Environment and Ecology Research 10(6): 738-748, 2022 http://www.hrpub.org
DOI: 10.13189/eer.2022.100609

Anthropogenic Impacts on Water Quality of Kedong Stream in Idomi, Yakurr, Nigeria

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Received May 31, 2022; Revised November 30, 2022; Accepted December 22, 2022

Cite This Paper in the Following Citation Styles

(a): *[1] Inah E. O., Eneyo V. B., Odey S. A., Ushie M. A., Udonwa R. E., Esuabana S. B., Ekpo E. E., Akintoye O. A., Ajake A. O. , "Anthropogenic Impacts on Water Quality of Kedong Stream in Idomi, Yakurr, Nigeria," Environment and Ecology Research, Vol. 10, No. 6, pp. 738 - 748, 2022. DOI: 10.13189/eer.2022.100609.*

(b): *Inah E. O., Eneyo V. B., Odey S. A., Ushie M. A., Udonwa R. E., Esuabana S. B., Ekpo E. E., Akintoye O. A., Ajake A. O. (2022). Anthropogenic Impacts on Water Quality of Kedong Stream in Idomi, Yakurr, Nigeria. Environment and Ecology Research, 10(6), 738 - 748. DOI: 10.13189/eer.2022.100609.*

Abstract Anthropogenic activities on water sources have continued to attract the attention of scholars worldwide due to their increasing negative impacts on man, the economy, and its associated environmental consequences. The study examined the anthropogenic impacts on the water quality of the Kedong stream in Idomi, Yakurr, Nigeria. The participatory research method, field observation, and global positioning system (GPS) were used to generate data from the purposively sampled location. Samples were collected weekly during the rainy (May, June and July) and dry seasons (October, November, and December). The data collected were later compared with the World Health Organization (WHO) acceptable standard. The data collected were analysed using descriptive and inferential statistics. Results of the independent t-test analysis statistics showed that the calculated t-values were pH (-5.137), DO (4.040), specific conductivity (-17.614), BOD (.559), NO_3 (-5.561), NH_4 (34.774), PO_4 (-5.799), SO_4 (-6.810), Fe (1.836), Zn (.545), Mn (-3.687), total coliform (2.811), and faecal Coliform (.242). These parameters differ from the critical because of the numerous human activities in the area. This implies that the water quality varies with the seasons and that anthropogenic activities have significantly impacted on water quality indicators of the Kedong stream in Yakurr local government area, Nigeria. Results revealed that the water quality of the Kedong stream has a significant difference from the World Health Organisation (WHO) permissible limit with the calculated t-value for pH (-6.277), DO (2.559), specific conductivity (-5.880), BOD (-1.627), NO_3 (-91.929), NH_4 (.444), PO_4 (.663), SO_4 (-326.976), Fe (.323), Zn (-179.722), Mn (-14.158), total coliform (2.319) and faecal coliform (2.517) were all different from the critical t-value of about 2.069 at the normal 0.05 level of significance with approximately 23 degrees of freedom. Therefore, the study revealed that the stream receives various inputs, including municipal, industrial, and agricultural pollutants, resulting in considerable changes in water quality. The study recommended improving the stream's physical state cost-effectively and ensuring a low pollutant to meet the requirements of the WHO standard. Again, rural people should be trained to treat contaminated water through boiling and filtering before it can be used for domestic purposes.

Keywords Anthropogenic Impacts, Water Quality, Physico-chemical Parameters, Bacteriological Parameters, Kedong Stream, Cross River State

1. Introduction

Anthropogenic activities have a significantly negative impact on surface water quality and ecosystem function in most cities of the world. Most streams and rivers in a watershed play an essential role in conveying or absorbing agricultural runoff as well as urban and industrial effluent [1,2]. As a result, a stream or river reflects its watershed. River inflows, for example, provide the primary pollutants to most lakes in a watershed, causing substantial sanitary and ecological issues [1,3,]. In contrast, streams are the principal suppliers of water in most rural areas across the globe. Streams supply water for industrial, residential, and agricultural usage. Pollution of streams caused by humans is an increasing global problem. Consequently, successful management requires preventing and controlling stream pollution and having trustworthy information on water quality [1,4].

Stream water quality varies greatly in location and time for most watersheds with dramatically shifting topographical situations owing to the diversity of land cover surrounding them. This often makes determining water levels and pollution sources challenging, which is required for effective and efficient pollution control and water resource management [5,6]. Many streams and rivers in Nigeria are polluted due to untreated wastewater and other organic wastes being dumped directly into them, particularly in urban and rural areas [7,8]. Stream and river pollution has become a critical challenge in Nigerian water management [7,8]. The most notable rivers in Nigeria, according to available statistics, have been extensively contaminated by the discharge of sewage, agricultural wastes, and industrial effluents, among other things [9].

However, in Cross River State, the Yakurr people in the central part of the state solely depend on Kedong streams, and springs for their day-to-day water usage. The stream is utilised for agricultural, industrial, and other domestic activities. It gets a variety of inputs, including industrial, municipal, and agricultural waste, which cause significant changes in water quality and all segments of our sustainable livelihood [7,8]. The current situation is disturbing since several scholars have revealed that the water quality in most streams is very poor, contaminating the area's water supply sources [2,4,5,9,10]. Furthermore, studies carried out by [11,12] illustrated that most streams had not been treated for decades. Nevertheless, stream water is continuously consumed and used for other domestic purposes. Other studies showed that anthropogenic activities decrease surface water quality for domestic, agricultural, and industrial uses [1,3,8,10,12]. Streams, particularly in most semi-urban areas, get polluted due to untreated wastewater and other anthropogenic activities [11-13]. The earth's surface and vegetation modifications have changed the water quality as water is essential for life sustainability in rural areas in Nigeria.

