/l. However, the range of alkalinity as 0.0 – 20.0mg/l for low production, 20 – 40mg/l for medium production and 40-90 mg/l for high production. (Pandey and Shukla, 2005).

In the study area, the monthly DO ranged from 5.32 to 8.58 mg/l. As a general rule, concentrations of DO above 5 mg/L are considered supportive of marine life, while concentrations below this are potentially harmful. According to Swingle (1967), the minimum DO of marine waters is 2 mg L-1 under normal conditions and it is not contaminated by toxic compounds, thus being sufficient to support the life of the organism. Yuniarno et al (2015) stated that aquatic organisms usually require oxygen concentrations in the range of 5-8 mg L.

The monthly phosphate values varied from 0.31 to 0.46 mg/l as recorded in June and February, respectively exceeded the permissible limits. A phosphate range of 0.01 to 3.00 mgL1 is prescribed for fish survival and growth (Boyd 1998). Phosphate and nitrate are indicators to evaluate the quality of the water (Fachrul et al., 2005). Boyd (1990), reported that urban people activities (Anthroopogenic) contribute organic materials containing of NO3 – compound, besides, the existence of influence of upwelling factor that can lift (NO_3 –) from bottom of the water column, mainly, in shallow water. All nutrient almost compounds (NO_3 and PO_4) in marine waters and sourced from river flows which generated by agricultural, aquaculture, industrial and household or waste activities population (Casali et al., 2007). In this study the monthly nitrite concentrations were high ranged from 0.51 to 0.69 mg/L. Nitrite is formed due to oxidation of ammonia by the bacterial action which is considered as pollution indicator parameter. The high values of nitrite-N due the organic pollution were also reported in Tapi estuary (Gadhia et al., 2012). The monthly nitrate observed in this study ranged from 0.57 to 1.13 mg/L Nitrate concentrations in excess of 0.2 mg/l can cause in eutrophication of waters which stimulates rapid growth of algae and aquatic plants (blooming) (ObinnaIsiuku and Enyoh, 2020). Sharp (1983) stated that the nitrate concentration in the seawater for normal conditions ranges from 0-0.14 ppm. Sulphate values varied from 3.41 to 4.51 mg/l, with the highest mean value recorded in December and the lowest in April. Sulphate comes through fertilizers, they contributes to water pollution and increase sulphate concentration in water body. They also come from the runoff water, which contain relatively large quantities of organic minerals and sulphate compound.

There was strong positive significant correlation between temperature and nitrate (0.927, $p<0.01$), and sulphate ($r = 0.894$, $p<0.05$). Also, strong

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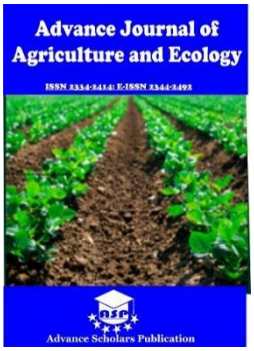


positive significant correlation between pH and sulphate (r =0.898, p<0.05) Surface temperature also positively associated with sulphate, nitrate, nitrite and silicate indicating that higher temperatures increase the mineralization rate of fresh easily degradable organic material and release of minerals from rocky bottoms as reported by Hou et al. (2013). The intrusion of a huge load of nutrients, viz., nitrate, ammonia, and phosphate levels, were associated with sewage discharge and other anthropogenic.

Conclusion

This study evaluated physico-chemical parameters in relation to monthly, location, and season for the surface water of the coastal waters in Rivers State, Nigeria, following mass fish kills. The obtained results show that most of the water quality parameters vary significantly with season and location. The physico-chemical conditions that were obtained for the pH, temperatures, alkalinity, salinity, and dissolved oxygen of the water showed signs of good water quality, which could support the existence of fish and other aquatic life throughout the study period. However, the values obtained for the nutrients, i.e., nitrite, nitrate, phosphate, and sulphate were slightly high but not above permissible limits.

Acknowledgments

The authors would like to thank the TETE Fund Institution-Based Research Grant (TETEF/UPH/IBR/2019/015).

References

Adams, S.M., Allen, M., Ronald, W. 1993. A quantitative health assessment index for rapid evaluation of fish condition in the field. Trans Am Fish Soc 122: 63-73.

Alikunhi, K.H. 1957. Fish Culture Technique in India Programme. Fish Development India 63-73.

APHA, *Standard Methods for Examination of Water and Wastewater*, American Public Health Association, Washington, DC, USA, 19th edition, 1995.

American Academy of Pediatrics (APHA). 2017. *3010 Introduction, Standard methods for the examination of water and wastewater*. https://www.standardmethods.org/doi/full/10.2105/SMWW.2882.039

Boyd C.E. 1990. Water Quality in Warm Water Fish Pond. Auburn University Agricultural Experimental Station. Auburn Alabama

Boyd C.E. 1998. Water quality for pond aquaculture. Alabama: International Centre for Aquaculture and Aquatic Environments, Auburn University.

