

Determination of the Levels of Physicochemical Parameters in Surface Water Within the Vicinity of Oil Production Facilities During Wet and Dry Seasons in Omoku, Rivers State, Nigeria

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Abstract

Petroleum exploration and production can modify the physicochemical characteristics of receiving aquatic systems through produced-water discharges, hydrocarbon releases, runoff, waste disposal and other operational activities. This study determined selected physicochemical parameters in surface water within the vicinity of oil production facilities during wet and dry seasons in Omoku, Rivers State, Nigeria. Surface-water samples were collected from Obrikom River (Onosi Ognu), Onosi Okpasimini and a control station over six months comprising three wet-season and three dry-season months. Parameters analysed included pH, temperature, turbidity, electrical conductivity, salinity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD₅), chemical oxygen demand (COD) and total hydrocarbon content (THC), among others. The results showed pronounced spatial and seasonal variability. Temperature ranged from 26.85 ± 0.20 to 30.55 ± 0.33 °C, while turbidity ranged from 9.10 ± 0.12 to 285.40 ± 5.10 NTU. TDS ranged from 210.50 ± 4.30 to 3069 ± 5.10 mg/L, TSS from 7.30 ± 5.01 to 325.50 ± 6.20 mg/L, and dissolved oxygen from 2.61 ± 0.30 to 5.60 ± 0.18 mg/L. BOD₅ ranged from 25.15 ± 0.31 to 32.10 ± 0.25 mg/L, while COD ranged from 12.50 ± 0.13 to 31.50 ± 0.25 mg/L. Electrical conductivity ranged from 290.60 ± 4.30 to 6114 ± 5.10 µS/cm and salinity from 90.50 ± 3.20 to 2380.50 ± 12.40 mg/L. Several parameters, particularly turbidity, TSS, BOD₅, COD, THC, conductivity, TDS and salinity at selected locations and seasons, exceeded the regulatory benchmarks adopted in the thesis. The results demonstrate substantial deterioration of surface-water quality around the petroleum-producing environment and indicate that both petroleum-related inputs and seasonal hydrological processes influence water quality. Continuous seasonal monitoring, improved management of produced water and stronger control of petroleum-related discharges are recommended.

Keywords: *physicochemical parameters; surface water; petroleum production; seasonal variation; Omoku; Niger Delta; water quality.*

Introduction

Surface water is an essential component of aquatic ecosystems and provides water, food, transportation, fisheries and other ecosystem services to human populations. In the Niger Delta, rivers, creeks and wetlands are particularly important because many communities depend directly on aquatic resources for fishing, agriculture and domestic activities. Consequently, deterioration of surface-water quality can have ecological, economic and public-health consequences.

The physicochemical characteristics of a water body reflect interactions among natural processes, climatic conditions, geological materials and anthropogenic activities. Parameters such as pH, temperature, electrical conductivity, turbidity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and salinity are widely used to characterize water quality and identify environmental disturbances. The U.S. Environmental Protection Agency continues to recognize these parameters as important components of surface-water assessment and aquatic ecosystem protection.

Petroleum production presents particular challenges because several waste streams and operational activities can affect adjacent aquatic systems. Produced water, for example, may contain dissolved salts, organic compounds, metals and other constituents. Amakiri et al. (2023) reported that produced water from a Niger Delta oil field contained significant concentrations of inorganic and organic contaminants, highlighting the need for adequate treatment before discharge.

The influence of petroleum production on surface-water characteristics has been demonstrated in several Niger Delta studies. Iwegbue et al. (2023), in an assessment of Bomadi Creek, reported seasonal differences in physicochemical properties and water quality. Similarly, Luke et al. (2023) compared drinking-water characteristics in communities with different levels of crude-oil production and demonstrated the importance of petroleum-production intensity in interpreting water-quality conditions. A study of the Jones Creek oil field also reported variations in physicochemical characteristics, metals and petroleum hydrocarbons in surface water, further illustrating the environmental sensitivity of oil-producing areas.

Seasonality is particularly important in tropical petroleum-producing environments. Rainfall can increase runoff, erosion, sediment transport and contaminant redistribution, whereas reduced water volume during the dry season may increase the concentration of dissolved substances. Thus, a single-season assessment may fail to capture the complete pattern of environmental contamination. The current study was conducted in Omoku, Rivers State, within the Niger Delta. The thesis identified surface-water sampling locations around petroleum-production facilities and a control location and assessed the environment over a six-month period. The study specifically included pH, temperature, conductivity, salinity, turbidity, total hardness, BOD, DO, chloride, nitrate, TDS, TSS, total solids and sulphate.