In addition, the narrative of water contamination is as far back as the 19th century when water-borne diseases such as typhoid, dysentery, cholera, and the epidemic outbreak were reported in some countries due to organic pollution of streams by human waste and technological advancements [14,15]. Likewise, stream pollution is becoming a central issue in water management in most developing countries, particularly Nigeria. As a result, the scale and the extent of anthropogenic impact on stream water are expanding. They will almost certainly put the affected areas under pressure if measures are not taken to checkmate it. The increased changes in the streams make the impact associated with impact more complex to control and manage. It has rendered most of the water sources musky and odoriferous, not suitable for any beneficial use to man. Again, a review of available data shows that a few studies on water quality in streams and rivers have been conducted in recent years [2,5,10,11,12,14]. These findings, however, fall short of explaining the human influence on water quality in the study area. The present study attempts to ascertain the impact of anthropogenic activities on the water quality of the Kedong stream in Idomi, Yakurr, Nigeria. It further contrasts the water quality indicators of the Kedong stream with the WHO acceptable limit for domestic water uses. The findings and conclusions might be useful for future management techniques of the stream environment.

2. Research Methods

The study area is Kedong stream. Kedong stream is located in Yakurr local government area of Cross River State, Nigeria (see Figure 1). This stream is a white water type; it empties into the Igologolon stream. The landmass of the study area (Idomi) is 14672.315855 sqm [16-18]. This research utilised a descriptive research method and a survey design. Based on ecological parameters, physiographic context and diverse, dynamic processes influencing the circulation and the exchange of water, water samples were collected in the stream catchment. The samples were collected in the upper course with plastic bottles treated with diluted nitrite acid and rinsed with the stream water. The samples were collected for two seasons. In the rainy season, it was once a week for three months (April, May, and June 2021) and during the dry season (October, November and December 2021) with the help of the geographic positioning system (GPS) for consistency of the samples collected. The water samples were stored in a cold box of 4^oC and taken to the laboratory for physico-chemical and bacteriological parameters analysis. Also, potential of hydrogen ion (pH), total dissolved solids (TDS), total suspended solids (TSS), and dissolved oxygen (DO) were measured in situ. Other parameters measured in the laboratory were total hardness, calcium, coliform, copper, iron (Fe), nitrate (NO_3), magnesium (Mn), sodium, calcium, specific conductivity (us/cm), zinc (Zn), potassium, sulphate, and sodium. Statistical analyses were carried out using statistical software, which is known as the

SPSS software. An independent t-statistical test instrument was used in testing the stated hypotheses.

3. Results and Discussion

3.1. Physico-chemical and Bacteriological Parameters of Water Quality in the Area for Rainy Season across Three Months (April, May and June, 2021)

Human activities have impacted on water quality of the study area negatively. Table 1 indicates the laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for four weeks during the rainy season. The findings reveal that for week one in April 2021, the pH level was 5.29, week two 6.31, week three 6.39, and week four 6.37. The result shows that week four had the highest impact of human activities on water quality. DO (Mgi^{-1}) level in week one was 6.8, week two accounted for 7.9, week three was 6.8, while week four indicated 5.9. The findings indicate that week two had the highest impact. Specific conductivity level in week one was 76. Week two was 64. Week three indicated 5.7, and week four was 6.5. Hence, week one was considered the week with the highest human impact on the area. The result illustrates that the impact on the area could, directly and indirectly, affect the plant, animals, landscapes, properties, infrastructures, and human lives and may lead to the destruction of farmlands. On the other hand, the total coliform (CFU's) level was 2 in week one, and week two had 2, week three was four and week four was 10. The result reveals that week four had the highest impact on the stream. The findings indicate that faecal coliform (CFU/100m1) levels in week one, week two, week three and week four, representing 10, 2, 2 and 11, respectively, were considered for the months considered in this study. BOD (Mgi^{-l}) level was in week one 1.5, week two 1.6, week three 1.7 and week four 1.8 and week four indicated the highest impact, and zinc (ug/dL) level was in week one 0.021, week two 0.031, week three 0.041 and week four 0.050 and week four indicated the highest impact from the result.