Boyd, C.E., Lichtkoppler, F.R., 1979. Water quality management in pond fish culture. Research and Development Series 22, 30.

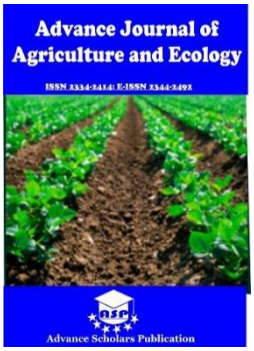
Casali J.R., Gimenez J., Diez J., Álvarez Mozos J., de Lersundi D.V., Goni M., Campo M. A., Chahor Y., Gastesi R., Lopez J. 2010. Sediment production and water quality of watersheds with contrasting land use in Navarre (Spain). Agricultural Water Management, 97, 1683–1694.

Clark, J.R. 1992. Integrated management of coastal zones. FAO Fisheries Technical Paper No. 327. 167 pp

Eissa, A.E., Tharwat, N.A., Zaki, M.M., 2013. Field assessment of the mid-winter mass kills of trophic fishes at Mariotteya stream, Egypt: Chemical and biological pollution synergistic model. Chemosphere 90, 1061—1068. https://doi.org/10.1016/j.chemosphere.2012.09.010

Fachrul, F.M., H. Haeruman, dan L.C. Sitepu. 2005. Komunitas Fitoplankton ebagai Bio-

Advance Journal of Agriculture and Ecology
Adv. J. Agric. & Eco.
Volume: 8; Issue: 4
April-2023
ISSN 2334-2414
E-ISSN 2344-2492
Impact Factor: 5.39
Advance Scholars Publication
Published by International Institute of Advance Scholars Development
https://aspjournals.org/Journals/index.php/ajae/index



indikator Kualitas Perairan Teluk Jakarta. Seminar Nasional MIPA 2005.

Gadhia, M., Surana, R. and Ansari, E. 2012. Seasonal variation in physico-chemical characteristics of Tapi Estuary in hazira industrial area. Our Nat., 10: 249-257.

Hou D, He J, Lu C, Sun Y, Zhang F, Otgonbaya K. 2013. Effects of environmental factors on nutrients € release at sediment-water interface and assessment of trophic status for a typical shallow lake, northwest China. Sci. World J. 2013:716342.

Karr, J.R., 1981. Assessment of biotic integrity using fish communities. Fisheries 6, 21-27.

Kamboj, N., Kamboj, V. 2019. Water Quality Assessment using Overall Index of Pollution in Riverbed-mining Area of Ganga-River Haridwar, India.Water Science,33 (1); 65–74

ObinnaIsiuku, B., Enyoh C. 2020. Pollution and health risks assessment of nitrate and phosphate concentrations in water bodies in South astern, Nigeria, Environmental Advances Volume 2, December, 100018 https://doi.org/10.1016/j.envadv.2020.100018.

Pandey, K., Skukla J.P 2005. Fish and Fisheries. Rastogi Publications, Meerut, India 504pp.

Qureshimatya, U.M., Maurya, R.R., Gamit, S.B., Patel, R.D., Solanki H.A. 2014. Determination of Physico -Chemical Parameters and water quality index (WQI) of Chandlodia Lake, Ahmedabad, Gujarat,India. J. Environ. Anal. Toxicology Vol 5 (4): 28

Ram, A., Jaiswar, J.R.M., Rokade, M.A., Bharti, S., Vishwasrao, C., Majithiya, D., 2014. Nutrients, hypoxia and mass fish kill events in Tapi Estuary, India. Estuar. Coast. Shelf Sci. 148, 48–58. https://doi.org/10.1016/j.ecss.2014.06.013

Sarkar, S., Adhikari, S, Tiwari, P.K. 2018. Importance of Soil and Water Quality Management in Freshwater Aquaculture with Special Reference to Catfish Farming. In Proceedings of the Mass Breeding and Culture Technique of Catfishes, Odisha, India, 16–21 July 2018; p. 25.

Sharp, J.H. 1983. The distributions of inorganic nitrogen and dissolved and particulate organic nitrogen in the sea. In: Nitrogen in the marine environment. E.J Carpenter and D.G. Capone. (Eds.). Academic Press New York: 1- 29 p

Swingle H.S. 1967. Standardization of chemical analysis for water and pond muds. FAO Fish Rep., 4(44), 397–421.

UNEP. 2011. Environmental assessment of Ogoni land First published in 2011 by the United Nations Environment Programme. United Nations Environment Programme.

Warman I., 2015 Water quality test at the Lais River estuary for fisheries in North Bengkulu. Journal of Agroqua 13(2):24–33.

Yuniarno H.A., Ruswahyuni S.A. 2015. Abundance of periphyton in massive and branching corals in Panjang Island Waters, Jepara. Diponegoro Journal of Macquares 4(4):99–108