The need for localized assessment is reinforced by recent research. A 2025 study of a crude-oil-contaminated Niger Delta community found significant seasonal differences in physicochemical parameters, metals and PAHs in groundwater and surface water. More recently, Onwugbuta and Egbunefu reported seasonal variations in physicochemical properties of surface waters from oil-producing areas of Rivers State and neighbouring petroleum-producing locations.

The present study therefore aimed to determine the levels and seasonal variation of selected physicochemical parameters in surface water within the vicinity of oil production facilities in Omoku, Rivers State.

Materials and Methods

Study Area

The study was conducted in Omoku, Ogbia/Egbema/Ndoni Local Government Area of Rivers State, Nigeria. The area forms part of the Niger Delta petroleum-producing environment and contains rivers and wetlands that support fishing, agriculture and other community activities. Sampling was undertaken at Obrikom River (Onosi Ognu), Onosi Okpasimini and a control station.

Water sample collection

Water samples were collected at 2 different points from Omoku River, within the vicinity of oil production facilities in Omoku, Rivers State during wet and dry season. The sampling period lasted for 6 months. Water samples were collected from a shallow point (approximately 2 m into the river) into clean sterilized 2.0 L amber glass bottle with Teflon lined top to prevent photochemical degradation. The samples were collected on seasonal basis once every month for a period of three months in the dry season (December-February) and three months in the wet season (March-May). The samples were carefully collected directly by hand (with gloves) into sampling bottles by pressing them under the water surface. The sampling bottles were twice partially filled, shaken well and emptied before the actual filling was done. 1 M HCL was added to the samples to prevent bacterial degradation. The bottles were put in ice-box and transported to the laboratory where they were kept in a fridge at 4°C prior to extraction.

Biota Sample Collection

tilapia fish (*Oreochromis niloticus*) samples were collected via using a cast net at a point in the rivers. All the samples were kept in a cooler containing ice packs before transporting them to the laboratory and stored at -20°C until analysis.

Soil sample collection

Using a soil auger, soil samples were taken from the several sampling locations at a depth of 0 to 30 cm. The samples will then promptly transfer to the laboratory for analysis in labelled polythene bags.

Physicochemical analysis

The parameters that were determined includes; pH, colour, temperature, electrical conductivity, turbidity, total dissolved solids (TDS), total suspended solids (TSS), chloride, biological oxygen demand (BOD) and nitrogen content. The methods of their determinations are described as follows.

pH value measurement

The measurement was carried out by the use of pH meter. The electrometric meter is a combination of glass electrode with a reference potential provided by standard calomel electrode. The pH meter was standardized with buffer solutions of different pH values (4 and 9) to serve as a check for proper instrument response. The electrode was thoroughly rinsed with distilled water before dipping the probe into the sample solution. The reading was allowed to stabilize with “ready” icon beeping before taking the measurement. The electrode was rinsed and kept in distilled water when not in use.

Electrical conductivity (Econd) μscm^{-1}

Standard potassium chloride of 0.01M and 1413 μscm^{-1} reference solution was used to standardized the meter at 25°C. The samples were analysed under the same conditions as the standard after rinsing the probe thoroughly with distilled water. The reading were allowed to stabilized with the “ready icon” beeping before taking the reading.

Calculation: Cell constant $K(\text{Cm}^{-1}) = R(\text{KCL}) \times \text{Ct cm}^{-1}$

Where $R(\text{KCL})$ = is measured resistance of standard potassium chloride solution.

Ct, is the conductivity (μscm^{-1}) of the standard potassium chloride solution at T°C 25.

$\text{Ct} = 0.001413 \text{ Scm}^{-1}$ or 1413 μscm^{-1} .

$\text{Cs} = \text{conductivity of sample} = K/\text{Rs} = R(\text{KCL}) \times \text{Ct cm}^{-1} / \text{Rs}$

Rs = resistivity of sample.

Temperature

It was measured with the aid of a mercury thermometer. The meter was vertically immersed with mercury bulb in the liquid substance. The measurement was allowed to proceed; reading was taken as the temperature becomes steady in degree centigrade.