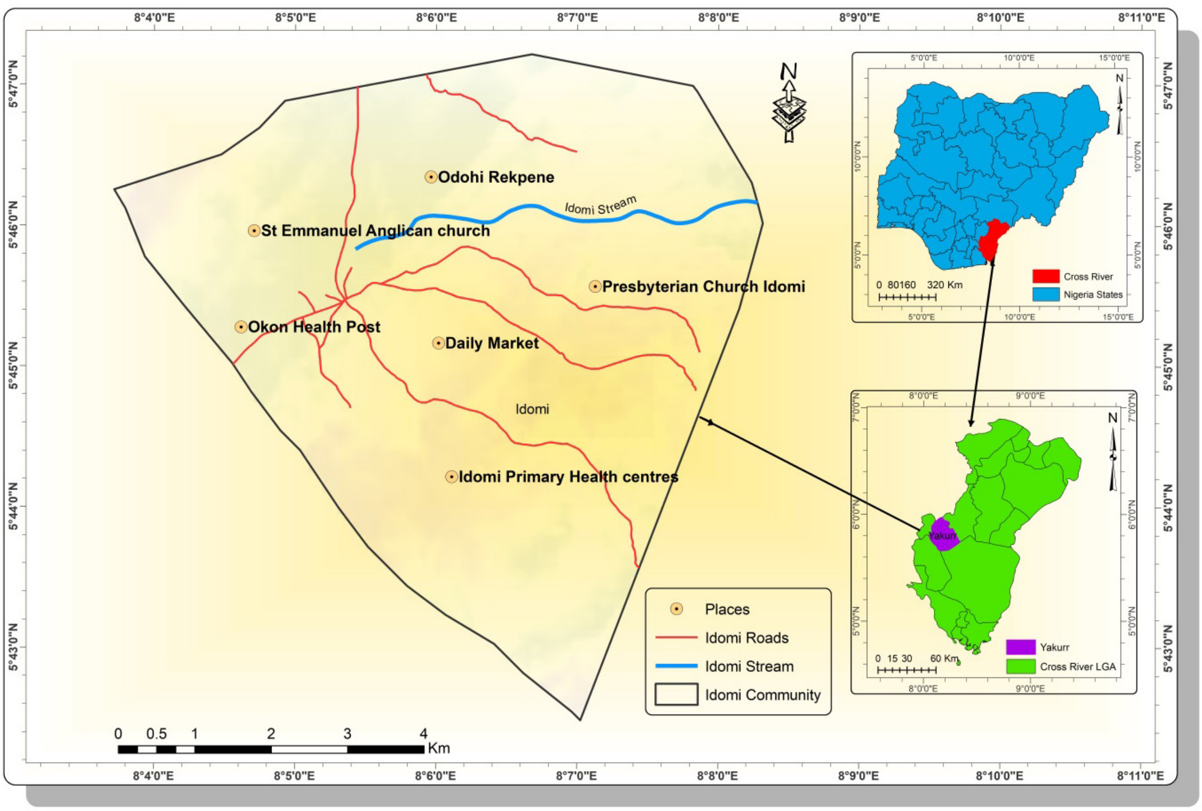

Figure 1. Study area

Table 2 indicates the laboratory analysis of the physico-chemical and bacteriological parameters of water quality of the Kedong stream for the rainy season in May 2021. The result reveals that in week one, the pH level was 6.30, week two 6.34, week three 6.35 and week four 6.36, further showing that week four had the highest impact. DO (Mgi^{-l}) level was 4.51 in week one, week two 5.49, week three 6.48, week four 7.40 and week four indicated the highest impact. Similarly, Specific conductivity (µs/cm) level was 7.2, and in week four, 8.1. The result shows that week four indicated the highest impact. BOD (Mgi^{-l}) level was in week one 1.5, week two 1.7, week three 1.9 and week four 1.10 and week four indicated the highest impact. Faecal coliform (CFU/100m1) in week one was 4, week two 5, week three 4 and week four 5 and week four indicated the highest impact. Total coliform (CFU's) was in week one 8, week two 7, week three 4 and week four 7 indicated the highest impact. While zinc (ug/dL) level was in week one 0.015, week two 0.018, week three 0.019 and week four 0.024 respectively, week four indicated the highest impact.

Table 1. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of Kedong stream for the rainy season in April 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH	5.29	6.31	6.39	6.37
DO (Mgi^{-l})	6.8	7.9	6.8	5.9
Specific conductivity (µs/cm)	76	64	5.7	6.5
BOD (Mgi^{-l})	1.5	1.6	1.7	1.8
NO_3 (Mgi^{-l})	2.461	2.341	2.512	2.617
NH_4 (Mg/L)	0.615	0.716	0.718	0.712
PO_4 (Mg/L)	0.009	0.008	0.010	0.015
SO_4 (Mg/L)	4.315	3.410	3.440	3.450
Fe (Mcg/dL)	0.361	0.359	0.419	0.420
Zn (ug/dL)	0.021	0.031	0.041	0.050
Mn (M/L)	0.013	0.014	0.015	0.018
T. coliform (CFU's)	2	2	4	10
F.coliform (CFU/100m1)	10	2	2	11

Table 2. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of Kedong stream for the rainy season in May 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH	6.30	6.34	6.35	6.36
DO (Mgi^{-l})	4.51	5.49	6.48	7.40
Specific conductivity (µs/cm)	7.2	6.8	7.4	8.1
BOD (Mgi^{-l})	1.5	1.7	1.9	1.10
NO_3 (Mgi^{-l})	1.724	1.825	1.629	0.619
NH_4 (Mg/L)	0.651	0.752	0.814	0.820
PO_4 (Mg/L)	0.007	0.008	0.010	4.011
SO_4 (Mg/L)	4.427	4.518	4.519	0.520
Fe (Mcg/dL)	0.315	0.419	0.420	0.425
Zn (ug/dL)	0.015	0.018	0.019	0.024
Mn (M/L)	0.021	0.024	0.029	0.030
T. coliform (CFU's)	8	7	5	7
F. coliform (CFU/100m1)	4	5	4	8

The result in Table 3 indicates the laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for the rainy season in June 2021. The Table indicates that in week one, the pH level was 6.28, week two 6.30, week three 6.34 and week four 6.35 and week four indicated the highest impact. DO (Mgi^{-l}) level was 3.8, week two 3.9, week three 3.10 and week four 3.11 and week four indicated the highest. Specific conductivity (µs/cm) level was in week one, 6.7, week two, 7.5, week three, 7.6 and week four, 6.8 and week four indicated the highest impact. BOD (Mgi^{-l}) level was in week one 1.8, week two 1.9, week three 7.6 and week four 1.11, and from the result, week four indicated the highest impact. Zinc level was in week one 0.024, week two 0.025, week three 0.030 and week four 0.031 and week four indicated the highest impact. The total coliform (CFU's) level was in week one 8, week two 7, week three 7 and week four 9 and week four showed the highest impact. Faecal coliform (CFU/100m1) level was in week one 5, week two 8, week three 9 and week four 10 and week four indicated the highest impact.

