Original Research Article

Assessment of Water Quality ~~Parameters~~ of Odor River, Anambra State

Abstract

This study examined the physicochemical and bacteriological parameters of Odor River in Orumba North, Anambra State. The parameters considered were pH, turbidity, temperature, Dissolved Oxygen (DO), Alkalinity, total hardness, sulphate(SO_4^{2-}), chloride, calcium (C~~c~~a^{2+}) hardness, magnesium (Mg^{2+}) hardness, Iron(), Nitrate(), conductivity, Total Dissolved Solids (TDS), total coliform and Escherichia coli (E. coli). The objectives of the study were to assess the similarities that exist amongst the physicochemical and bacteriological parameters of Odor River in Orumba North, Anambra State. Also, to test whether water from Odor river is safe for drinking by the people of Orumba North and its environs. The Statistical Software (Rstudio, SPSS???????~~tools~~ used for the analysis were the Cluster analysis and the one-sample T-test method. The findings of the study revealed that the parameters can be grouped in two groups as follows: group A consists of pH, turbidity, temperature, Dissolved Oxygen (DO), Alkalinity, total hardness, sulphate, chloride, ca hardness, Mg hardness, Iron, Nitrate, and conductivity while group B consists of Total Dissolved Solids (TDS), total coliform and E.coli. Also, it was found the physicochemical parameters were significantly different and within the required WHO standards. Further findings revealed that the bacteriological parameters of the river such as the faecal Coliform and total Coliform were significantly different and are higher than the WHO standards. Although the bacteriological parameters are not the best indicator of faecal contamination high coliform bacteria measure could still be used to indicate a greater risk for the users of the river who might develop certain health problems through water contact activity.

Keyword: Bacteriological, Physicochemical, Odor River, Similarities

1. Introduction

Water remains an important and abundant natural resource which is necessary for the survival of all living beings. Its quality plays an important role in promoting agricultural production and human health standards. Population growth and the standard of living in developing countries have increased, resulting in increased demand for drinking water. On the other hand, factors such as accelerated pace of industrialization, the lack of environmental education and the overexploitation of natural resources have seriously affected water resources by increasing the pressure on urban hydrology [1]. These factors have deteriorated the quality of surface water for drinking and causing serious damage to most surface water bodies. Therefore, constant monitoring of a river system is necessary to evaluate the effects of environmental factors on water quality for correct use and sustainable development of the resource.
The deterioration of water has become a global problem. In many developing countries, the availability of drinking water has become critical and the majority of the communities in the rural areas depend on a non-public supply system. Direct contamination of surface water from

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anthropogenic activities such as municipal wastewater, industrial effluents and the influx of land is a long-standing phenomenon. In the developing countries, there are increasing evidence of contamination of surface water bodies, which are sensitive to leaching from landfills, septic tanks such as pit latrines which are commonly used in slums where there is no sewage system and industrial effluents. Organic manure, municipal waste and agricultural waste such as fungicides in runoff often contain fairly high concentrations of chemicals and substances found in most water bodies. These impurities can give the water a bad taste, colour, odour or turbidity and cause hardness, corrosivity, stains or foaming. The mixing and the reactions of the materials modify the physicochemical and biological characteristics of the drilling water, affecting the quality of the water. Water quality reflects the composition of water affected by natural processes and human activities, and therefore the need to establish water quality in the natural hydrological cycle.

Surface water quality has been identified as an irreplaceable element of the aquatic ecosystem and has become an interesting issue for researchers to deliberate. Also, Odor River is located in an area classified as a rural area in Anambra State and the majority of the people living in this area don't have access to the supply of pipe-borne water. Hence, the need to examine the similarities that exist amongst the physicochemical and bacteriological parameters of Odor river in Orumba North, Anambra State. Also, to test whether water from Odor river is safe for drinking by the people of Orumba North and its environs.

2.Literature Review

A study by [2] used the cluster analysis (CA) to assess temporal and spatial variations in the water quality of Euphrates River, Iraq, for a period 2008-2009 using 16 parameters at 11 sampling sites. The Hierarchical cluster analysis grouped the 8 months into three periods (I, II and III) and classified the 11 sampling sites into two groups (I and II) based on similarities of water quality characteristics. The temporal pattern shows that April has higher pollution level relative to the other months. Spatially, sampling site 7 was found to have the lower pollution level while the other sampling sites have higher pollution level.