Total dissolved solids (TDS)

TDS meter provides a reading by measuring the conductivity of the dissolved ions in solution. Once the reading is taken, a formula was used to convert it into an estimation of TDS. The dissolved solids have electrical charge; the TDS meter measures the conductivity by emitting small electrical current that passes through the water. The meter then captures electrical conductivity and converts it into a TDS number by multiplying by 0.05.

Total suspended solids (TSS) and turbidity

The turbidity was read directly from the meter after the sample has been turned into the sample tube, shook and kept for a while to eliminate air bubble. And then it was inserted in a cleaned Nephelometer tube. Total dissolved solids was estimated by multiplying the turbidity value with 0.02 in mg/l.

Dissolved oxygen (DO) and biological oxygen demand BOD

The initial DO of the water sample with the aid of DO meter probe was measured, and value recorded. The value was recorded in mg/L. The sampled water in an appropriate BOD bottle after taking the initial DO was wrapped in a foil completely and incubated in an incubator at 20°C for 5 days. At the elapse of the 5 days the DO at 5 days was measured with DO probe. The difference in the DO and DO 5 (after 5 days) was the BOD₅ value.

Total hardness: Using EDTA titrimetric method 2ml buffer solution was added to 100 ml of the sample and 2-3 drops of Black T. was added. It was titrated with standard EDTA solution (with continuous stirring). At the end point, the volume used was noted. Total Hardness was calculated as follows:

$\text{Hardness (in mg/l as CaCO}_3) = (V \times N \times 50 \times 1000) / (SV) \text{ (5)}$

Where: V = volume of titrant (ml)

N = normality of EDTA

50 = equivalent weight of CaCO_3

SV = sample volume (mL)

Determination of nitrate: 50 ml of the water was pipetted into a beaker, and 1 ml of 1 M HCl was added. It was mixed well and transferred into a square UV-Vis cuvette. The spectrometer was used to measure the absorbance of the standards and the sample. Using Beer's law, the NO₃ concentration of the sample was determined from the standard curve.

Determination of sulphate: 250 ml of the sample was taken in a conical flask and the acidity was adjusted with HCl to 4.5 to 5 using a pH meter and an additional 1 to 2ml HCl was added. It was heated to boiling and while stirring gently, barium chloride solution was added slowly until precipitation appeared to be completed. The precipitate was digested at 80°C to 90°C and the contents was filtered in the flask through an ashless filter paper. The precipitate was washed with small portion of warm distilled water until the washing is free of chloride as indicated by testing with silver nitrate-nitric acid reagent. The precipitate was placed along with filter paper in a crucible after finding its empty weight and dry it. The crucible was kept in a muffle furnace and ignite at 800°C for 1 hour. It was cooled in a desiccator and weighed and the weight of the barium sulphate precipitate was known.

Chapter Four Results

Table 1: Physico-hemical Characterization of Water during dry Season

Parameters	Obrikom River (Onosi Ognu)	Onosi Okpasimini	Control	DPR LIMIT
pH	8.20±0.28	7.37±0.30	7.00±0.30	6.5-8.5
TEMP °C	30.34±0.35	30.55±0.33	28.55±0.33	25
Turbidity (NTS)	19.50±0.30	9.10±0.12	9.10±0.21	10
TDS (mg/l)	3069±5.10	328.5±2.40	250.5±2.40	2000
TSS (mg/l)	14.50±3.50	8.30±5.10	7.30±5.01	30
DO (mg/l)	2.61±0.30	3.11±0.12	4.11±0.12	-
BOD ₅ (mg/l)	30.34±0.35	30.55±0.33	25.15±0.31	10
COD (mg/l)	14.30±0.35	25.50±0.33	12.50±0.13	10
THC (mg/l)	14.7±0.30	1.74±0.12	0.74±0.01	10
Conductivity (mg/l)	6114±5.10	452.5±2.40	300.5±2.40	-
Salinity (mg/l)	150.50±9.10	127.50±3.20	90.50±3.20	600

Table 2: Physico-chemical Characterization of Water during Wet Season

Parameters	Obrikom River (Onosi Ognu)	Onosi Okpasimini	Control	DPR LIMIT
pH	6.85±0.22	7.02±0.18	7.02±0.18	6.5-8.5
TEMP °C	27.10±0.25	26.85±0.20	26.85±0.20	25
Turbidity (NTU)	285.40±5.10	78.50±2.40	78.50±2.40	10

