Journal of Agriculture, Environmental Resources and Management
ISSN2245-1800(paper) ISSN 2245-2943(online)
6(5)1-800:**August**.2024: pp1 -14

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Human-Induced Wastes and Water Quality of Ibaka Marine Coastal Waters in Mbo Local Government Area of Akwa Ibom State

Victor A. Bassey and Beulah I. Ofem

Department of Urban and Regioal Planning. University of Uyo, Uyo; beulahofem@uniuyo.edu.ng

Abstract

The water quality of Ibaka marine coastal area was investigated to examine the level of human-induced wastes in the water quality. With a cross-sectional design, 432 respondents were sampled and administered the questionnaire to obtain data on sources and types of induced wastes and their levels of pollution. This was followed by a detailed physical, chemical, and bacteriological analyses of water from four locations namely; Ibaka, James Town, Ibuot Ikot, and Mkpanutong. Descriptive statistical analyses of the physicochemical parameters of water sources were carried out. Some parameters such as pH, turbidity, conductivity, Total Suspended Solids (TSS), Total Dissolved Solid (TDS), and heavy metals such as Cu, Zn, Mg, Fe, Cd, Pb, and Cr were analyzed. The obtained values of each parameter were compared with the standard values set by the World Health Organization (WHO) and local standards such as the Nigeria Standard for Drinking Water Quality (NSDWQ). ANOVA analysis was used to compare the levels of the physicochemical properties in the water from the sampled locations. Results revealed that the different causes of the degradation of coastal water quality are agricultural wastes; sewage dumping, and industrial wastes. Based on the analyses, the presence of Total coliform count, Total E. coli, faecal strept, vibrio species, and salmonella species in the water samples indicates human-induced wastes. Both physicochemical and bacteriological parameters were either below or within the accepted standards in the four different communities. The ANOVA result showed that since the P-value (0.007) is less than 0.05level of significance, there were significant levels of physicochemical parameters in the coastal water. Hence, the quality of Ibaka coastal water does not meet WHO and NSDWQ standards. Based on the findings, it is recommended that the government should address a range of human activities that generate pollutants and cause pollution in the coastal area.

Keywords: Human-induced Waste, Water quality, Marine, Coastal area

Introduction

Waste is defined[as any material, solid, liquid, gas or a mixture that is surplus in quantity required in a medium or environment such as coastal areas and must be disposed of in line with regulatory requirements (Derefaka. 2014). Coastal areas contain many valuable economic, social, tourist, and recreational resources. It is also the region where wastes are discharged indiscriminately which lead to degradation of the marine environment. The different types of wastes generated in the coastal areas are mostly human-induced wastes resulting from the activities of man. These include municipal solid wastes, agricultural and animal wastes, medical wastes, radioactive wastes, hazardous wastes, industrial, non- hazardous wastes, construction and demolition debris, oil and gas production waste, fossil fuel combustion waste, and sewage sludge (Derefaka, 2014). In most coastal areas all over the world, the amount of human-induced waste generated from households and commercial establishments is on the increase, and at an alarming rate (Omole and Isiorho, 2011). These wastes are not being collected and disposed of in a manner that would protect the health and safety of the environment. Some of the factors responsible for this unsocial and irresponsible habit of unsanitary waste disposal can be attributed to overpopulation, poverty, government insensitivity and negligence; and ignorance on the part of the populace (Omole and Isiorho, 2011). Consequently, these have contributed to coastal water quality problems and management which is a global issue. According to the State Coast Report (2009), good quality coastal water is an important part of keeping our coasts healthy and sustainably for the future. Natural marine systems, including plants and animals need clean coastal water to survive. Humans need these marine systems to stay healthy to benefit from them as well as the use of the water for domestic and industrial purposes and other activities.

Coastal water quality refers to the physical, chemical, and biological characteristics of salt and brackish water (Omer, 2019). Brackish water is a mixture of salt and freshwater, found typically in estuaries where freshwater rivers and streams mix with the tides. Arthurton and Korateng (2014) listed some of the ecological, social, and economic effects of deteriorating coastal water quality to include; the loss of marine plant, animal, and fish species, deteriorating shellfish quality, and restriction of recreational use. The areas of our coast that are prone to coastal water quality problems are particularly estuaries, bays, and waters next to densely populated areas. The coastline is long and many activities both land and marine based, take place close to the shore (Arthurton and Korateng, 2014). Akwa Ibom State is one of the nine states in the Niger Delta, Nigeria, a region rich in oil and gas. The region is described by Zabbey and Babatunde (2019) as the 'pollution hotspot of Nigeria'. It is underdeveloped even though oil is exploited both offshore and onshore. One of the major oil-induced water pollution is oil spillage. With the expansion of oil production, the incidence of oil spills has greatly increased. Available records show that a total of 6,817 oil spills occurred between1976 and 2001with a loss of approximately three million barrels of oil in the region. Approximately 25% spilled in swamps and 69% off-shore (UNDP Report, 2006).

