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Industrial Contributions to Surface Water Pollution: A Physicochemical Study of the Ona River, Nigeria

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Abstract **Original Research Article**

Freshwater degradation in Nigeria remains a critical environmental and public health concern, driven by industrial effluents, agricultural inputs, and inadequate wastewater management. This study evaluated the physicochemical and bacteriological quality of the Ona River in the Oluyole Industrial Area of Ibadan. Water samples collected in June 2024 from upstream, industrial discharge points, and downstream residential zones were analyzed for thirteen parameters using APHA standard protocols. Elevated levels of TDS, EC, COD, BOD, manganese, and magnesium at industrial discharge sites frequently exceeded WHO and NIS limits, while DO values were consistently below recommended thresholds. Water Quality Index (WQI) scores indicated poor quality in industrial zones (Sumal: 43.2; Amir Plast: 47.3; P&G: 49.0) and moderate quality downstream (54.4). Coliforms were absent in industrial samples but detected in trace amounts at the residential site. Findings highlight the substantial influence of industrial effluents on water quality and associated community health risks. This study provides essential baseline data for water resource management, regulatory enforcement, and pollution control strategies.

Keywords: Water Quality Index (WQI), physicochemical parameters, Public health risk, Ona River, Nigeria, Industrial effluents.

1. INTRODUCTION

In recent decades, the quality and availability of water resources have been increasingly compromised by a combination of anthropogenic pressures. Rapid population growth has heightened domestic and agricultural demand, while industrialization has accelerated the release of untreated effluents and heavy metals into aquatic systems (Olalekan et al., 2018; Ihuoma et al., 2020). Similarly, the intensive application of chemical fertilizers and pesticides in agriculture has significantly contributed to nutrient enrichment, leading to eutrophication, oxygen depletion, and disruption of aquatic ecosystems (Smith et al., 2016; Adefemi & Awokunmi, 2010).

Furthermore, indiscriminate human activities such as urban runoff, open waste disposal, and deforestation have aggravated the pollution burden, introducing a complex mix of physical, chemical, and biological contaminants into surface and groundwater sources (WHO, 2017; UNEP, 2019). Water resources are increasingly imperiled by a spectrum of anthropogenic pressures, notably inadequate agricultural drainage and pollution from human activities. Inefficient drainage systems facilitate the transport of agrochemicals including fertilizers, pesticides, and sediments into adjacent rivers and streams, contributing substantially to nutrient loading, eutrophication, and degradation of aquatic ecosystems Sravani et al (2020).

Concurrently, the uncontrolled discharge of domestic and industrial effluents introduces diverse chemical and microbial pollutants into freshwater systems, further compromising water quality and posing risks to ecological integrity and human health (Ali and Khairy 2016). Industrialization has been identified as a principal contributor to riverine pollution in Nigeria, chiefly through the unchecked discharge of untreated industrial effluents into adjacent aquatic ecosystems. For example, research conducted on River Kaduna revealed that industrial discharge points and downstream areas exhibited elevated levels of total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), ammonia, phosphate, and microbial indicators, many of which exceeded permissible limits and were markedly higher than upstream concentrations (Deinmodei et al 2020). Similarly, a study on River Rido in Kaduna State documented statistically significant differences in pH, electrical conductivity (EC), turbidity, TSS, and nutrient parameters between control (upstream) sites and areas receiving industrial discharge. These elevated levels frequently surpassed drinking water standards, pointing to pollution propagation downstream (Butu et al 2022).

One of the problems facing the people of Ibadan is inadequate supply of potable water. Rivers, streams and wells water are the alternatives to the scarce pipe borne water. Most especially in Oluyole Estate, people depend on well and river water for domestics and industrial water use since the area is not connected to any water supply grid in Ibadan (Ojo 2018).). River Ona, which is the only river in the area, is being used by people for their domestic and industrial water use and also serves as a point of discharge of domestic and industrial wastewater. The concentration of industries within a particular environment or area has its various and broad advantages and disadvantages as well. One of the major disadvantages of industrial concentration is environmental pollution (Ojo *et al.*, 2018).

