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PROSPECTS OF OTAMIRI RIVER AS A SOURCE OF WATER SUPPLY TO ITS CATCHMENT COMMUNITIES IN RIVERS STATE.

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ABSTRACT.

Groundwater is the main source of water supply to most of the communities within the catchment area of Otamiri River. Evidence of stress in the groundwater system has necessitated a search for a source to augment groundwater abstraction and reduce the stress on the groundwater system. The hydrological and physico-chemical characteristics as well as the microbial load of Otamiri River were evaluated at two stations to determine its suitability as a source of water supply. Hydrological and hydrodynamic characteristics of the River were determined at two stations for both wet and dry seasons. Water samples were also collected at the stations for analysis using standard methods. The sampling stations were located across a stretch of approximately five kilometers of the river. Water depths were determined using a graduated hollow metal pole by taking average of dips at measured intervals across and along the river while surface flow velocities were determined by timing a tennis ball released at known point and allowed to travel downstream. Results of the depth determination showed that the station at Umuechem was 2.742m deep while that at Isu was 2.396m deep. Discharge analysis and seasonal variation in volume and size were also in the same order. Water velocity was higher at the station at Isu (0.86m/s) while the velocity at Umuechem Station was 0.29m/s. At all the stations, the water temperature was uniform at 27°C in both seasons. Heterotrophic bacterial load was at acceptable level in all the stations. However, Total Coliform Bacteria and Faecal Coliform Bacteria were high; exceeding WHO acceptable limit in all the stations. Values of Total Hardness of the water in all the stations show the water to be soft in both wet and dry seasons. The concentration of Ca, Ph, Mn, Cl, $NO3^-$, SO_4^{2-} and pH are within WHO acceptable limit for all the stations in the two seasons. However, the concentration of Mg and Fe exceeded WHO stipulated limit with iron concentration ranging from 0.05 to 3.89mg/l. Alkalinity values for the water is uniform at 0.05mg/l. BOD for the stations ranged from 0.2 to 6.5mg/l. Dissolved Oxygen varied from 0.4 – 9.7mg/l. The result of the study showed that the station at Isu with a discharge rate of 972.34m^3/s (84,010,176m^3/d) demonstrated suitable hydrologic and quality characteristics to serve as a station should Otamiri River be considered an alternative source for water supply its the catchment communities.

1.0 INTRODUCTION

The quantity and quality of a nation's water resources is positively related to economic well-being of its people and healthy coastal ecosystems. Port Harcourt, a city in the Niger Delta houses the operational headquarters of all of the oil and gas prospecting and producing companies in Nigeria. There is invariably an upsurge of inhabitants who work directly in the oil industry or whose businesses provide support services to the oil and gas industry. Early planners of water supply facilities apparently did not envisage this scenario. Subsequent governments also did not see the need to match the population increase, and subsequent rise in water demand, with provision of water supply facilities. If any projection for increased water demand was made at all, the population increase far outweighed such projection. As a result, there is a gross deficiency in public water supplies to most parts of Port Harcourt metropolis. In reaction to this, households resort to private sources for their daily water needs. The most common of such sources is shallow water boreholes often completed into the alluvial deposits or first aquifer of the Benin Formation. The cluster of such boreholes all completed to about the same depth is feared to have put some stress on the shallow aquifer systems of the area. As urbanisation increases with the attendant increase in population and hence water demand, more shallow boreholes are drilled on daily basis resulting in over dependence on groundwater as the source of water supply. Apart from the cost of construction of the boreholes, the quality of groundwater delivered is in doubt as the water is often not potable in its untreated natural state. Yet the households could not be bothered as long as there is water to drink! This situation gave rise to the need to diversify the sources of water supply to some parts of Port Harcourt metropolis not only to relieve the hydraulic stress on first aquifer but also to provide an alternative raw water source for which treatment is imperative. There are a few surface fresh water bodies in and around Port Harcourt such as Ntawogba river but they run through the city and their pollution loads are very high. Otamiri River drains mainly the hinterland and is much less affected by anthropogenic influences. This study attempts to evaluate its suitability for water supply to its catchment communities.

1.1 DESCRIPTION OF STUDY AREA

The Otamiri River, a river in **Imo State, Nigeria** is named after *Ota Miri*, a deity in Igboland.. It originates in the highlands around **Egbu** and runs southward past **Owerri**, draining through **Nekede**, **Ihiagwa**, Eziobodo, OlokwuUmuisi, Mgbirichi and **Umuagwo** to Ozuzu,Isu and Umuechem in **Etche**, **Rivers State**, from where it flows into the Imo River at Umuebulu Rivers State, (Figure 1).