Parameters	Obrikom River (Onosi Ognu)	Onosi Okpasimini	Control	DPR LIMIT
TDS (mg/l)	1850±10.20	210.50±4.30	210.50±4.30	2000
TSS (mg/l)	325.50±6.20	105.40±4.50	105.40±4.50	30
DO (mg/l)	4.82±0.15	5.60±0.18	5.60±0.18	-
BOD ₅ (mg/l)	32.10±0.25	28.70±0.20	28.70±0.20	10
COD (mg/l)	31.50±0.25	16.40±0.20	16.40±0.20	10
THC (mg/l)	9.85±0.15	1.45±0.18	1.45±0.18	10
Conductivity (µS/cm)	3710±8.40	290.60±4.30	290.60±4.30	-
Salinity (mg/l)	2380.50±12.40	92.50±3.60	92.50±3.60	600

Discussion of Findings

Physico-Chemical Characteristics of Surface Water During Dry and Wet Seasons

The results of the physicochemical characteristics of surface water obtained from Obrikom River (Onosi Ognu), Onosi Okpasimini, and the control station during the dry and wet seasons revealed varying degrees of environmental impact associated with crude oil production activities in Omoku, Rivers State. The observed variations in water quality parameters between impacted locations and the control station indicate the influence of petroleum exploration, production activities, produced water discharge, gas flaring, surface runoff, and other anthropogenic activities within the study area.

Hydrogen Ion Concentration (pH)

The pH values recorded during the dry season ranged from 7.37±0.30 to 9.37±0.30, while values during the wet season ranged from 6.85±0.22 to 7.02±0.18. The dry season pH at Obrikom River (8.20±0.28) and Onosi Okpasimini (7.37±0.30) and the control value (7.00±0.30) fell within the Department of Petroleum Resources (DPR) permissible limit of 6.5–8.5. Also, during the wet season, all locations remained within the acceptable regulatory range.

The reduction in pH during the wet season may be attributed to dilution effects and the introduction of acidic materials through rainfall and runoff. Similar seasonal decreases in pH have been reported in oil-producing communities of the Niger Delta, where rainfall enhances the transport of organic acids and decomposition products into aquatic systems (Aigberua & Tarawou, 2022). The observed pH values suggest that the water bodies remain generally neutral to slightly alkaline and may not pose immediate threats to aquatic organisms. However, fluctuations in pH can influence metal solubility, nutrient availability, and microbial activities within aquatic ecosystems (APHA, 2023).

Temperature

Water temperature during the dry season ranged from 28.55±0.33°C to 30.55±0.33°C, while wet season values ranged from 26.85±0.20°C to 27.10±0.25°C. All measured values exceeded the DPR recommended value of 25°C. The elevated temperatures observed particularly during the dry season may be linked to intense solar radiation, gas flaring activities, and thermal discharges associated with oil production facilities. Elevated temperatures are known to reduce the solubility

of oxygen in water, thereby affecting aquatic organisms and biological processes. The lower temperatures recorded during the wet season can be attributed to rainfall-induced cooling and increased water volume. Similar findings were reported by Nwineewii and Marcus (2021), who observed elevated temperatures in surface waters surrounding oil-producing facilities in Rivers State. The consistently high temperatures indicate thermal stress conditions which may alter aquatic biodiversity and affect sensitive species.

Turbidity

Turbidity values exhibited significant seasonal variation. During the dry season, turbidity ranged from 9.10 ± 0.12 NTU to 19.50 ± 0.30 NTU. The highest value was recorded at Obrikom River, exceeding the DPR limit of 10 NTU. During the wet season, turbidity increased dramatically, reaching 285.40 ± 5.10 NTU at Obrikom River and 78.50 ± 2.40 NTU at Onosi Okpasimini. The substantial increase during the wet season can be attributed to erosion, surface runoff, resuspension of sediments, and transportation of particulate matter into the river system. Oil exploration activities often destabilize soil surfaces, thereby increasing sediment loads during rainfall events. High turbidity reduces light penetration, inhibits photosynthesis, affects primary productivity, and may clog fish gills, leading to physiological stress (WHO, 2022). The exceptionally high turbidity observed at Obrikom River suggests severe ecological disturbance and indicates substantial sediment contamination from oil field operations.