3.2. Physico-chemical and Bacteriological Parameters of Water Quality for Dry Season across the Three Months (October, November and December) in 2021

The physico-chemical and bacteriological parameters of water quality for the dry season from October to December 2021, as presented in Tables 4, 5 and 6, indicate that human activities have impacted the water quality of Kedong stream negatively. Table 4 shows the physico-chemical and bacteriological water quality parameters for the dry season in October 2021. The result reveals that the pH (PH Unit) level in week one was 6.67, week two 6.66, week three 6.62 and week four 6.61. It reveals that week one was 3.10, week two 3.11, week three 3.12 and week four 3.14. Thus, week four showed the highest impact. Specific conductivity (µs/cm) level in week one was 105, week two 106, week three 107 and week four 108 and week four had the highest impact. BOD (Mgi^{-l}) level was in week one 1.5, week two 1.6, week three 1.8, and week four 1.9 and week four indicated the highest impact. Total coliform (CFU's) in week one was 3, week two 4, week three 5 and week four 4 and week three indicated the highest impact. The faecal coliform level was in week one 4, week two 6, week three 7 and week four 9 and week four indicated the highest. Zinc (ug/dL) level was in week one 0.018, week two 0.079, week three 0.020 and week four 0.010 and week two showed the highest impact. The study results revealed varying degrees of anthropogenic impacts on the study area based on the scale and extent of the occurrence.

Table 5 shows the physico-chemical and bacteriological water quality parameters for the dry season in November 2021. The result reveals that the pH (PH Unit) level in week one was 6.74, week two 6.72, week three 6.71 and week four 6.73 and week four showed the highest impact. DO (Mgi^{-l}) level in week one was 3.7, week two 3.6, week three 3.8 and week four 3.5 and week three indicated the highest impact. Specific conductivity (µs/cm) level in week one was 101, week two 104, week three 105 and week four 108 and week four indicated the highest impact. BOD (Mgi^{-l}) level in week one was 1.5, week two 1.6, week three 1.7 and week four 1.8 and week four showed the highest impact. Zinc (ug/dL) level in week one was 0.08, week two 0.09, week three 0.020 and week four 0.011 and week three indicated the highest impact. Faecal coliform (CFU/100m1) level in week one was 3, week two 4, week three 6 and week four 5 and week three indicated the highest impact. Total coliform (CFU's) in week one was 4, week two 5, week three 8 and week four 6 and week three was the period that anthropogenic activities had the highest impact.

Table 3. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for the rainy season in June 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH	6.28	6.30	6.34	6.35
DO (Mgi^{-l})	3.8	3.9	3.10	3.11
Specific conductivity (µs/cm)	6.7	7.5	7.6	6.8
BOD (Mgi^{-l})	1.8	1.9	1.10	1.11
NO_3 (Mgi^{-l})	1.418	1.420	1.424	1.443
NH_4 (Mg/L)	0.652	0.663	0.645	0.641
PO_4 (Mg/L)	0.008	0.009	0.010	0.011
SO_4 (Mg/L)	4.330	4.335	4.333	4.334
Fe (Mcg/dL)	0.281	0.285	0.274	0.275
Zn (ug/dL)	0.024	0.025	0.030	0.031
Mn (M/L)	0.013	0.015	0.017	0.018
T. coliform (CFU's)	8	7	7	9
F. coliform (CFU/100m1)	5	8	9	10

Table 4. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for the dry season in October 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH	6.67	6.66	6.62	6.61
DO (Mgi^{-l})	3.10	3.11	3.12	3.14
Specific conductivity (µs/cm)	105	106	107	108
BOD (Mgi^{-l})	1.5	1.6	1.8	1.9
NO_3 (Mgi^{-l})	2.619	2.618	2.619	2.620
NH_4 (Mg/L)	0.018	0.016	0.017	0.018
PO_4 (Mg/L)	0.015	0.017	0.018	0.019
SO_4 (Mg/L)	5.324	5.325	5.319	5.320
Fe (Mcg/dL)	0.317	0.318	0.317	0.318
Zn (ug/dL)	0.018	0.079	0.020	0.021
Mn (M/L)	0.08	0.09	0.08	0.010
T. Coliform (CFU's)	3	4	5	4
F. Coliform (CFU/100m1)	4	6	7	9

Table 5. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for the dry season in November 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH (PH Unit)	6.74	6.72	6.71	6.73
DO (Mgi^{-l})	3.7	3.6	3.8	3.5
Specific conductivity (µs/cm)	101	104	105	108
BOD (Mgi^{-l})	1.5	1.6	1.7	1.8
NO_3 (Mgi^{-l})	2.616	2.621	2.623	2.631
NH_4 (Mg/L)	0.019	0.020	0.021	0.024
PO_4 (Mg/L)	0.014	0.016	0.018	0.019
SO_4 (Mg/L)	5.831	5.835	5.824	5.826
Fe (Mcg/dL)	0.016	0.017	0.020	0.021
Zn (ug/dL)	0.08	0.09	0.010	0.011
Mn (M/L)	0.013	0.015	0.017	0.016
T. coliform (CFU's)	3	4	6	5
F. coliform (CFU/100m1)	4	5	8	6