Ibaka in Mbo LGA of Akwa Ibom State, the study area is the biggest, most dynamic, and strategically located fishing community (see Figure 1). Fish production, processing, and fish trade are the major occupations in the community which has more fishermen and women, fish processors, and traders than any other fishing community in Akwa Ibom State (Udosen, 2008). Ibaka is also the only permanent fishing community in Akwa Ibom State with an established fresh fish beach and upland markets, where smoked bonga, big fish and crayfish are sold in commercial quantities. Also available is a motor park where all the fish products are evacuated to different parts of Nigeria. The economic and human activities in the region are expected to have some negative impact on the coastal water quality if there is significant pollution of the coastal water by the wastes resulting from human activities (human-induced wastes). It is because of this that this study is set to examine the levels of human-induced wastes on the water quality of Ibaka marine coastal area in Mbo Local Government Area (LGA) of Akwa Ibom State (Okon, Olaniran and Kalu, 2018).

Research Problem

The world over coastal water pollution has become an emerging issue, detrimental to the natural balance of the marine ecosystem (Chakraborty and Das, 2022). Lack of quality water due to wastes generated from certain human activities that are directly or indirectly discharged into Ibaka coastal waters is a major problem facing the rural people of Ibaka, Mbo LGA. The people rely largely on the available rivers, streams, and borehole water for domestic and commercial uses. Hence, there is an urgent need for its water quality to be ascertained.[u5]Human-induced wastes resulting from human activities in the study area such as farming, fishing, boat making, net making, lumbering, trading, dredging, ocean dumping, fish processing, ballast water discharged from ships, activities of the offshore energy industry, petroleum refining wastes, industrial discharge, failing domestic septic systems, trading and marine transportation, exploration and exploitation activities among others bring about pollution of Ibaka coastal waters. The wastes generated from these human activities have the potential to render the coastal waters unfit for human use. Above all, there is a gap in the literature on studies on the levels of human-induced waste and the water quality of the study area. To bridge this gap, therefore, interest is aroused to study the quality of the coastal water to ascertain the present water quality in Ibaka.

Research Hypothesis

To guide the study, the following hypothesis was formulated for testing:

H_0: The physicochemical/bacteriological parameters of the Ibaka marine coastal environment are not affected by human-induced wastes.

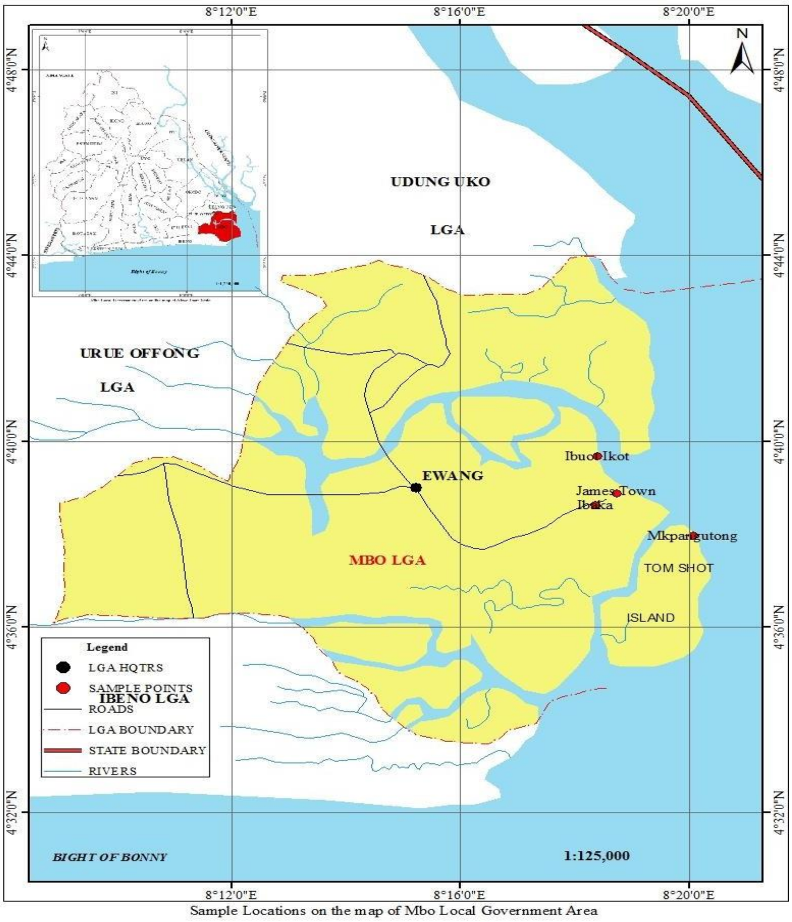

Figure1: The Study on the Map of Mbo Local Government Area showing the Communities Studied

Review of Related Literature

Human-induced wastes are the highest contributor to the alteration of water quality in coastal areas (State of Novia Coast Report, 2009). Although the quality of water can also be influenced by other factors such as natural geological and oceanographic processes and human activities that generate wastes which adversely impact the coastal water quality. Some human activities that lead to waste generation can be categorized into two. These are: Land and Marine-based activities. Land-based activities result into municipal discharge of wastewater by treatment plants, failing domestic septic systems, industrial discharge, and petroleum-refining wastes (Ducrotoy, 2024). It also includes seepages of pollutants, nutrients, or sedimentation from residential, agricultural, and forestry activities, as well as storm water drainage. Marine-based activities include dredging and ocean dumping, wharves and coastal structures, fishing, fish processing, and aquaculture activities. Others include ballast water discharged from ships, activities by shipyards and activities by the offshore energy industry (State of Novia Coast Report, 2009).