Total Dissolved Solids (TDS)

Total dissolved solids during the dry season ranged from 250.5 ± 2.40 mg/L to 3069 ± 5.10 mg/L. The value recorded at Obrikom River exceeded the DPR permissible limit of 2000 mg/L. During the wet season, TDS values declined considerably, ranging from 210.50 ± 4.30 mg/L to 1850 ± 10.20 mg/L. The elevated dry season TDS at Obrikom River suggests contamination from produced water discharges, petroleum hydrocarbons, dissolved salts, and industrial effluents associated with oil production activities. Produced water generated during crude oil extraction is known to contain high concentrations of dissolved salts and inorganic substances (United Nations Environment Programme [UNEP], 2023). The reduction during the wet season is attributable to dilution by rainfall. High TDS concentrations can alter water taste, affect aquatic organisms, and increase osmotic stress in freshwater ecosystems.

Total Suspended Solids (TSS)

Dry season TSS values ranged from 7.30 ± 5.01 mg/L to 14.50 ± 3.50 mg/L and remained below the DPR limit of 30 mg/L. However, during the wet season, TSS increased substantially, ranging from 105.40 ± 4.50 mg/L to 325.50 ± 6.20 mg/L, significantly exceeding the regulatory standard. The elevated wet season TSS reflects increased sediment transport from erosion, oil-contaminated soils, and runoff from disturbed surfaces surrounding oil facilities. Suspended solids can transport adsorbed pollutants including hydrocarbons and heavy metals, thereby increasing contaminant mobility and ecological risk. High TSS levels also reduce light penetration and negatively affect aquatic productivity. Similar observations have been reported in oil-producing regions of the Niger Delta where seasonal flooding enhances sediment transport into receiving water bodies (Ogamba et al., 2022).

Dissolved Oxygen (DO)

Dissolved oxygen concentrations ranged from 2.61 ± 0.30 mg/L to 4.11 ± 0.12 mg/L during the dry season and from 4.82 ± 0.15 mg/L to 5.60 ± 0.18 mg/L during the wet season. The low dry season DO values, particularly at Obrikom River, indicate oxygen depletion likely resulting from microbial degradation of petroleum hydrocarbons and organic pollutants. Oil contamination often forms surface films that reduce atmospheric oxygen transfer into water bodies. The improvement observed during the wet season may be attributed to increased aeration, dilution, and water flow resulting from rainfall. Nevertheless, DO values at impacted locations remain relatively low compared with healthy aquatic ecosystems, where concentrations above 5 mg/L are generally preferred for sustaining aquatic life (USEPA, 2023). Reduced oxygen availability can impair fish growth, reproduction, and survival.

Biochemical Oxygen Demand (BOD₅)

Biochemical oxygen demand values ranged from 25.15 ± 0.31 mg/L to 30.55 ± 0.33 mg/L during the dry season and from 28.70 ± 0.20 mg/L to 32.10 ± 0.25 mg/L during the wet season. All values substantially exceeded the DPR limit of 10 mg/L. The elevated BOD values indicate excessive organic pollution and increased microbial activity associated with the decomposition of petroleum residues and other biodegradable materials. High BOD values are characteristic indicators of polluted water bodies receiving industrial discharges. The slightly higher values during the wet season suggest increased influx of organic materials through runoff. Such elevated BOD levels contribute directly to oxygen depletion and may create stressful conditions for aquatic organisms. These findings corroborate reports by UNEP (2023), which identified elevated BOD levels as common indicators of petroleum-related water pollution within the Niger Delta region.

Chemical Oxygen Demand (COD)

Chemical oxygen demand values ranged from 12.50 ± 0.13 mg/L to 25.50 ± 0.33 mg/L during the dry season and from 16.40 ± 0.20 mg/L to 31.50 ± 0.25 mg/L during the wet season. All impacted stations exceeded the DPR permissible limit of 10 mg/L. High COD values indicate elevated concentrations of oxidizable organic and inorganic substances in the water. Petroleum hydrocarbons contribute significantly to COD because they require large amounts of oxygen during chemical oxidation. The higher wet season values suggest increased transport of contaminants into water bodies through runoff. Elevated COD often signifies severe pollution and can result in oxygen depletion, thereby threatening aquatic ecosystem stability.

Total Hydrocarbon Content (THC)

THC values during the dry season ranged from 0.74 ± 0.01 mg/L to 14.70 ± 0.30 mg/L. Obrikom River exceeded the DPR limit of 10 mg/L. During the wet season, THC values ranged from 1.45 ± 0.18 mg/L to 9.85 ± 0.15 mg/L. The elevated THC concentration at Obrikom River during the dry season indicates direct petroleum contamination from crude oil production activities. Hydrocarbons entering aquatic systems may originate from spills, leakages, produced water discharges, pipeline failures, and operational activities. The lower wet season concentrations likely reflect dilution effects resulting from increased water volume. However, the persistent presence of hydrocarbons at impacted stations confirms ongoing petroleum influence. Hydrocarbons are toxic to aquatic organisms and may bioaccumulate within aquatic food chains, posing ecological and human health risks (International Energy Agency, 2023).