The study also revealed the physico-chemical and bacteriological water quality parameters for the dry season in December 2021. Table 6 indicates that the pH level in week one was 6.76, week two 6.75, week three 6.74, week four was 6.75 and week one indicated the highest impact. DO (Mgi^{-l}) level in week one was 3.8, week two 3.9, week three 3.10 and week four 3.11 and week four was the highest. Specific conductivity (µs/cm) level in week one was 104, week two 105, week three 106, week four 108 and week four indicated the highest impact. BOD (Mgi^{-l}) level was 1.3 in week one, week two 1.4, week three 1.5 and week four 1.8 and week four showed the highest impact. The zinc (ug/dL) level was 0.013 in week one, week two 0.015, week three 0.018 and week four 0.016 and week three indicated the highest impact. The total coliform (CFU's) level was 2 in week one, week two, 4, week three, 5 and week four, 5 and week four showed the highest impact . Faecal coliform (CFU/100m1) level for week one was 5, week two 6, week three 7 and week four 8 and week four indicated the highest impact.

Impact of anthropogenic activity later on determined using the data in Tables 1 to 6, and an independent t-statistical test instrument was adopted to determine the level of anthropogenic impact in the area. The result is presented in Table 7.

Table 6. Laboratory analysis of physico-chemical and bacteriological parameters of water quality of the Kedong stream for the dry season in December 2021

Parameters/Unit	Week one	Week two	Week three	Week four
pH	6.76	6.75	6.74	6.75
DO (Mgi^{-l})	3.8	3.9	3.10	3.11
Specific conductivity (μs/cm)	104	105	106	108
BOD (Mgi^{-l})	1.3	1.4	1.5	1.8
NO_3 (Mgi^{-l})	2.651	2.652	2.652	2.651
NH_4 (Mg/L)	0.016	0.617	0.017	0.018
PO_4 (Mg/L)	0.015	0.016	0.010	0.011
SO_4 (Mg/L)	4.861	4.863	4.862	4.861
Fe (Mcg/dL)	0.334	0.335	0.336	0.337
Zn (ug/dL)	0.013	0.015	0.018	0.016
Mn (M/L)	0.06	0.08	0.09	0.010
T. coliform (CFU's)	2	4	5	5
F. coliform (CFU/100m1)	5	6	7	8

Table 7. Independent t- statistical test analysis of the level of anthropogenic impact in the area across different seasons in 2021

Parameters/Unit	Season	N	Mean value	Std. deviation (SD)	Std. error mean value	T- test
pH	Rainy	12	6.2483	.30352	.08762	-5.13
	Dry	12	6.7050	.05214	.01505	
DO (Mgi^{-l})	Rainy	12	5.4325	1.69807	.49019	4.040
	Dry	12	3.4150	.33050	.09541	
Specific Conductivity (μs/cm)	Rainy	12	70.25	6.635	1.915	-17.614
	Dry	12	105.58	2.065	.596	
BOD (Mgi^{-l})	Rainy	12	1.559167	.3045252	.0879089	-.559
	Dry	12	1.616667	.1850471	.0534185	
NO_3 (Mgi^{-l})	Rainy	12	1.869417	.4742231	.1368964	-5.561
	Dry	12	2.631083	.0155181	.0044797	
NH_4 (Mg/L)	Rainy	12	.699917	.0678427	.0195845	34.774
	Dry	12	.018500	.0022764	.0006571	
PO_4 (Mg/L)	Rainy	12	.009667	.0021034	.0006072	-5.799
	Dry	12	.015667	.0029025	.0008379	
SO_4 (Mg/L)	Rainy	12	4.152583	.4394448	.1268568	-6.810
	Dry	12	5.337583	.4126087	.1191099	
Fe (Mcg/dL)	Rainy	12	.354417	.0650363	.0187744	1.836
	Dry	12	.297867	.0845480	.0244069	
Zn (ug/dL)	Rainy	12	.027417	.0100495	.0029010	.545
	Dry	12	.023750	.0210114	.0060655	
Mn (M/L)	Rainy	12	.018917	.0059154	.0017076	-3.687
	Dry	12	.057583	.0358417	.0103466	
T. coliform (CFU's)	Rainy	12	6.42	2.539	.733	2.811
	Dry	12	4.17	1.115	.322	
F. coliform (CFU/100m1)	Rainy	12	6.50	3.205	.925	.242
	Dry	12	6.25	1.603	.463	

*Significant at 0.05 level, df = 22, critical t.= 2.074

The test result indicates the calculated t-values for pH (-5.137), DO (Mgi^{-l}) (4.040), specific conductivity (µs/cm) (-17.614), BOD (Mgi^{-l}) (.559), NO_3 (Mgi^{-l}) (-5.561), NH_4 (Mg/L) (34.774), PO_4 (Mg/L) (-5.799), SO_4 (Mg/L) (-6.810), Fe (Mcg/dL) (1.836), Zn (ug/dL) (.545), Mn (M/L) (-3.687), total coliform (CFU's) (2.811), and faecal coliform (CFU/100m1) (.242) all differ from the critical because of the numerous human activity zones in the research region. Again, Table 7 shows that the T-test value for biochemical oxygen demand (BOD) during dry and rainy seasons in 2021 was -.559. It further revealed that the level of impurities in the water quality in the Kedong stream is higher than the World Health Organization benchmark for safe drinking water. Thus, by implication, the availability of a high BOD in the Kedong stream requires a high level of water treatment. Hence there should not be any BOD in the stream. Hence, the T.coliform (CFU's), which was 2.811, and the F.coliform (CFU/100m1), which was .242, should be reduced to zero, according to the WHO standard. The study revealed that water quality varies with the seasons. These findings reject the null hypothesis and support the alternative. This analysis implies that anthropogenic activities significantly impact water quality indicators of the Kedong stream. These findings agree with [5,7,8,19], which stated that the industrial areas' streams were more polluted than those in the business areas and resulted from untreated waste that pollutes the water sources. It also aligns with studies by [13,20, 21] that the streams and rivers were polluted due to anthropogenic activities. Therefore, the analysis affirms that the Kedong stream is highly polluted, and the level of pollution has a negative effect on the water's physico-chemical and microbiological parameters of the water quality.