Figure 1: Location of study area

It is a micro-watershed of the greater Imo river basin. With a length of 105 kilometers Otamiririver is the principal tributary of Imo River. Previous studies showed that the river has an average flow of 10.7m3/s in the rainy season (September – October) and about 3.4m3/s in the dry season (November to February) in Owerri Urban. The total annual discharge of the Otamiri is about $1.7\times10^8 m^3$, with 22percent of this ($3.4 \times 10^7 m^3$) coming from direct runoff from rainfall. This figure constitutes the safe yield of the river (Egboka and Uma, 1985). In Owerri urban, the depth to water varies from 15 to 35m (Ibe and Njemanze, 1998)

2.0 MATERIALS AND METHOD

Two sampling and measurement stations were established along Otamiri River in Etche land before it joins with Imo River around Umuebule, a distance of 5 km. The measuring stations are: Otamiririver at IsuEtche, and Otamiri river at UmuechemEtche. Sampling for water quality analysis and measurements of hydrological and hydrodynamic properties were carried out on a monthly basis for 12 months covering both rainy (April – September 2009) and dry seasons(October – March 2010).

2.1 Determination of hydrological/hydrodynamic parameters

For the measurement of water velocity, a timed tennis ball was released at known point upstream and allowed to travel downstream. The time taken by the tennis ball (t) to travel the distance (L) was measured and the surface velocity was calculated as V = L/t (m/s), (Ogbeibu 1987). The ball was released at a point where the reach of the River was straight to ensure uniform flow with least surface disturbances. The cross-sectional areaof the River was determined by measuring the depths to water bed at a series of points across the stream. This figure was multiplied by the width of the stream within each segment represented by the depth measurement. The areas were summed to determine the entire cross sectional area. Measurements of water levels and volume were made in both rainy and dry season. In a particular location, seasonal variation in water level was measured relative to a fixed point using a staff gauge, a rigid metal plate graduated in meters attached to a secure backing and located in a part of the stream where water is present even at low flows. During installation, the staff gauge was related, by survey, to a fixed reference (e.g., a bridge deck) so that the elevation of the gauge can be checked periodically and re-established if it has been disturbed. Seasonal variation measurements were taken by simply noting the elevation of the water surface on thegraduations of the staff gauge per season. A graduated hollow metal pole was used to measure the depth of the river.

2.2 Collection of water Samples for Analysis

Water samples for bacteriological analyses were collected on pre-sterilized 100ml bottles with stoppers attached. To collect water sample, the stopper was removed with the left hand while the bottle was held in the right hand. The bottles were tilted and faced in the direction of water current. When the bottle got filled, it was corked under the water. Samples for analysis of Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) were separately collected on pre-sterilized brown bottles. The oxygen in the DO containers was fixed on site by adding 1.2ml each of Winkler's solution A and B. The DO and BOD containers were then covered with Aluminium foil and taken to laboratory. Water samples for other physico-chemical parameters, were collected with 2 litres plastic containers form the various stations and sent immediately to the laboratory in ice packed cooler. Generally, all the samples were collected while standing in the creek. Temperature was measured on site.

The samples were analysed for pH, Turbidity, Colour, Total Suspended Solids, Total Dissolved Solids, Total Solids, Total Hardness, Salinity, Alkalinity, Dissolved Oxygen, Biochemical Oxygen Demand, Iron, Calcium, Magnesium, Phosphate, Nitrate, Sulphate, Chloride and microbial population. These analysis were carried out at the laboratory of the Institute of Pollution Studies, Rivers State University of Science and Technology using standard methods.

3.0 RESULTS AND DISCUSSION

3.1 Hydrological/hydrodynamic characteristics of the river

Table 1 shows the results of thehydrological/hydrodynamic parameters of Otamiri River at the different sampling stations.

Table .1: Hydrologic/Hydrodynamic Parameters for Otamiri River

S/No	Sampling Station	Depth (m)	Area (m^2)	Velocity (m/s)	Discharge (m^3/s)
1.	Umuechem	2.742	1414.001	0.29	417.60
2.	Isu	2.396	1128.004	0.86	972.34

3.2 Seasonal variation in river stage

The variation in river stage at the two stations showed that water level was highest in the month of September in two stations with the level at Umuechem station being greater than that at Isu station, (figure 2). This can be explained by the heavy rainfall recorded in that month. Temperature of water at the two stations was uniform at 27°C in both seasons.