Electrical Conductivity

Conductivity values ranged from 300.5 ± 2.40 $\mu\text{S}/\text{cm}$ to 6114 ± 5.10 $\mu\text{S}/\text{cm}$ during the dry season and from 290.60 ± 4.30 $\mu\text{S}/\text{cm}$ to 3710 ± 8.40 $\mu\text{S}/\text{cm}$ during the wet season. The exceptionally high conductivity values recorded at Obrikom River indicate elevated ionic concentrations resulting from dissolved salts, hydrocarbons, and industrial contaminants associated with oil production. Conductivity serves as an important indicator of pollution and salinity intrusion. The reduction observed during the wet season reflects dilution effects from rainfall. Similar elevated conductivity levels have been reported in water bodies impacted by produced water discharges in the Niger Delta region (Aigberua & Tarawou, 2022).

Salinity

Salinity values during the dry season ranged from 90.50 ± 3.20 mg/L to 150.50 ± 9.10 mg/L, all within the DPR limit of 600 mg/L. However, during the wet season, salinity increased significantly at Obrikom River to 2380.50 ± 12.40 mg/L, exceeding the permissible limit by nearly four times. The elevated wet season salinity may result from the discharge of saline produced water, mobilization of salt-rich sediments, and contamination associated with oil production activities. Produced water from oil fields often contains high concentrations of dissolved salts and chlorides. Excessive salinity can alter aquatic community structure, reduce freshwater biodiversity, and affect the physiological functioning of aquatic organisms. The extremely high salinity observed at Obrikom River indicates severe ecological disturbance and possible produced water contamination. The results clearly demonstrate that crude oil production activities have significantly influenced the physicochemical quality of surface waters around Obrikom, particularly at Onosi Ognu. Parameters such as turbidity, TDS, BOD₅, COD, THC, conductivity, and salinity showed elevated concentrations relative to the control station and frequently exceeded DPR regulatory limits. Seasonal variations further revealed that wet season runoff intensifies sediment and contaminant transport into aquatic environments, while dry season conditions promote concentration of dissolved pollutants. The observed deterioration in water quality suggests potential ecological consequences including reduced biodiversity, habitat degradation, oxygen depletion, impaired primary productivity, hydrocarbon toxicity, and disruption of aquatic food webs. The findings therefore provide strong evidence that crude oil production facilities in Omoku have contributed substantially to environmental degradation and ecological stress within the receiving aquatic ecosystem. Taken together, the physicochemical results indicate that the aquatic environment around the petroleum-production facilities is experiencing multiple forms of stress. Elevated turbidity and TSS can reduce light penetration and interfere with primary production; high TDS and conductivity can alter ionic conditions; elevated BOD and COD can increase oxygen demand; and low DO can compromise aquatic organisms. The EPA's current water-quality framework emphasizes that assessment should consider the conditions necessary to protect aquatic life rather than relying solely on a single chemical parameter. The results therefore support an integrated approach to environmental management in Omoku. Periodic monitoring should include both dry and wet seasons because the controlling mechanisms differ between them.

Conclusion

Surface water within the vicinity of oil production facilities in Omoku showed considerable spatial and seasonal variability in physicochemical quality. Turbidity, TSS and salinity were particularly elevated during the wet season, while TDS, conductivity and THC reached their highest values during the dry season. BOD₅ and COD were elevated during both seasons, while dissolved oxygen

was comparatively low during the dry season. Several measured parameters exceeded the regulatory benchmarks adopted in the study. The findings indicate that petroleum-related activities interact with seasonal hydrological processes to influence surface-water quality.

Recommendations

1. Seasonal monitoring of surface-water quality should be maintained around petroleum-production facilities in Omoku.
2. Produced-water treatment and discharge controls should be strengthened.
3. Petroleum spills and equipment leaks should be detected and contained promptly.
4. Wet-season runoff pathways should be assessed because of the pronounced increase in turbidity and TSS.
5. Monitoring should include both physicochemical and hydrocarbon indicators to establish relationships between petroleum contamination and water-quality deterioration.
6. Control stations should be maintained in future investigations to distinguish petroleum-related changes from natural seasonal variability.

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