A study by Basamba et al. [3] assessed the quality of water in Tanzania. The study analyzed water samples obtained from the borehole for physicochemical and microbiological characteristics of the underground water. The statistical tool employed to analyze the obtained data were the Pearson correlation coefficient, Factor analysis and Cluster analysis. The findings of the study revealed that calcium was significantly correlated with electrical conductivity, total dissolved solids, and total hardness for underground water sources. Also, it was found that calcium concentration was attributed to anthropogenic activities, and/or natural processes within the aquifers. The findings showed that the parameters can be classified into five groups; Group I comprises of total and faecal coliform, Group II contains aluminum, Group III contains manganese, ammonia, and water color, Group IV contains electrical conductivity, total dissolved solids, calcium, total hardness and turbidity, and Group V contains alkalinity and chlorides. Further findings identified three sources of pollutants in the underground water to comprise mixed origin of human wastes and soil in runoff, dual origin of turbidity (human wastes and soil/organic matter) and natural/geochemical processes in aquifers.

In their contribution, Ewa et al. [4] employed the principal component analysis (PCA), cluster analysis (CA) and discriminant analysis (DA) to evaluate the variations of water quality and to identify probable pollution sources of the Calabar River. The findings of the study showed that the PCA extracted eight (dry season) and seven (wet season) latent components responsible for the pollution of the Calabar River. The latent components were found to explain about 94 – 98% of the total variance in the water parameter data set. It was found that in the dry season, the Calabar River received pollutants from residential and industrial sectors, whereas in the wet season, its pollution sources came from non-point sources such as surface runoff from agriculture, industrial and residential areas. The 25 water parameters were classified into two groups of homogenous sources of pollution for each season, being agricultural, residential and industrial wastes. Also, it was identified that transparency, DO, salinity, calcium, magnesium, sodium and potassium are the most significant water parameters responsible for the spatial and temporal variations in water quality of the Calabar River with 100% correct assignment. The findings of the study indicate that industrial and residential wastes were largely responsible for the temporal and spatial variation in water quality of the Calabar River.

Dabgerwaland Tripathi [1] assessed the physicochemical quality of river Varuna in Varanasi, India. The study employed the Pearson correlation analysis and the Cluster analysis to assess the extent of the relationship among physicochemical parameters and to determine the sources of pollution in the river Varuna respectively. The finding of the study shows a high value of Dissolved Oxygen (DO), Nitrate, and total Alkalinity, above the WHO Standard. Also, findings identified the key water parameters to comprise of pH, electrical conductivity, total alkalinity and nitrate, which were found to influence the concentration of other water parameters. In addition, findings identified three major clusters of sampling sites out of a total of 10 sites considered in the study based on the similarity in water quality.
A study by Aydin [5] examined the water quality of the pond in Bektaş, Turkey based on the sites and seasons, the water quality classes were determined and pollution problems were detected. The study considered the suitability of aquatic life forms by examining 21 physicochemical parameters and seven heavy metal parameters in the pond water. Pearson correlation, hierarchical cluster analysis and principal component analysis were used to test the relationships of all parameters and loads of pollutants. The results of the study revealed that the main source of pollution could be non-punctual pollution, i.e. agricultural pollution and soil leaching in this region.

Guptaa et al. [6] considered for the development of water quality index using eight parameters pH, Temperature, Total Dissolved Solids (TDS), Turbidity, Nitrate-Nitrogen, Phosphate, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO) measured at six different sites along the river Narmada. The findings of the study showed that the water quality was between excellent - good in the season summer and winter and poor to unsuitable for human consumption in the season monsoon along the river Narmada. The fall in the quality of water in monsoon season was attributed to poor sanitation, turbulent flow, soil erosion and high anthropogenic activities

3. Materials and Methodology

3.1 Data Collection

The primary source of data collection was adopted in this study. Water samples were collected from Odor River in Amaokpala, Orumba North L.G.A of Anambra State from March – November 2019 in polyethene bottles, transported to the laboratory, and analyzed. Water samples were analyzed for most water quality influencing physiochemical and bacteriological parameters. The physicochemical parameters comprise of pH, turbidity, temperature, Dissolved Oxygen (DO), Alkalinity, total hardness, sulphate, chloride, ca hardness, Mg hardness, Iron, Nitrate, conductivity, and Total Dissolved Solids (TDS) while the bacteriological parameters are total coliform and E.coli.

Table 1

List of physiochemical parameters and their methods

S/.NO	Parameters	Units	Method used
1	pH		pH meter
2	Alkalinity	m~~M~~g/L	Winkler method
3	Total dissolved solids	m~~M~~g/L	Digital conductivity meter
4	Chloride	m~~M~~g/L	Argentometric titration
5	Sulphate	m~~M~~g/L	Gravimetric method
6	Turbidity	NTU	Nephelometric
7	Ammonia-Nitrogen	m~~M~~g/L	Spectrophotomeric (Phenate method)
8	Total Hardness as $CaCO_3$	m~~M~~g/L	EDTA titration
9	Conductivity	$\mu S\ Cm^{-1}$	Conductivity meter

Source: (Patel and Parikh [7])

3.2 The Study Area

Orumba North is one of the 21 areas of local government in the state of Anambra and was created on August 27, 1991. Orumba North was part of the local government of Aguata until 1989 when the local government of Orumba was created based in Umunze.