Green et al (2023) examined 'Assessment of Physico-Chemical Parameters of Water from Iwofe River, Rivers State, Nigeria' The results indicate that seasonal dynamics significantly influenced water quality parameters, with elevated DO, TDS, salinity, and temperature observed during the dry season, while higher pH and BOD values characterized the wet season. Conductivity, however, remained relatively stable across both seasons. Overall, the analysis suggests that anthropogenic activities within the study area have exerted minimal adverse effects on surface water quality, a condition that may be attributed to the buffering effect of tidal hydrodynamics. Dauda;Olaofe (2020) studied Determination of Physico-Chemical Parameters of River Majowopa, Sagamu, Ogun State, Nigeria. The results of this study indicate that the water quality of River Majowopa is potentially at risk of future deterioration, primarily due to the continuous input of contaminants such as phosphates, nitrates, and organic acids derived from laundry effluents. However, comprehensive studies examining the effects of domestic and industrial activities on the water quality of the Ona River remain limited. This study evaluated the physicochemical properties of water from the Ona River to determine its overall quality status. The assessment is significant for monitoring anthropogenic impacts, protecting public health, and providing baseline data for sustainable water resource management to ensure the river's conservation and responsible use for present and future needs.

2. MATERIALS AND METHODS

2.1 Description of Study Area

Ibadan, the capital city of Oyo State, is located between latitudes 7°20'–7°40' N and longitudes 3°35'–4°10' E of the Greenwich Meridian (Ganiyu et al. 2021). The city experiences a humid to sub-humid tropical climate, with an average annual rainfall of about 1230 mm and a mean maximum temperature of 32 °C (Ganiyu et al., 2021). The rainy season spans from April to October, while the dry season extends from November to March, with peak rainfall averaging around 180 mm in September (Ganiyu et al., 2021). Ona River, located in the northern part of Ibadan, stretches for 55 km and covers an area of 81 km² (Ojo et al., 2018). Flowing north to south, it originates from the Eleyele catchment area and passes through Oluyole in Oluyole Local Government (Ganiyu et al., 2021). Residential settlements are situated in close proximity to its banks (Ganiyu et al., 2021). The study area was affected by flooding in 2011 (Egbinola et al., 2015), and an overhead road network also crosses the river (Ganiyu et al., 2021). The study area is within Oluyole industrial area and the sampling points is as shown in Figure 1.

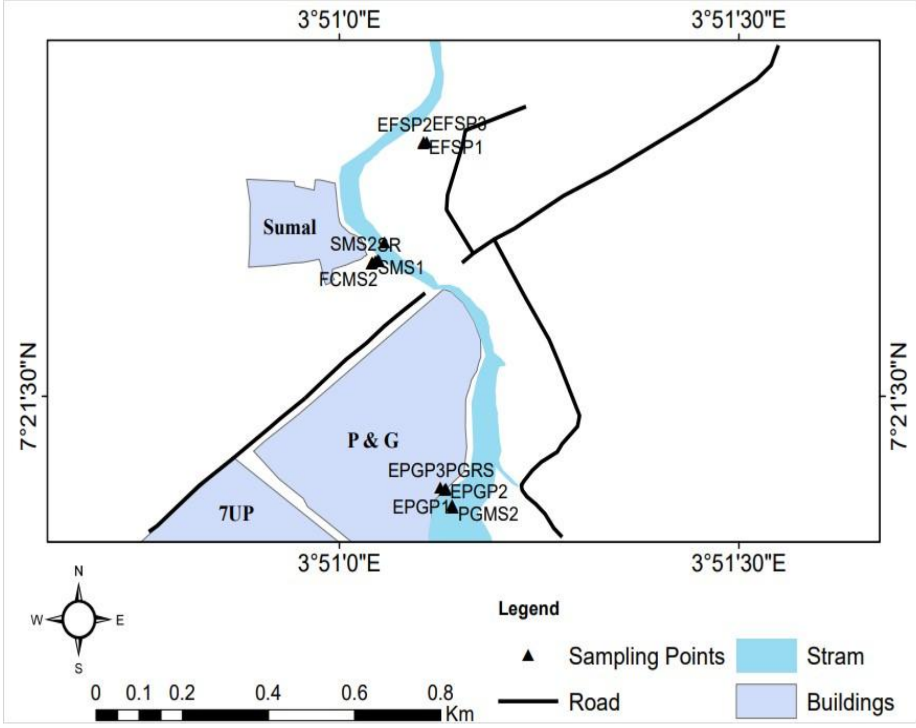

Figure 1. **Map of River Ona showing the sampling points and the industries in Polygon**