As reported by Yusuf (2007) a combination of increasing population, flat terrain, and lack of adequate sewage and waste disposal put many localities at health risk. Sanitary and sewage systems are poor, and where they exist, are poorly managed. In addition, most houses lack indoor plumbing and adequate sources of potable water is limited. Increasing industrialization and the growth of large urban centres have been accompanied by an increase in the pollution stress on the aquatic environment (Hart 2009). Since ancient times, rivers, lakes and oceans had been regarded as readily available receptacles for wastes. This use (or abuse) conflicts significantly with many uses of water especially the use of freshwater for drinking, personal hygiene and food processing. Consequently, Hart (2009) observed that human use of water for almost all purposes results in the deterioration of water quality and generally limits the further potential use of the water. Characteristically, pollutant or dense compounds such as chlorinated solvents move vertically downwards and accumulate at the bottom of an aquifer (Omole and Isiorho, 2011). Oil spillages that result from the leakage of hydrocarbon from the pipes into water bodies are also considered as an industrial source of water pollution. Production of oil and gas is usually accompanied by substantial discharge of wastewater in the form of brines. Constituents of brines include sodium, calcium, ammonia, boron, trace metals, and high Total Dissolved Solids (TDS). These constituents are no doubt injurious to the coastal environment. The local people of the oil rich Niger-Delta, including women and children are mostly victims of oil spills and other environmental hazards caused by the oil companies (Krist, 2000).

Mateo-Sagasta and Burke (2014) identified the following as the most important water pollution problems related to agriculture; excess nutrients accumulating in surface and coastal waters that cause eutrophication, hypoxia and algal blooms, accumulation of nitrates in groundwater and pesticides accumulated in groundwater and surface water bodies. Water pollution caused by nutrients (particularly nitrate) and pesticides has increased as intensive farming methods have proliferated, such as increased use of chemical fertilizers and higher concentrations of animals in smaller areas. Sources of pollution are generally diffused but

others can be concentrated. Excess nitrogen (N) driving accumulation of nitrates in groundwater is another crucial issue. Nitrate is a soluble compound that can be easily leached from soil by deep percolation to aquifers. This is directly related to the intensive and improper use of mineral fertilizer and manure for agriculture, sometimes exceeding crop–nitrogen demand. Pesticide accumulation in groundwater and surface water bodies, especially lakes and wetlands, is an increasing concern (Mateo-Sagasta and Burke, 2014).

Daily, reasonable quantities of different wastes are generated and dumped in fresh waterways. Road side sellers, the major culprits, dispose various items such as cans of soft drinks, banana and orange feels, wrappers of sweets, street mechanic dusts etc. Abattoirs are also generally performing opposite (anti-sanitation) function, blood, faeces and related wastes from animal slaughter find their ways into gutters and the so called drainage system, the final destinations are rivers, lakes, hand dug wells and reservoirs used by people as sources of household water (Adeleye and Adebiyi, 2003).

Chukwu (2008) in Minna, Niger State, Nigeria analysed well waters showed physical, chemical and organic parameters that exceed the upper boundaries set by WHO. The waters are generally hard, containing elevated concentrations of $CaCO_3$, $MgCO_3$, sulphates, nitrates, phosphates and heavy metals. Nwanta, Onunkwo and Ezenduka (2010) reported that a totalof 194 kg of solid waste is generated daily in Nsukka metropolitan abattoir, without any hygienic disposal and/or management system. Further studies on the wastes raised serious public health concerns, as bacteria such as E. *colli*, *Bacillussp*, and *Staphylococcus sp* were frequently detected. In addition to these, elevated heavy metals concentration, that is some time more than one thousand (1000) times the permissible limits in drinking water, had been reported from Oko-oba abattoir, Lagos, Nigeria (Adeleye and Adebiyi, 2003). Abattoir to water‖ pollution is a great problem with common phenomenon across the country.

Natural water contains a variety of substances ranging from suspended particles of all sizes to dissolved chemical species as well as micro-organisms (Cunningham, Cunningham and Saigo, 2007). Water pollution problems resulting from the introduction of these foreign bodies into water, have made it necessary to describe or evaluate natural water sources in terms of quality. Hence, the greater the extent of pollution of water source, the lower its quality and vice versa.

According to UNEP and WHO (1996), water quality is a term used to describe the suitability of water for specific usage. For water to be used for a particular purpose, it has to meet certain requirements (physical, chemical or biological).The composition of surface and

underground water is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal differences in runoff volumes, weather conditions and water levels (Omole and Isiorho, 2011). Large natural variations in water quality may, therefore, be observed even where only a single watercourse is involved. Human intervention also has significant effects on water quality. Some of these effects are the result of hydrological changes, such as the building of dams, draining of wetlands and diversion of flow. More obvious are the polluting activities, such as the discharge of domestic, industrial, urban and other wastewaters into the watercourse (whether intentional or accidental) and the spreading of chemicals on agricultural land in the drainage basin (Omole and Isiorho, 2011).

The quality of water may be described in terms of the concentration and state (dissolved or particulate) of some or all of the organic and inorganic material present in the water, together with certain physical characteristics of the water. It is determined by *in situ* measurements and by examination of water samples on site or in the laboratory. The main elements of water quality monitoring are, therefore, on-site measurements, the collection and analysis of water samples, the study and evaluation of the analytical results, and the reporting of the findings. The results of analyses performed on a single water sample are only valid for the particular location and time at which that sample was taken.