It was later sculpted by the local government of Orumba so that what remained became Orumba South. Orumba North is located in the southern senatorial area of Anambra and forms a federal constituency with Orumba South. The national population census put its population at one hundred and seventy-two thousand people.

Local government is delimited by Aguata, Anaocha, Awka and Oji-River. It is made up of sixteen communities. They are Ajalli, Amaetiti, Amaokpala, Awa, Awgbu, Nanka, Ndikelionwu and Ndiokolo. Others are Ndiokpaleze, Ndiokpaleke, Ndiowu, Ndiukwuenu, Oko, Okpeze, Omogho and Ufuma. Orumba North is a markedly fertile land for agriculture with prominent products around rice, yam, cassava and palm oil. Most of the people are subsistence farmers and traders. There is also a large student community following the presence of the Federal Polytechnic, located in Oko.

The local government hosts beautiful tourist attractions such as the mythical Odor river that appears and disappears at will. It is perhaps the first of its kind in the world. The always peaceful Obutu lake; the beautiful rivers Agho-mmili and Nama, with other small rivers, have made this area unique. Orumba North has some undeveloped tourist water resources such as Iyi-Ochalake, Orizu torrent, Ivolo torrent, Nju-Oyi and Nchioku streams.

Show the location area with the sampling sites (Figure)

3.3 Method of Data Analysis

Cluster analysis helps to identify natural groupings among a group of variables or individual measurements with no direct relationship. Also, cluster analysis is an exploratory data analysis tool for solving classification problems. Its purpose is to sort cases, data or objects (events, people, things, etc.) into groups or clusters. The resulting clusters of objects should exhibit high internal homogeneity (within clusters) and high external heterogeneity (between clusters) [8].
Cluster analysis (CA) was used in the present study to develop significant aggregations or mutually exclusive groups of water parameters based on multivariate similarities between entities [8]. This technique divided a large number of water parameters into a smaller number of homogeneous groups based on their correlation structure [9]. Hierarchical cluster analysis was used to group each of the water parameters in two groups using the ward linkage based on Pearson's distance. The groups or clusters should be as homogeneous as possible and the differences between the various groups as wide as possible.
Also, the One-Sample T-test was used to test the quality of the water against the WHO Standard.

4.Data Analysis, Result and Discussion

The result of the Cluster Analysis of the parameters obtained from Odor River was presented in the dendrogram (figure 1) and summarized in Table 2.

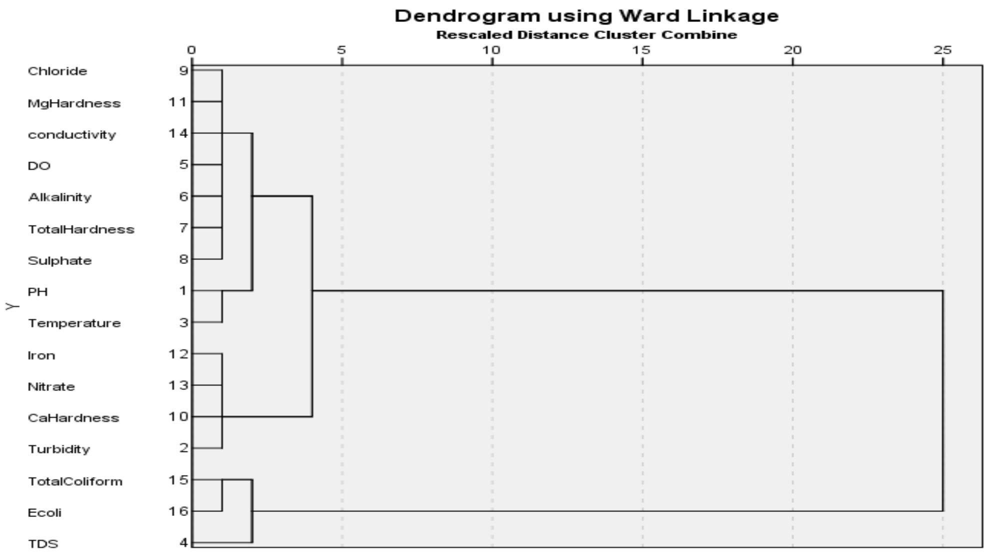

Figure 1: Dendogram showing the relationship between different water quality parameters.