2.2 Sample and Sampling Sites

Water sampling was carried out in June 2024. The sampling locations were strategically chosen to include three major industries (Sumal, P&G, and Amir Plast) along with a residential area, thereby covering the upstream, industrial, and downstream sections of the Ona River within the Oluyole Industrial Area. In addition to the direct effluent discharge points of the industries, two other locations were identified at 3-meter intervals away from each discharge point within the industrial zones. At every sampling site, three sub-samples were collected from well-mixed regions of the river at a depth of 10 cm. All sampling sites were geo-referenced using a Global Positioning System (GPS).

2.3 Measurement of Physicochemical Parameters

Thirteen physicochemical parameters were analyzed, including acidity, hardness, pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), alkalinity, total suspended solids (TSS), magnesium, chemical oxygen demand (COD), phosphate, biochemical oxygen demand (BOD), dissolved oxygen (DO), and manganese. The analyses were performed following the standard procedures for water examination (APHA-AWWA-WPCF, 1995). Field measurements for pH, EC, DO, and TDS were taken immediately during sampling using a digital CS-C933T Multimeter (TOPAC INSTRUMENTS INC). COD was assessed through the titrimetric method, while BOD was measured using the incubation technique at 20 °C for five days (APHA-AWWA-WPCF, 1995). Total solids (TS) were determined using a gravimetric approach by evaporating a known volume of water to dryness in a pre-weighed crucible on a steam bath at 105 °C.

2.4 Determination of water quality index

The Water Quality Index of River Ona was determined using a common approach which is the National Sanitation Foundation Water Quality Index (NSF-WQI) method. While there is not a single universal equation for calculating WQI, the mentioned method was chosen out of others. It is a tool used to assess the overall quality of water based on several parameters**.** The method was achieved by the selection of parameters, obtaining of sub-index values (transformation to a common scale), establishing weights and aggregation of sub-indices to produce the final index value.

$$WQI = \sum_i^n (Qi \times Wi) \quad \text{Equation 1}$$

Where; WQI = the Water Quality Index

Wi = the weight assign to each parameter (reflecting its relative importance)

Qi = the Sub-index value for each parameter (normalized value for each parameter).

Each parameter is weighted, and its impact on the overall water quality index (WQI) is calculated using the Q-value (which represents the quality rating of each parameter) and WiQi (the product of the weight and Q-value). The final WQI is the sum of these WiQi values, which is then interpreted according to the standard water quality index ratings (Table 1).

Table 1: Standard table of water quality index

Water Quality Rating	Water Quality Status
91-100	Excellent quality
71-90	Good quality
51-70	Moderate quality
26-50	Poor quality
0-25	Very poor quality

Source: WHO Geneva (2011)

3. RESULT AND DISCUSSION

3.1 Physicochemical Analysis

The mean TDS concentrations of the water samples ranged from 0.911 mg/L to 2.14 mg/L. The TDS level recorded at 1.408 mg/L at residential, which is low compared to the Nigerian Industrial Standard (NIS) of 500 mg/L (Table 1). The highest values of TDS, EC, TS and TSS were recorded at the effluent discharge points in all stations. The pH values at the point of discharge showed an increasing tendency towards acidity. There was however a progressive increase in DO values at all sampling points. COD and BOD values were markedly increased at the points of effluent discharge throughout the sampling period thus showing the contribution of effluent discharge to the increased values. Manganese and magnesium concentrations were significantly elevated at the effluent discharge points across the sampling points. There were no coliform bacteria detected in the samples collected at all 3 stations along the river.