Galadima, Garba, Leke, Almustapha and Adam (2011) described quality of aquatic environment as a broader issue which can be explained in terms of:

i. The composition and state of the biological life present in the water body,

ii. The nature of the particulate matter present, and

iii. The physical description of the water body (hydrology, dimensions, nature of lake bottom or river bed).

Galadima *et al.* (2011) also held that complete assessment of the quality of aquatic environment requires that water quality, biological life, particulate matter and the physical characteristics of the water body be investigated and evaluated.

Pollution of the aquatic environment occurs when humans introduce, either by direct discharge to water or indirectly substances or energy that result in deleterious effects to human health, harm to living resources, hindrance to aquatic activities such as fishing, and impairment of water quality with respect to its use in agriculture, industry or other economic activities or reduction of amenity value. If the natural, pre-polluted quality of a water body is unknown, it may be possible to establish some reference values by surveys and monitoring of unpolluted water in which natural conditions are similar to those of the water body being studied (Galadima *et al.*, 2011).

According to Udosen (2011), the following constitute water quality parameters/indicators. These are; biological parameters, physical parameters, odour, temperature, electrical conductivity, total and dissolved solids, turbidity, chemical properties, biochemical oxygen demand (bod), dissolved oxygen (do), pH, salinity, hardness, metals, non-metallic ions or groups and oil.

For the avoidance of health risks or any other undesirable consequences, the World Health Organization (WHO), Nigeria Standard for Drinking Water Quality (NSDWQ) and the Federal Environmental Protection Agency (FEPA) have set down certain standards based on the water quality parameters, which a given source of water must meet before it can be considered fit for the intended use.

2.0 Research Method

The study was designed to assess the levels of human-induced waste and quality of water along Ibaka marine coastal area using survey and experimental approaches. The survey approach involved the sampling of the target population, administration of questionnaire and field observation was conducted to confirm the responses of the respondents. The experimental method required the collection of water samples and laboratory analysis. The target population was made up of fishermen, farmers, lumbers, traders, marine transporters and boat makers among the coastal communities of Mbo LGA. According to the 1991 Population Census report, the study area within the study scope had a total population of 4220 which was projected to 2023 (32 years difference) as calculated thus:

$$Pt = Po\ (1 + r)^n$$

Equation (1)

Where: Po = Based year population (1991 population), n = Number of years projected (32 years), t = Population growth rate (3.42%), Pt = Current population to be determined, 1= Constant

$$=1246\ (1+3.42)^{32}$$

$$\overline{}$$
$$100$$

$$=1246\ (1+0.0342)^{32}$$

$$=1246(2.836)$$

$$=3,534$$

Therefore, the projected population for Ibaka is3,534

Table1:Questionnairedistributioninthestudyarea

S/N	Name of Sample Locations	1991Population	ProjectedPopulation2023
1	Ibaka	1246	3654
2	Mkpangutong	485	1422
3	Ibuot Ikot	810	2375
4	James Town	1679	4924
	Total	**4,220**	**12,375**

Source: Projectedfrom1991PopulationCensus Figures(2023)

The water samples were collected from four (4) sampled sites in the communities as outlined in Table 1. The sites were selected using the systematic random sampling technique. This procedure was followed so as to achieve a fairly even distribution of sampling sites throughout Ibaka marine coastal area and also minimize bias as much as possible. Also, to enhance easy identification of sampling sites in the event of future work, a map of Ibaka showing the sampled sites is presented as Figure 1. The water samples at each site were collected using a clean 2.5 litres of white polythene bottles with caps. A sample of this volume is considered sufficient to allow replication or confirmatory analysis to be carried out in some cases (Udosen and Orok, 1997). Composite surface water (stream) was obtained at each site by putting together water samples taken from three positions, 150 metres apart, soas to obtain a representative sample (Udosen, 2011).

Table2: Sample Locations and Sources

S/N	Sample location	Source	Coordinates
1	Ibaka	Surface (SW)/sub-surface(SSW)/sediment(SED)water of Ibaka and borehole	4.38N8.19E
2	Mkpangutong	Surface (SW)/ sub-surface (SSW)/ sediment(SED)water of Mkpangutong and borehole	4.36N8.16E

3	Ibuot Ikot	Surface(SW)/sub-surface(SSW)/sediment (SED)water of the Ibuot Ikot and borehole	4.37N8.20E
4	James Town	Surface(SW)/sub-surface(SSW)/sediment (SED) water of James Town and borehole	4.39N8.17E

Field Survey(2023)
SW-Surface water; SSW-Sub-surface water; SED-Sediment

For the purpose of this study, four locations (sites) were selected and out of these, three sample points were taken from each location making a total of twelve sampling points. The sampling locations were designated as SSS1, SSS2, SSS3 and SSS4. Each sample point represented the drinking spot of a village. These were geographically referenced using a hand-held Global Positioning System (GPS).

Two sets of variables were used for the study. These are: Dependent variables (Y) – these relate to the Ibaka marine coastal waters physic-chemical and bacteriological properties as presented in Table 3 for laboratory analyses.

Table3: Dependent variables (Y)

Dependent variables(Y)	**Unit of Measurement**
pH	Moles per liter
Calcium Hardness(Ca^{2+})	Mg/l
Magnesium Hardness	Mg/l
Chromium (Cr^{6+})	Mg/l
Sulphate (SO_4^{3-})	Mg/l
Nitrates(No_3^-)	Mg/l
Lead (Pb^{2+})	Mg/l
Total Dissolved Solid(TDS)	Mg/l
Sodium	Mg/l
Chloride	Mg/l

Independent variables (X) these are the socio-economic indices obtained data through a structured questionnaire as shown in Table 4.