Table 2
A table showing the distribution of parameters in group

No	Cluster Analysis (CA)	Parameters
1	Group A	pH, turbidity, temperature, DO, Alkalinity, total hardness, sulphate, chloride, ca hardness, Mg hardness, Iron, Nitrate, and conductivity
2	Group B	TDS, total coliform and E.coli

Source: Authors Analysis

The result of the cluster analysis presented in figure 1 and table 2 shows that the parameters were clustered in two groups (Group A and Group B). The findings showed that parameters that fall into group A consist of pH, turbidity, temperature, Dissolved

Oxygen (DO), Alkalinity, total hardness, sulphate, chloride, ~~ca~~ hardness, ~~Mg~~ hardness, Iron, Nitrate, and conductivity while the parameters that fall into group B consists of Total Dissolved Solids (TDS), total coliform and E.coli. The table 3 summarize the results of the different test

Table 3

Summary of One Sample T-test of the parameters of Odor Rivers in Anambra State

S/N	PARAMETER	W.H.O Standard	Mean Difference	df	*t*-value	*P*-value	Decision
1	Temp ˚C	25	-1.07	39	-10.36	0.000	Significant
2	Turbidity (NTU)	10	-7.54	39	-20.30	0.000	Significant
3	Conductivity U ohms/Cm	500	-378.65	39	-79.83	0.000	Significant
4	Calcium	200	-190.00	39	-297.13	0.000	Significant
5	Magnesuim	250	-249.24	39	-1541.22	0.000	Significant
6	Sulphate	400	-397.07	39	-1785.17	0.000	Significant
7	Chloride	250	-238.58	39	-115.93	0.000	Significant
8	Carbonate	500	-492.20	39	-1090.95	0.000	Significant
9	Nitrate	10	-8.50	39	-51.26	0.000	Significant
10	Total Hardness	100	-87.33	39	-212.75	0.000	Significant
11	Total Dissolved solids	500	-445.42	39	-125.73	0.000	Significant
12	pH	6.5 -8.5	-1.14	39	-39.01	0.000	Significant
13	Feacal Coliform	Nil	1.27500	39	3.909	0.000	Significant
14	Total Coliform	10	14.252	39	6.356	0.000	Significant

Source: Authors Analysis

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The result of the analysis obtained in table 3 showed that all the physical parameters such as temperature, turbidity and conductivity were significantly different from the WHO standard since their *P*-value was less than the critical value of 0.05. However, the result of the mean difference shows that the measure of the parameters was all below the WHO standard. Hence, the physical properties of the river were found to be adequate and within the required standard.

Also, it was found that all the chemical parameters of the river such as Calcium, Magnesium, Sulphate, Chloride, Carbonate, Nitrate, Total Hardness, Total Dissolved Solids, and pH were significantly different from WHO standard. Though, their measures were all below the WHO Standard. This indicates that the chemical parameters of the river are within the required standard.

Also, it was found that the bacteriological parameters of the river such as the faecal Coliform and Total Coliform were significantly different from the WHO standard. Also, it was found from the result of the mean difference that the bacteriological parameters were greater than the WHO standard. Although the bacteriological parameters are not the best indicator of faecal contamination, high coliform bacteria measure could still be used to indicate a greater risk for the users of the river who might develop certain health problems through water contact activity.

5. Conclusion

This study examined the physicochemical and bacteriological parameters of Odor River in Orumba North, Anambra State. The parameters considered were pH, turbidity, temperature, Dissolved Oxygen (DO), Alkalinity, total hardness, sulphate, chloride, calcium (ca) hardness, magnesium (Mg) hardness, Iron, Nitrate, conductivity, Total Dissolved Solids (TDS), total coliform and Escherichia coli (E. coli). The findings of the study revealed that the parameters can be grouped in two groups as follows: group A consists of pH, turbidity, temperature, Dissolved Oxygen (DO), Alkalinity, total hardness, sulphate, chloride, ~~ca~~ hardness, ~~Mg~~ hardness, Iron, Nitrate, and conductivity while group B consists of Total Dissolved Solids (TDS), total coliform and E.coli. Also, it was found the physicochemical parameters were significantly different and within the required WHO standard.

Further findings revealed that river bacteriological parameters such as fecal Coliform and total Coliform were significantly different and higher than the WHO standard. Although bacteriological parameters are not the best indicator of faecal contamination, the measurement of highly coliform bacteria could still be used to indicate a greater risk for river users who could develop certain health problems through water contact activity.

Availability of Data and Material
Available on request

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