pH

The pH at the Sumal discharge point was 6.22, increasing downstream to 7.22 (3 m) and 7.50 (6 m), indicating progressive neutralization of acidity as effluents mixed with the river. At Amir Plast and P&G stations, pH values were slightly above neutral, reflecting mild alkalinity but remaining within the Nigerian Industrial Standard (6.5–8.5). The residential site also recorded a neutral pH (7.15) Table 2, consistent with safety thresholds. Overall, pH values across all stations complied with regulatory limits, suggesting minimal risk from acidity or alkalinity. These findings are consistent with Andem et al. (2012), who reported no significant variation in pH among stations, highlighting relative stability of this parameter in riverine systems.

Temperature

(Table 2). The temperature of water is important in terms of its intended use. The temperature values obtained in all stations were the same all through having a value of 26℃, as shown in Table 3 which certainly maintain the ambient temperature at the time of measurement. Sunday et al. (2012) reported that changes in environmental temperature can impact macro-invertebrate species distributions example of which, a moderate increase in temperature may be beneficial for warm adapted taxa and they could be expected to expand their ranges to higher alti-tudes (Gebert et al., 2022) or latitudes (Sunday et al., 2012). The Nigerian Industrial Standard (NIS 554, 2007) standard on water temperature stated ambient, that is based on the weather condition while the testing.

Table 2: Physicochemical parameters of water sample from River Ona

Physicochemical Parameters	W.H.O Standard Reference	N.I.S Standard Reference	Sumal Raw	Sumal Mixed 1	Sumal Mixed 2	Amir. P Raw	Amir. P Mixed 1	Amir. P Mixed 2	P&G Raw	P&G Mix 1	P&G Mix 2	residential
Apparent Colour	15 TCU	15 TCU	Black	-	-	Green	-	-	Brown	-	-	-
Odour	NG	Unobjectionable	Stinky	-	-	stinky	-	-	Stinky	-	-	-
pH	NG	6.5-8.5	6.22	7.22	7.50	7.55	7.40	7.50	7.30	7.25	7.25	7.15
Temperature °C	NG	Ambient	26	26	26	26	26	26	26	26	26	26
Acidity	-	-	75	22	25	31	22	25	36	18	14	15
Alkalinity mg/L	< 120	-	56	29	22	40	28	29	67	41	38	25
Hardness mg/L	100-150	150	28	11	15	18	12	15	54	26	28	10
Electrical Conductivity µS/cm	NG	1000	328	132	124	143	119	120	230	130	129	121
Turbidity µmg/ml	< 4	NG	0.323	0.002	0.010	0.058	0.004	0.034	0.012	0.018	0.016	0.04
T.D.S mg/L	NG	500	0.996	0.726	0.398	0.956	1.184	0.594	0.546	2.402	3.482	1.408
T.S.S mg/L	1.0	NG	1.22	0.29	0.12	0.82	0.72	1.29	0.25	0.28	0.3	1.58
Chloride mg/L	NG	250	+	-	-	+	-	+	+	+	-	+
Chlorine mg/L	5	NG	-	-	-	-	-	-	-	-	-	-
Magnesium mg/L	NG	0.2	23.333	24.013	5.832	55.081	2.53	36.02	51.054	7.78	9.332	12.001
Manganese mg/L	0.08	0.2	0.969	1.068	0.652	0.879	0.721	0.532	0.353	1.274	0.177	0.014
D.O mg/L	4.0-5.0	NG	2.399	1.714	2.513	2.285	0.517	2.913	2.97	2.57	2.171	2.513
B.O.D mg/L	< 10.0	NG	86.3	9.2	16.565	11.42	8.845	14.28	14.85	15.665	10.28	9.95
C.O.D mg/L	< 3.0		57.1	2.855	8.44	10.2	8.1	8.45	8.55	9.88	8.68	5.995
Total Coliform Bacteria cfu/ml	ND	< 1.0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Hardness

Total hardness varied across sites, reflecting differences in calcium and magnesium salts. Concentrations were low at Sumal (15 mg/L) and Amir Plast (18 mg/L), but higher at P&G (36 mg/L), (as show in Table 2) possibly due to industrial processes. The residential site recorded 10 mg/L, all values well below the NIS guideline of 150 mg/L, classifying the water as soft. Soft water offers household advantages such as reduced scaling and greater soap efficiency. In contrast, hard water has been associated with adverse health outcomes. Roland (2019) reported potential links between drinking hard water and certain diseases, as well as skin irritation due to altered pH balance. Such findings discovered the importance of monitoring hardness levels, since excessive hardness not only compromises water usability but may also pose health risks.