Table 4: Independent Variables (X)

Indices	**Unit of measurement**
Sand Dredging	Number
Fishing/Processing	Number
Farming/Farm Fertilizer	Number
Washing	Number
Bathing	Number
Sewage Dumping	Number
Defecation	Number
Oil Spillage	Number
Marine Transportation	Number

Source: Authors' Field Survey (2023)

Descriptive statistical technique was used to describe the basic features of the data in the study. It provided simple summaries about the samples and the measures. Analysis of Variance (ANOVA) was used to determine the variability of human-induced wastes among the sampled communities and establishment of the levels of pollution.

ANOVA is given as:

$$SS_t = \frac{\sum Ti^2}{c} - \frac{\sum T^2}{rc} \quad \text{------------------------------ Equation (2)}$$

Where: SS_t, is the sum of square due to treatment. T is the total of all parameters. $Ti^2$is the square of T. C is the total number of parameters (frequency).r is the number of independent variables (streams).

$$2.1.\mathbf{I}=\sum X_{ij}\ SS^2 - \frac{T^2}{rc} \quad \text{--} \quad \text{Equation (3)}$$

Where:$\sum X_{ij}$ is the sum of square due to error. SST is the sum of square due to total.

$$SS_T = SS_t + SS_e \quad \text{---} \quad \text{Equation (4)}$$

Where: SS_e is the sum of all square due to error.

Replicate measurements was done to ensure that the readings obtained were accurate and helped to confirm the true state of the study area.

3.0 Data Presentation, Analysis and Discussion

6.1Occupation of Respondents

The occupational data of respondents in the study area are presented in Table 5.

Table5: Occupation of Respondents

	Ibaka	%	Mkpan-Utong	%	Ibuot Ikot	%	James Town	%
Subsistent Farming	21	19.2	20	24.3	16	17.0	28	19.0
Fishing	25	22.9	23	28.0	26	27.6	56	38.0
Trading/Business	18	16.5	16	19.5	17	18.0	29	19.7
Boat Makers	10	9.2	5	6.0	8	8.6	9	6.1
Marine Transport	11	10.1	8	9.7	9	9.5	10	6.8
Sand Mining	13	12.0	6	7.3	11	11.7	12	8.2
Lumbering	11	10.1	4	5.2	7	7.6	3	2.2
Total	**109**	**100**	**82**	**100**	**94**	**100**	**147**	**100**

Source: Field survey (2023)

Table 5 shows that the major occupations of the respondents in the four communities were trading and fishing. The implication of occupation of the population is significant as it reflects the economic and environmental context of the study area. This economic variable is crucial forassessing the levels of human induced waste in the marine environment as well as help to highlight areas where interventions are needed.

Sources of Human Induced Wastes

The sources of human induced wastes and human activities that contaminate the coastal waters are presented in Table 6. From Table 6, the three different sources of human induced wastes in the coastal area are; inappropriate fishing methods, farm fertilizers and industrial processes. The commonest source of human induced wastes being inappropriate fishing methods, with above average of 58.4% of the respondents; 26.6% indicated that farm fertilizers is the second commonest; industrial processes had 11% of the respondents, while 4% indicated none of the above.

Table6: Sources of Human-induced Wastes

Sources/Human Activities	**Ibaka**		**Mkpanutong**		**Ibuot Ikot**		**James Town**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Sources of human induced waste?								
Inappropriate fishing methods	42	38.5	34	41.4	39	41.4	57	38.7

Farm fertilizers	36	33.0	26	31.7	28	29.7	41	27.8
Industrial processes	10	9.1	8	9.7	8	8.5	20	13.6
All of the above	18	16.5	12	14.6	16	17.0	23	15.6
None of the above	3	2.9	2	2.6	3	3.6	6	4.3
Total	**109**	**100**	**82**	**100**	**94**	**100**	**147**	**100**

6.2 Results of Physicochemical and Bacteriological Parameters

6.3.1Geographical Location of Sample Stations

Global Positioning System (GPS) was used to locate both the coordinates of latitudes and longitudes of the sampled locations (Table 7).

Table7: Geographical Locations and their Sampling Coordinates.

Location	Code	Latitude	Longitude
Ibaka	SQ-1	4.38N	8.19 E
Mkpangutong	SQ-2	4.36N	8.16E
Ibuot Ikot	SQ-3	4.37N	8.20E
James town	SQ-4	4.39N	8.17E

Source: Field survey (2023)

Physico-chemical and Bacteriological Parameters; **Ibaka**

The results of physicochemical parameters and their corresponding values obtained from the test carried out on four different water sources from Ibaka are presented in Table8. From the analysis, pH value of Sea water (W1) was alkaline (7.11), while the other three sources range between 5.8 to 6.7. The $Ca^{2+}$of 179 was recorded in Sea water (W1) which is far above the maximum permissible concentration of 75. The other three sources were within the normal range. The Mg^{2+}value of 209 was recorded in Sea water (W1) far above the permissible value of 150. The other three water sources ranged from 13 to 16. The Sea water (W1) has a large value of Chromium (Cr) of 4659, still far above the permissible value of 500. The other three water sources were within the permissible range. The So_{4+}^{2-}value of the Sea water (W1) was 179 which is higher than the acceptable value of 150. The other three water sources were within the acceptable value. The No^{3-}value of all the four water sources was above the permissible value of 0.5. All the four sources of water had the value of Pb^{2+}greater than the acceptable value of 0.01. The W1 had a large value of TDS of 7903 above the permissible value when compared to the other three water sources.