The result also reveals that the water quality in seasons is due to different human activity zones. The result reveals that further use of the stream could lead to an exponential rise in disaster incidence. However, the finding contradicts the assertion of [12,19,21] that indicate that individuals typically adapt to the changes in water sources and may likely invent ways to treat artificial polluted water. Findings by experts in the likes of [2,11,13] further unravelled anthropogenic activities' impacts on urban surface waters. It further opined that the industrial and agricultural streams were more polluted than those in the business areas. Other studies further showed that Yakurr people in Cross River State, Nigeria, depend heavily on stream water sources, springs, and boreholes for their daily water use because the government of the day cannot make pipe bore water available for them [8,12,17,19]. However, the goal of management is to help as many people as possible using the available resources. Learning from other climes is imperative for reducing the anthropogenic impact on different water sources.

Furthermore, to compare the water quality of the stream with the WHO permissible limit of water for domestic purposes. The result in Table 8 shows that the calculated t-values for pH (-6.277), DO (Mgi^{-l}) (2.559), specific conductivity (µs/cm) (-5.880), BOD (Mgi^{-l}) (-1.627), NO_3 (Mgi^{-l}) (-91.929), NH_4 (Mg/L) (.444), PO_4 (Mg/L) (.663), SO_4 (Mg/L) (-326.976), Fe (Mcg/dL) (.323), Zn (ug/dL) (-179.722), Mn (M/L) (-14.158), total coliform (CFU's) (2.319) and faecal coliform (CFU/100m1) (2.517) all differ from the critical t-value of about 2.069 at the normal 0.05 level of significance with approximately 23 degrees of freedom. The faecal coliform count indicated a significant difference in dry and rainy seasons; and WHO permissible limit, which is 0 level and other parameters showed impact levels in seasons of 2, 4,5,8,9,10,11 showing that the water quality of the Kedong stream is highly impacted by faecal coliform bacteria (see Table 8).

In other words, the physico-chemical and bacteriological parameters of the Kedong stream differ significantly from WHO's (1984) permissible limit on the water for domestic purposes and consumption. Furthermore, the result suggests that the physico-chemical and biological parameters of the stream are not substantially different from the WHO 1984 permissible level for household water. This work aligns with studies of [7,8,12,22,23] which revealed that most water sources were not within the approved WHO benchmark. Their studies further revealed that the increased human activity in the research affected surface and groundwater quality.

Again, the stream's physico-chemical and bacteriological values differ from the WHO limit for household use. The result showed that the streams were highly polluted in the area, resulting from untreated waste that pollutes the water sources. The study reveals that the streams are contaminated at many locations, and using the stream's water for domestic uses imposes health risks from water-borne diseases. Consequently, the study aligns with [24-26] studies that noted the use of physico-chemical and microbiological indicators to assess the surface water quality in Ado Ekiti, Nigeria. The samples were tested for physical, heavy metals, and bacteriological contamination. The results revealed that turbidity was 3.1-9.40, much lower than dissolved oxygen, 1.00-40. The physico-chemical characteristics examined by the researchers were above the WHO acceptable standard. While heavy metal levels also exceeded WHO guidelines. Chromium ranges from 0.16 to 0.29, Lead from 0.3 to 2.4, Iron from 4.1 to 9.5, and Nickel from 0.03 to 0.6. According to the analysis of variance, the amounts of Iron (Fe), Chromium (Cr), and Nickel (Ni) fluctuate considerably. The p-value was 0.05; T. Coliform (CFU's) in the Kedong stream was 5.27 above the approved WHO benchmark of 0.00 for safe drinking water (see Table 8). Hence, the study discovered that increased human activity in the study area might be to blame for contaminants entering the stream, including urban, industrial, and agricultural pollution. The present status of the stream falls below WHO-approved limits, making the water unfit for households and other applications.

Table 8. Independent t- statistical test analysis of the water quality of the Kedong stream with the WHO permissible limit

Parameters/Unit	Parameter/WHO	N	Mean value	Std. deviation(SD)	Std. error mean value	t-test
pH (PH Unit)	parameter	24	6.4767	.31585	.06447	-6.277
	WHO	1	8.5000			
DO (Mgi^{-l})	parameter	24	4.4237	1.57896	.32230	2.559
	WHO	1	.3000			
Specific Conductivity (µs/cm)	parameter	24	87.92	18.676	3.812	-5.880
	WHO	1	200.00			
BOD (Mgi^{-l})	parameter	24	1.587917	.2481756	.0506586	-1.627
	WHO	1	2.000000			
NO_3 (Mgi^{-l})	parameter	24	2.250250	.5089302	.1038849	-19.929
	WHO	1	50.000000			
NH_4 (Mg/L)	parameter	24	.359208	.3511879	.0716859	.444
	WHO	1	.200000			
PO_4 (Mg/L)	parameter	24	.012667	.0039416	.0008046	.663
	WHO	1	.010000			
SO_4 (Mg/L)	parameter	24	4.745083	.7349145	.1500138	-326.976
	WHO	1	250.000000			
Fe (Mcg/dL)	parameter	24	.326142	.0792207	.0161709	.323
	WHO	1	.300000			
Zn (ug/dL)	parameter	24	.025583	.0162157	.0033100	-179.722
	WHO	1	3.000000			
Mn (M/L)	parameter	24	.038250	.0319555	.0065229	-14.158
	WHO	1	.500000			
T. Coliform (CFU's)	parameter	24	5.29	2.236	.456	2.319
	WHO	1	.00			
F. Coliform (CFU/100m1)	parameter	24	6.38	2.481	.507	2.517
	WHO	1	.00			