Electrical Conductivity (EC)

Electrical conductivity (EC), an indicator of dissolved ion concentration, showed marked variation among sites. Sumal recorded the highest EC (328 µS/cm), substantially exceeding values at Amir Plast (127 µS/cm), P&G (163 µS/cm) (Table 2), and the residential site (121 µS/cm). This highlights Sumal as the dominant contributor of ionic pollutants to the river, consistent with the elevated mean value (195 µS/cm) compared to other stations. The pronounced discharge at Sumal reflects higher effluent loads from its industrial processes, while lower downstream values likely result from dilution. Although all EC values remained below the NIS limit of 1000 µS/cm, Sumal's elevated levels suggest localized risk factors of contamination. Seasonal rainfall may have further reduced ion concentrations, masking potentially higher pollution loads. These results align with Oladele et al. (2015), who reported similar EC ranges in industrially influenced waters.

Turbidity

Turbidity values across all stations were within the WHO guideline of <4 NTU (Table 2). The residential site recorded an especially low value (0.04 µg/mL), indicating clear water with minimal suspended particles and suitability for domestic use. Low turbidity reduces treatment costs and supports aquatic health, whereas elevated levels are known to impair fish gill function and increase water treatment expenses (Moreira et al., 2021). Overall, the Ona River exhibited favorable turbidity conditions during the study period.

Total Dissolved Solid (TDS)

Total dissolved solids (TDS) showed clear variation across sites, with mean concentrations of 0.71 mg/L at Sumal, 0.91 mg/L at Amir Plast, and the highest level at P&G (2.14 mg/L) (Table 2). The elevated values at P&G point to substantial inorganic inputs from toiletry production, identifying this industry as the dominant contributor of dissolved solids to the Ona River. The residential site recorded 1.41 mg/L, and all values remained far below the NIS guideline of 500 mg/L, indicating overall suitability for consumption. While TDS itself poses no direct health risk, elevated levels can impair taste and accelerate scaling and corrosion in water systems (Hach Solids, 2023). Continuous monitoring is warranted to track the disproportionate influence of P&G effluents on river water quality.

Total Suspended Solid (TSS)

Total suspended solids (TSS) varied among industries, with mean concentrations of 0.54 mg/L at

Sumal, 0.94 mg/L at Amir Plast, and 0.28 mg/L at P&G (Table 2). The residential site, however, recorded 1.58 mg/L, exceeding the WHO guideline of 1.0 mg/L and indicating particulate contamination of potential concern for households. While WHO does not specify a TSS limit, maintaining low levels is essential for water clarity, treatment efficiency, and ecological stability (WHO, 2022). Elevated TSS can disrupt aquatic ecosystems and increase treatment costs, highlighting the importance of regular monitoring to safeguard community water quality (Hach Solids, 2023).

Dissolved Oxygen (DO)

Dissolved oxygen (DO) levels were low across all sites, ranging from 2.2–2.9 mg/L at industrial stations and 2.51 mg/L at the residential site (Table 2). The overall mean (2.26 mg/L) was well below the NIS guideline of 4.0–5.0 mg/L, consistent with findings by Andem et al. (2012). Such depressed DO concentrations indicate organic pollution from industrial effluents and pose risks to aquatic organisms, as survival declines when levels remain below species-specific thresholds (Wilson, 2023). The residential sites substandard DO further highlight the ecological stress and potential community-level impacts of effluent discharge.