Table8: Physicochemical Parameters of Analyzed Water Sample from Ibaka

Parameters	N	WI	W2	W3	W4	Range	Mean	SD
pH	4	7.11	5.88	6.18	6.7	1.23	6.47	0.546
Ca^{2+}	4	179	16.37	18.09	13.49	165.51	56.73	81.530
Mg^{2+}	4	209	4.96	7.22	8.36	204.04	57.38	101.08
Cr	4	4659	19.30	16.84	14.06	4644.94	1177.30	2321.13
$So4+^{2-}$	4	179	8.10	15.03	0.01	178.99	50.53	85.86
Fe^{2+}	4	0.20	0.49	0.32	0.10	0.39	0.27	0.167
No^{3-}	4	1.56	0.91	0.96	0.70	0.86	1.033	0.369
Pb^{2+}	4	0.21	0.11	0.09	0.05	0.16	0.115	0.068
TDS	4	7903	29.67	10.22	8.2	7894.80	198.77	3943.49

W1-Seawater,W2-Freshwater,W3-Tapwater,W4-Rainwater Authors‘ Analysis (2023)

James Town

The results of physicochemical parameters and their corresponding values obtained from the test carried out on four different water sources from James Town are presented in Table 9. From the analysis, pH value of Sea water (W1) was alkaline (7.09), while the other three water sources were acidic. The Ca^{2+}of166 was recorded in Sea water(W1) which is far above the maximum permissible concentration of 75, while the other three water sources were within the permissible value. The Mg^{2+}value of 194 was recorded in Sea water (W1) far above the permissible value of 150. The other three water sources were within the acceptable value. The Sea water (W1) has a large value of Chromium (Cr) of 3951, still far above the permissible value of 500. The other three water sources were within the permissible range.

The $So_{4+}{}^{2-}$value of the Sea water (W1) was169 which is higher than the acceptable value o

150. The other three water sources were within the acceptable value. The No^{3-} value of all the four water sources was above the permissible value of 0.5. All the four sources of water had the value of Pb^{2+}higher than the acceptable value of 0.01. The TDS value of all the four water sources was within the permissible value of 500.

Table9: Physicochemical Parameters of Analyzed Water Sample from James Town

Parameters	N	WI	W2	W3	W4	Range	Mean	SD
pH	4	7.09	6.76	6.41	6.70	0.68	6.74	0.278
Ca^{2+}	4	166	15.61	6.92	13.22	159.08	50.43	77.128
Mg^{2+}	4	194	5.41	3.11	10.43	190.89	53.23	93.891
Cr	4	3951	0.66	2.99	7.49	3950.34	990.53	1973.645
$So_{4+}{}^{2-}$	4	169	10.00	14.84	0.007	168.99	48.46	80.595
No^{3-}	4	2.06	0.88	0.87	0.12	1.94	0.98	0.801
Pb^{2+}	4	8.41	0.09	0.79	0.69	8.32	2.49	3.955
TDS	4	4.93	5.71	10.14	6.28	5.21	6.76	2.317

W1-Seawater,W2-Freshwater,W3-Tapwater,W4-Rainwater Authors‘ Analysis (2023)

Ibuot Ikot

The results of physicochemical parameters and their corresponding values obtained from the test carried out on four different water sources from Ibuot Ikot are presented in Table 10. From the analysis, pH value of all four water sources was acidic. The $Ca^{2+}$of 163 was recorded in Sea water (W1) which is far above the maximum permissible concentration of 75. The other three sources were within the normal range. The Mg^{2+}value of 199 was recorded in Sea water (W1) far above the permissible value of 150. The other three water sources ranged from 13 to 16. The Sea water (W1) has a large value of Chromium (Cr) of 4471, still far above the permissible value of 500. The other three water sources were within the permissible range. The $So_{4+}{}^{2-}$value of the Sea water (W1) was167 which is higher than the acceptable value of 150. The other three water sources were within the acceptable value. The No^{3-}value of Rain water (W4) was 0.10 which was within the permissible value of 0.5, while the other three water sources were above the permissible value. All the four sources of water had the value of Pb^{2+}greater than the acceptable value of 0.01. The W1 had a large value of TDS of 6749 above the permissible value when of1000when compared to the other three water sources.