Significant at 0.05 level, df = 23, critical t. = 2.069

This research shows that the stream is not fit for domestic purposes. The water is polluted, as shown in the results of the study. Human activities are the primary cause of the high pollution rate of the stream. The results indicate the maintenance of the excellent water quality of the stream. Thus, the available water could be of better importance to the people of the Idomi community. In addition, the statistics revealed that the stream's water quality is inappropriate for household use or consumption. The water quality parameters with particular reference to total and faecal coliform bacteria are higher than the WHO permissible limit for domestic purposes. The water is not fit for domestic purposes. The non-potable water in the study area strongly correlates with water-borne diseases. There is higher pollution in faecal and total coliform count in the water. Also, a significant difference exists between dry and rainy seasons in the stream, respectively. Finally, there is a significant difference between measured water quality parameters and with WHO permissible limit. Others are above and below their respective limits.

4. Conclusions

Water usage is limited to quality, making it unfit for a particular use but suitable for another purpose. The study discovered that numerous major anthropogenic activities negatively influenced the water quality of the Kedong stream in Idomi, Yakurr, Nigeria. These activities and others in the watershed have cumulatively and individually affected the stream's water quality. These known water quality factors have directly and indirectly impacted the streams, domestic activities, ecological uses, and other uses. Residents in the research area are not permitted to use the water for cooking, drinking, industrial, and aquaculture purposes. Anthropogenic activities have adversely impacted the stream and the entire biotic community of the area. The stream's modification has significantly altered the water, rendering it unsafe for human consumption. The current study's independent T-test findings demonstrated that anthropogenic activities in the stream do not meet the WHO criteria for clean water. The 15 parameters examined were below the WHO acceptable standards. To reconstruct the stream's water quality and restore its appropriateness, stability, and economic vitality, an integrated strategy for overall development, including financial, social, and institutional development, is necessary. The procedure should include stream treatment (by the government, people, or corporate groups), water management, and sustainable resource use to meet the WHO-acceptable standards. A buffer zone should be created around the stream catchment to restrict impurities into the waterbody, and human activities will also be far from the stream catchment.

The study further suggests improving the stream's physical state cost-effectively and ensuring a low pollutant to meet the requirements of the WHO standard. The study also recommended effective water management education and participatory water management response practices. Again, there should be a need to raise public awareness of the dangers of consuming polluted water. Rural people should be trained to treat contaminated water through boiling and filtering before it can be used for domestic purposes. The study concluded that anthropogenic activities have adversely impacted the Kedong Stream in Idomi, Yakurr, Nigeria. The stream receives various inputs, including municipal, industrial, and agricultural pollutants, resulting in considerable changes in water quality. The current state of the stream is below the WHO acceptable standards, which is unsuitable for domestic use and other uses.

REFERENCES

[1] Massoud, M. A., El-Fadel, M., Scrimshaw, M. D., & Lester, J. N. “Factors influencing development of management strategies for the Abou Ali River in Lebanon: I: Spatial variation and land use”. *Science of the Total Environment*, Vol. 362, No. 1-3, pp. 15-30, 2006.

[2] Wang, X. L., Lu, Y. L., Han, J. Y., He, G. Z., & Wang, T. Y.”Identification of anthropogenic influences on water quality of rivers in Taihu watershed”. *Journal of Environmental Sciences*, Vol. 19, No. 4, pp. 475-481, 2007.

[3] Tang, X., & Adesina, J. A. “Integrated watershed management framework and groundwater resources in Africa—A review of West Africa sub-region”. *Water*, Vol. 14, No. 3, pp. 288, 2022

[4] Ghorbani, Z., Amanipoor, H., & Battaleb-Looie, S. “Water quality simulation of Dez River in Iran using QUAL2KW model”. *Geocarto International*, Vol. 37, No. 4, pp. 1126-1138, 2022.

[5] Askri, I. "An exchange market of water rights for irrigation in Tunisia: Case of asymmetric information on water quality," *Environment and Ecology Research*, Vol. 10, No. 2, pp. 225-237, 2022. DOI: 10.13189/eer.2022.100212.

[6] Arimoro, FAECAL O. “Impact of rubber effluent discharges on the water quality and macroinvertebrate community assemblages in a forest stream in the Niger Delta, Nigeria”. *Chemosphere*, Vol. 77, pp. 440-449, 2009.

[7] Iwara, E. E., & Inah, E. O. “Evaluating the activities of festival on surface water quality in Ugep, Cross River State, Nigeria”. *Journal of Social Science Studies*, Vol. 6, No. 2, pp. 86-96, 2019.

[8] Eneyo, V. B., Bassey, B., & Edward, J. E. "Spatial distribution of petrol filling stations in Calabar South local government area, Cross River State”. *Multi-Disciplinary Journal of Research and Development Perspectives*, Vol. 7, No. 1, pp. 66-83, 2018.

[9] World Bank. “*Nigeria strategic options for redressing industrial pollution*”. World Bank, Industry and Energy Division. 1st Edn. West Central Africa Department, Annexes, pp. 60 – 62,1995.