Biological Oxygen Demand (BOD)

Biological oxygen demand (BOD) values revealed Sumal as the most critical pollution hotspot, with concentrations ranging from 9.2 to 86.3 mg/L—far exceeding Amir Plast (8.9–14.3 mg/L), P&G (10.3–15.7 mg/L), and the residential site (9.99 mg/L) (Table 2). The overall mean BOD (15.79 mg/L) surpassed the WHO guideline of <3.0 mg/L, indicating severe organic loading. The extreme spike at Sumal directly corresponds with depressed dissolved oxygen levels (<2.5 mg/L), reflecting intense microbial oxygen consumption and heightened risk of ecological stress. Such elevated BOD, consistent with earlier findings by Andem et al. (2012), suggests a combination of industrial effluents, urban runoff, and agricultural inputs (Nguyen et al., 2023) as key drivers. The exceedance at the residential site further underscores the pervasive spread of organic pollution and its implications for aquatic life and community water use.

Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) values across all stations exceeded the WHO and NIS guideline of 10 mg/L, ranging from 2.85–57.1 mg/L (Table 2). The highest value occurred at Sumal (57.1 mg/L), highlighting its role as a major chemical pollution risk factors, likely linked to inorganic additives from food processing. Amir Plast and P&G recorded narrower ranges (8.1–10.2 mg/L and 8.56–9.88 mg/L, respectively), while the residential site measured 5.99 mg/L, close to the permissible limit. Elevated COD indicates high oxygen demand for chemical oxidation, which, when combined with the consistently high BOD values (up to 86.3 mg/L at Sumal) and depressed dissolved oxygen (mean 2.26 mg/L, below the NIS standard of 4–5 mg/L), emphasize severe oxygen depletion in the river. Such conditions threaten aquatic survival and pose public health risks, including dysentery, for communities reliant on the water. These findings align with earlier reports of COD ranging from 8–86 mg/L (Amadi, 2016), confirming the persistence of industrial effluent as a critical driver of oxygen stress in Ona River.

Manganese

Manganese concentrations across the industrial stations of River Ona exceeded both WHO (0.08 mg/L) and NIS (0.2 mg/L) limits (Table 2). While Sumal (0.969–1.068 mg/L) and Amir Plast (0.532–0.879 mg/L) showed elevated values, P&G's raw discharge peaked at 1.274 mg/L—the highest recorded and a distinct pollution hotspot. Although dilution downstream reduced concentrations sharply, the raw effluent reflects a substantial inorganic load. This manganese enrichment adds to the broader chemical and organic stress already evident from the extreme BOD spike at Sumal (up to 86.3 mg/L), depressed DO levels across all sites (mean 2.26 mg/L, below the 4.0–5.0 mg/L standard), and high COD values (up to 57.1 mg/L). Together, these findings illustrate a cumulative pollution burden where organic and inorganic contaminants act synergistically, intensifying oxygen depletion and threatening aquatic life. By contrast, the residential sample (0.014 mg/L Mn, 2.513 mg/L DO, 9.95 mg/L BOD, and 5.95 mg/L COD) remained closer to safe thresholds. The combined industrial impact underscores the need for stricter effluent management to protect ecosystem health and human water security.

Magnesium

Magnesium concentrations in the industrial samples showed marked variation, with Sumal ranging from 5.83–24.01 mg/L, P&G from 9.33–51.05 mg/L, and Amir Plast recording the highest level at 55.08 mg/L (Table 2). The residential sample (12.00 mg/L) also exceeded the NIS guideline of 0.2 mg/L, though such levels are generally associated with aesthetic concerns and water hardness rather than acute health risks. Elevated magnesium contributes to total hardness, consistent with earlier findings of Ca–Mg enrichment in effluent-impacted rivers. The present values align with those reported by Oladele et al. (2015) (5–55 mg/L), reinforcing the evidence that industrial discharges are the primary drivers of elevated Mg concentrations in the River Ona.