Table10: Physicochemical Parameters of Analyzed Water Sample from Ibuot Ikot

Parameters	N	WI	W2	W3	W4	Range	Mean	SD
pH	4	5.76	4.97	6.23	5.91	1.26	5.72	0.535
Ca^{2+}	4	163	18.96	21.00	10.96	152.04	53.48	73.142
Mg^{2+}	4	199	5.71	6.76	7.93	193.29	54.85	96.104
Cr	4	4471	17.79	16.79	14.86	4456.14	1130.11	2227.260
$So_{4+}{}^{2-}$	4	167	7.46	6.97	0.01	166.99	45.36	81.164
No^{3-}	4	1.47	0.84	0.62	0.10	1.37	0.75	0.567
Pb^{2+}	4	5.67	0.09	0.11	0.46	5.58	1.58	2.730
TDS	4	6749	26.45	24.67	5.91	6743.0	1701.50	3365.00

W1-Seawater, W2-Freshwater, W3-Tapwater,W4-Rainwater Authors‘ Analysis (2023)

Mkpangutong

The results of physicochemical parameters and their corresponding values obtained from the test carried out on four different water sources from Mkpangutong are presented in Table 11. From the analysis, pH value of all the four water sources was acidic. The $Ca^{2+}$of 147 was recorded in Sea water (W1) which is far above the maximum permissible concentration of 75, while the other three water sources were within the permissible value. The Mg^{2+}value of 203 was recorded in Sea water (W1) far above the permissible value of 150. The other three water sources were within the acceptable value. The Sea water (W1) has a large value of Chromium (Cr) of 3361, still far above the permissible value of 500. The other three water sources were within the permissible range. All the four water sources had the $So_{4+}{}^{2-}$value within the acceptable value of 150. The No^{3-}value of both the Tap water (W3) and Rain water (W4) were within the permissible value of 0.5, while the other two water sources were above the permissible value. All the four sources of water had the value of Pb^{2+}higher than the acceptable value of 0.01. The W1 had a large value of TDS of 5671 above the permissible value when of1000 when compared to the other three water sources.

Table11: Physicochemical Parameters of Analyzed Water Sample from Mkpangutong

Parameters	N	WI	W2	W3	W4	Range	Mean	SD
pH	4	6.11	5.28	5.79	6.16	0.88	5.83	0.404
Ca^{2+}	4	147	17.16	20.61	9.42	137.58	48.54	65.801
Mg^{2+}	4	203	6.79	5.92	8.46	197.08	56.04	97.977
Cr	4	3361	13.51	13.76	32.41	3347.49	855.17	1670.576
$So_{4+}{}^{2-}$	4	127	126	11.83	0000	127.00	66.20	69.788
No^{3-}	4	2.00	1.32	0.49	0.11	1.89	0.98	0.847
Pb^{2+}	4	4.96	4.92	0.10	0.75	4.86	2.68	2.620
TDS	4	5671	24.11	222.39	5.9	5665.10	1480.85	2795.153

W1-Seawater,W2-Freshwater,W3-Tapwater,W4-Rainwater Authors’ Analysis (2023)

ComparisonofthePhysico-chemicalParametersofAnalyzedWaterSamples from the Four Communities

The results of physico-chemical parameters and their corresponding values obtained from the test carried out on four different water sources from each of the four communities are presented in Table 12. From the analysis, the pH value of all the four water sources from James Town (L2) was below the World Health Organisation (WHO) range and within the Nigeria Standard for Drinking Water Quality (NSDWQ) range. Water sources from the other three communities were acidic. The Ca^{2+}values of all the four locations were within the permissible value. The $Mg^{2+}$and $So_{4+}{}^{2-}$values of all the four locations were within the permissible value of WHO and NSDWQ. All the four locations had large values of Chromium (Cr) above the permissible value of WHO and NSDWQ. The No^{3-}values of water sources from all the four locations were within the WHO value except water sources from Ibaka location (L1) were within the NSDWQ value, while water sources from the other three locations were not. All the water sources from the four locations had their values of Pb^{2+}higher than the acceptable value of 0.01 permissible by WHO and NSDWQ. Water sources from the two locations of L1 and L2 had the value of TDS permissible by WHO and NSDWQ, while the other two locations (L3 and L4)had values of TDS above the permissible value permissible by WHO and NSDWQ.

Table 12: Descriptive Statistics Comparing Physico-chemical parameters with WHO and NSDWQ Standards

P	N	LI	L2	L3	L4	Range	Mean	SD	WHO	NSDWQ
Ph	4	6.47	6.74	5.72	5.83	1.02	6.19	0.493	7.0-8.5	6.5-8.5
Ca^{2+}	4	56.73	50.43	53.48	48.54	8.19	52.29	3.589	75	75
Mg^{2+}	4	57.38	53.2	54.85	56.04	4.15	55.37	1.764	150	150
Cr	4	1177	990	1130	855	322	1038	145	500	500
$So_{4+}{}^{2-}$	4	50.53	48.4	45.36	66.20	20.84	52.63	9.287	200	150
No^{3-}	4	0.27	0.98	0.75	0.98	0.71	0.74	0.3347	1.0	1.0
Pb^{2+}	4	1.033	2.49	1.58	2.68	1.65	1.94	0.7750	0.01	0.01
TDS	4	0.115	6.76	1701	1480	1701	797	921	1000	500

P-Physiochemical parameters, L1-Ibaka, L2-Jamestown, L3-Ibuotikot, L4-Mkpangutong Authors' Analysis (2023)

The commonly monitored microbial indicators of the water samples from the four different communities/locations include Total Coliform Count, Total E. Coli, Faecal Strept, Clostridium pentriages, Vibrio species Salmonella species, Yersina species, Fungi and Algae are presented in Table 13. These organisms were used as indicators because their presence indicates contamination by human or animal faecal matter, which also contains harmful pathogens. Table 13 also shows the microbial quality of the water sample locations and their varying degrees of contamination. From the four water sample sources, the water source from Ibuot Ikot is considered good water‖ because the microbial indicators were within the acceptable level.