[10] Igbinosa, E. O., Uyi, O. O., Odjadjare, E. E., Ajuzie, C. U., Orhue, P. O., & Adewole, E. M. “Assessment of physicochemical qualities, heavy metal concentrations and bacterial pathogens in Shanomi Creek in the Niger Delta, Nigeria’. *African Journal of Environmental Science and Technology*, Vol. 6, No. 11, pp. 419-424, 2012.

[11] Babić, G., Vuković, M., Voza, D., Takić, L., & Mladenović-Ranisavljević, I. “Assessing Surface Water Quality in the Serbian Part of the Tisa River Basin”. *Polish Journal of Environmental Studies*, Vol. 28, No. 6, 2019.

[12] Inah, E. O., Obiefuna, J. N.,Eteng, E. O., Iwuanyanwu, I., & Bello A.A. “Physico-Chemical and Microbiological Analysis of Borehole Water Sources In E-One Estate Lemna, Calabar, Cross River State, Nigeria”. *International Journal Of Emerging Trends In Engineering Research”*, Vol. 10, No. 2, pp. 85-90, 2022.

[13] Galadima, A., Garba, Z. N., Leke, L., Almustapha, M. N., & Adam, I. K. “Domestic water pollution among local communities in Nigeria-causes and consequences”. *European journal of scientific research*, Vol. 52, No. 4, pp. 592-603, 2011.

[14] Ologbosere, O. A., Aluyi, H. S. A., Ogofure, A. G., Beshiru, A., & Omeje, FAECAL I. “Physico-chemical and microbiological profile of bacterial and fungal isolates of Ikpoba River in Benin City: Public health implications”. *African Journal of Environmental Science and Technology*, Vol. 10, No. 3, pp. 67-76, 2016.

[15] Van Grinsven, H. J., Ward, M. H., Benjamin, N., & De Kok, T. M. “Does the evidence about health risks associated with nitrate ingestion warrant an increase of the nitrate standard for drinking water?”. *Environmental Health*, Vol.5, No. 1, pp.1-6, 2006.

[16] Eneyo, V. B., Bassey, B., & Edward, J. “Mapping hotel distribution in Calabar, Cross River State, Nigeria”. *World*

Environment Journal, Vol. 1, No. 1, pp. 66-78, 2017.

[17] Ekong, M. O., & Eneyo, V. B. "The aesthetics value of plastics in carnival Calabar costume designs, Nigeria". *World Environment Journal,* Vol. 2, No. 1, pp. 73-86, 2018.

[18] Eneyo, V. B., Ajake, A.O., & Edward, J. "Assessing plastic waste generation by eateries in Calabar, Nigeria". *World Environment Journal,* Vol. 2, No. 1, pp. 95-106, 2018.

[19] Eja, I. E., Asuquo,V.E., & Edward, J. U. "Assessing urban renewal programme as a strategy for sustainable tourism development in Calabar Nigeria". Multi-Disciplinary Journal of Research and Development Perspectives, Vol. 4, No. 1, pp. 32-41, 2015.

[20] Le Thi Hong Phuong, Truong Quang Dung, Duong Ngoc Phuoc, Le Thi Thanh Thuy, Tran Cao Uy, Truong Van Tuyen, "The Resilience of Small-Scale Fishing Households to the Anthropogenic Environmental Shocks," *Environment and Ecology Research*, Vol. 9, No. 6, pp. 389-398, 2021. DOI: 10.13189/eer.2021.090606.

[21] Ologbosere, O. A., Aluyi, H. S. A., Ogofure, A. G., Beshiru, A., & Omeje, FAECAL I. "Physico-chemical and microbiological profile of bacterial and fungal isolates of Ikpoba River in Benin City: Public health implications". *African Journal of Environmental Science and Technology*, Vol. 10, No. 3, pp. 67-76, 2016.

[22] Milanović, A., Milijašević, D., & Brankov, J. "Assessment of polluting effects and surface water quality using water pollution index: a case study of Hydro-system Danube-Tisa-Danube, Serbia". *Carpathian Journal of Earth and Environmental Sciences*, Vol. *6*, No. 2, pp. 269-277,2011.

[23] Ibe, P. I., Aigbedion, I. P., Marcellinus, M., Okoli, FAECAL U., & Sola, A. B. "Assessment of water quality Index for groundwater in Ado Ekiti, Nigeria". *World News of Natural Sciences*, Vol. 22, pp. 93-101, 2019.

[24] Owokotomo, A. I., Ajayi, O. O., Alabi, O. O., & Chukwuka, A. V. "Watershed land use, surface water vulnerability and public health risks of two urban rivers, Ado-Ekiti, South-West Nigeria". *SN Applied Sciences*, Vol. 2, No.11, pp.1-21, 2020.

[25] Ajake, A.O., Eneyo, V., Akpan, N., Obi, FAECAL, Eja, E., Kharbish, S.,& Eldosouky, A. M. "Analysis of participatory dimensions of landslide disaster and risk management in some rural communities of south eastern Nigeria". *Carpathian Journal of Earth and Environmental Sciences*, Vol. 17, No. 2, pp. 323-338, 2022.

[26] Offiong E. E., Eneyo V. B., Ushie M. A., Agbor C. N., Ephraim I. E., Ajake A. O., & Antai A. S. "Survey and ethnobotanical investigations of key non-timber forest products in home gardens and sacred forests in Cross River State, Nigeria". *Environment and Ecology Research*, Vol. 10, No. 5, pp. 580-591, 2022. DOI: 10.13189/eer.2022.100506.