3.2. Water Quality Index of Physicochemical on River Ona

The Water Quality Index (WQI) analysis revealed consistent impairment across industrial sites, with Sumal (43.21), Amir Plast (47.25), and P&G (48.96) all falling within the poor quality category (WQI 26–50), reflecting significant contamination from effluent discharges (Tables 3). By contrast, the residential site showed a WQI of 54.39, placing it in the moderate quality range (51–70), which, while comparatively better, still indicates the presence of pollutants requiring treatment before safe use (Table 6). These findings align with earlier studies (Amadi et al., 2016; Oloruntoba et al., 2016), which similarly reported poor WQI values near industrial zones due to organic load and heavy metals, and moderate values in residential areas influenced by urban runoff (Aina, 2012). Overall, the results highlight the strong influence of industrial effluents in degrading riverine water quality and highlight the urgent need for improved wastewater management in the Oluyole Industrial Area. These corroborations indicate that industrial effluents continue to be a significant factor in poor water quality, while residential areas tend to show relatively better water quality, although still subject to potential contamination.

Table 3. Comparative Water Quality Index (WQI) across Sampling Stations

Parameter	Weight (Wi)	Sumal (WiQi)	Amir Plast (WiQi)	P&G (WiQi)	Residential (WiQi)
Dissolved Oxygen	0.17	2.38	2.21	2.72	2.55
E. coli	0.15	15.00	15.00	15.00	15.00
BOD	0.20	0.16	2.16	4.20	10.00
Temperature (°C)	0.20	3.00	3.00	3.00	3.00
Total Dissolved Solids	0.08	6.80	6.56	5.76	5.76
pH	0.12	10.44	11.28	10.92	10.92
Turbidity (NTU)	0.08	5.36	7.04	7.36	6.40
Overall WQI	—	43.21	47.25	48.96	54.39
Quality Class	—	Poor	Poor	Poor	Moderate

3.3 Biological Properties

Total Coliform Bacteria

Total coliform counts across all stations were consistently low at 0.001 cfu/ml, remaining well below the NIS guideline of <1.0 cfu/ml (Table 2). This indicates negligible microbial contamination, in sharp contrast to the pronounced physicochemical stresses shaping water quality in River Ona. Industrial risk factors were most evident at **Sumal**, where BOD spiked to **86.3 mg/L nearly 29 times higher than the WHO guideline of <3 mg/L**, driving oxygen depletion (DO ~2.4 mg/L, below the 4.0–5.0 mg/L standard) and reflecting extreme organic loading. COD levels at the Sumal raw station reached **57.1 mg/L, almost six times the 10 mg/L permissible limit**, reinforcing its role as a major chemical pollution source. Inorganic contamination was most pronounced at **P&G**, with manganese concentrations peaking at **1.274 mg/L, over 15 times the WHO limit of 0.08 mg/L** and more than six times the NIS standard of 0.2 mg/L. These exceedances highlight distinct industrial signatures, where organic and inorganic loads act synergistically to intensify oxygen stress and ecosystem degradation, even in the absence of coliform proliferation. The residential site, though comparatively moderate (BOD 9.95 mg/L, >3× WHO limit; COD 5.95 mg/L, near threshold; DO 2.51 mg/L, below standard; Mn 0.014 mg/L, within safe range), still reflected contamination above critical thresholds. Collectively, the findings confirm that industrial effluents are the dominant pollution drivers in Ona River, with chemical and trace metal enrichment posing a greater ecological threat than microbial inputs.

CONCLUSION

This study reveals that the Ona River in the Oluyole Industrial Area is severely impacted by industrial effluents, with pollution signatures dominated by physicochemical exceedances rather than microbial contamination. Although total coliform counts remained negligible, critical violations were observed for BOD (86.3 mg/L at Sumal, ~29× WHO limit), COD (57.1 mg/L, ~6× permissible standard), and manganese (1.274 mg/L at P&G, >15× WHO threshold), alongside depressed DO levels well below acceptable limits. Even the residential site exhibited elevated BOD and low DO, reflecting the pervasive downstream influence of untreated discharges. Water Quality Index scores consistently classified industrial zones as poor and the residential stretch as only moderate, underscoring industrialization as the dominant pollution driver. These findings highlight the urgent need for stricter effluent regulation, wastewater treatment enforcement, and watershed-level management strategies to protect aquatic ecosystems and safeguard public health.

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