Table13: Microbial quality of water from the sample sources

Sample source	Total Coliform Count	Total E. coli At 45^0C	Faecal strept	Clostridium pentringes	Vibrio species	Salmonella Species	Yersina species	Fungi	Algae	Remark
Ibaka	+(12)	+(9)	+	+	+ +	+	-	-	-	x
James Town	+(13)	-	-	-	+ + +	+ +	-	-	-	x
Mkpan gutong	+(15)	+(14)	+	-	+ + +	-	-	-	-	x
Ibout ikot stream water	+(9)	+(13)	+	+	+	+ +	-	-	-	√

Authors' Analysis (2023)
NOTE: Numbers in parenthesis indicate calories per 100 ml of sample

+=Scantygrowth,++=Moderategrowth,+++=Abundantgrowth,-=Notencountered x = Bad water, x√ = Fairly good water, √ = Good water

Hypothesis Testing

H_0: The physicochemical/bacteriological parameters of the Ibaka marine coastal environment are not affected by human-induced wastes.

The significance of the effect of human-induced wastes on the physicochemical parameters of the Ibaka coastal water quality was tested using ANOVA at a 0.05 level of significance. The statistical value, P-value (0.007) is less than 0.05, then the null hypothesis (Ho) is rejected, which means that there are significant levels in the physicochemical parameters on the Ibaka coastal water quality (Table 14).

Table14: ANOVA Summary of Sources of variation among the Sample locations.

Sources of Variation	Count	Sum	Average	Variance
L1	8	1349.528	168.691	166683.3
L2	8	1159.000	144.875	117143.4
L3	8	2992.74	374.0925	436957.3
L4	8	2515.27	314.4088	305789

ANOVA

Source of Variation	SS	df	MS	F	P-value	Fcrit
Between Groups	297670.2909	3	99223.43	0.38662	0.0076	2.946685
Within Groups	7186011.61	28	256643.3			
Total	7483681.901	31				

Discussion

The different sources of human-induced wastes as shown from the analyses are inappropriate fishing methods, application of farm fertilizers, and industrial processes (Table 5). An average of 58.4% of the respondents from the four different locations, namely Ibaka, Mkpanutong, Ibuot Ikot, and James Town indicate that inappropriate fishing methods are the major source of human-induced waste. Fertilizer application on farms (26.6%) and industrial processes (11%) being second and third major sources of wastes. This findings support the assertion of Omole and Isiorho (2011); and Ducrotoy (2024) that the application and spreading of chemicals on agricultural land in the coastal area is a major cause of coastal water quality problems.

From the analysis of the physicochemical and bacteriological parameters of Ibaka coastal water quality the human activities that contaminate the coastal waters include sand dredging, fishing, fish processing, washing, bathing, sewage dumping, defecation, oil spillage and marine transportation (Table 5). Based on the analyses of the microbial quality of water from the four sample sources, water from Ibout Ikot was considered only to be good water‘, while waters from the other three sample sources contain some degrees of Total Coliform Count, Total E.coli, faecal strept, vibrio species and salmonella species (Table13). This shows that the level of human-induced waste is high in Ibaka, Mkpanutong, and James Town coastal area. This is in line with the study of Hart (2009) which revealed that some of the human activities that alter the physicochemical parameters of water quality in the coastal area include; domestic sewage and latrines, disposal of municipal solid wastes, agricultural wastes and industrial wastes (tipping, direct injection, spillage and leakage). According to Udosen (2011), the presence of coliform, pathogens, viruses and fungi in a water sample is an indication of human-induced wastes, hence the greater the extent of pollution of water source, the lower its quality and vice versa. A comparison of the statistics of physiochemical parameters with WHO and NSDWQ Standards as presented in Table 12, shows the mean average of the pH value of the water in Ibaka coastal area to be 6.19 against the WHO standard ranging from 7.0 -8.5. According to Udosen (2007), the pH value of water influences the chemistry of the water and consequently its quality. The presence of a high amount of Chromium (Cr) (1038.27mg/l) was indicated in the water against the WHO standard of 500mg/l. Apart from the pH and Chromium, other parameters such as Ca^{2+}, Mg^{2+}, So^{2-}, No^{3}, Pb^{2+}, and TDS were within the range of WHO standards. Therefore, the quality of Ibaka coastal water is below WHO standards.

4+ 2

Conclusion

Based on the findings, it is concluded that there is a high degree of contamination of the coastal area through human activities such as inappropriate fishing methods, application of fertilizers and industrial processes. Specifically, the presence of dangerous microbial organisms such as Coliform Count and E.coli in water samples confirmed the unsuitability of water for humans and other living organisms in the study area.

The environmental implication of the findings is that the Ibaka coastal pollution resulting from human-induced wastes could threaten the economic, social and environmental sustainability of the coastal communities. The polluted coastal waters affect fish resource stocks, which can lead to food and employment shortages in coastal cities.

Recommendations

Based on these findings, the following recommendations are made in order to improve water quality and population health in the study area: Adequate environmental education and awareness on safe fishing methods and handling/use of fertilizers in order to minimize water pollution through agricultural practices should be given to farmers of coastal communities. Regular monitoring by relevant agencies of government such as Ministries of Environment, Land/Urban Planning and Health should be conducted to enforce compliance with location standards for industrial processing, sewage facilities and adequate waste disposal options

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