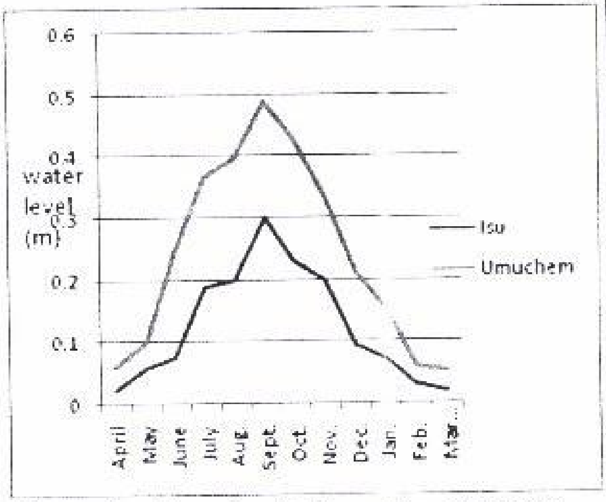


Figure 2: Water level Rise at the Sampling Stations (April 2009 – March 20)

3.3 Microbial Characteristics.

The laboratory results for the microbial characteristics are shown in Tables 2 (for rainy season) and 3 (for dry season). WHO (1996) set Acceptable Limits (Surface Water) for these parameters as follows: Total Heterotrophic Bacteria 0 – 100 in 10^7cfu ml^{-1}, Total Coliform Bacteria 0 – 10 Coliforms $100ml^{-1}$ and Faecal Coliform Bacteria, 0 Coliform $100ml^{-1}$

Table 2: Rainy Season Microbial Populations in Water Samples from the stations

MONTH	Sampling Station	Total Heterotrophic Bacteria ($x10^7cfuml^{-1}$)	Total Coliform Bacteria (MPN index $100m^{-1}$)	Faecal Coliform Bacteria (MPN index $100m^{-1}$)
April	Umuechem	6	0	0
	Isu	20	14	8
May	Umuechem	4	0	0
	Isu	32	20	10
June	Umuechem	13	0	2
	Isu	28	15	2
July	Umuechem	14	10	0
	Isu	19	12	8
August	Umuechem	27	20	10
	Isu	29	10	0
September	Umuechem	28	10	0
	Isu	26	20	10
October	Umuechem	27	0	0
	Isu	49	40	20

Table 3: Dry Season Microbial Populations of Water Samples from the stations

Month	Sampling Station	Total Heterotrophic Bacteria $(\times 10^3 cfu\ ml^{-1})$	Total Coliform Bacteria (MPN index $100ml^{-1}$)	Faecal Coliform Bacteria (MPN index $100ml^{-1}$)
November	Umuechem	10	0	0
	Isu	18	10	0
December	Umuechem	13	0	0
	Isu	18	10	0
January	Umuechem	9	0	0
	Isu	21	10	0
February	Umuechem	6	0	0
	Isu	16	8	0
March	Umuechem	8	10	0
	Isu	20	5	4

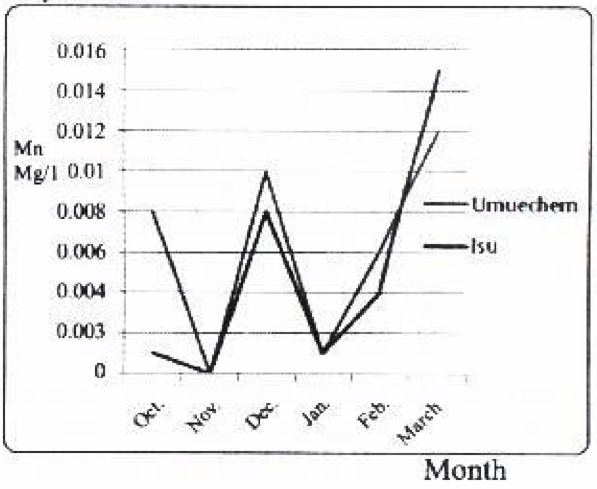
The results show that in most months of the rainy season, Total Heterotrophic bacterial population was within acceptable limit in the stations while Total Coliform Bacteria and Faecal Coliform Bacterial loads were higher than WHO (1996) acceptable limit especially in Isu station. The dry season bacterial load was different. Apart from the month of November where the rainy season pattern was maintained, the results for the rest of the dry month showed the Heterotrophic bacteria, Total Coliform Bacteria and Faecal Coliform Bacterial loads were within WHO acceptable limits except in Isu station where the Faecal Coliform Bacterial loads were also high in the month of March.

3.4 Physico-chemical Parameters.

The results of physico-chemical analysis showed that the concentration of total hardness, phosphate, magnesium, calcium and sulphate were uniform in both seasons at 3.8mg/l, 0.05mg/l, 0.5mg/l, 0.8mg/l and 1mg/l respectively. The seasonal variations in concentration of manganese, alkalinity, BOD, Chlorine, DO, Nitrate, pH and iron are shown in figures 3 – 10.

i) **Manganese**

Dry Season



Wet Season

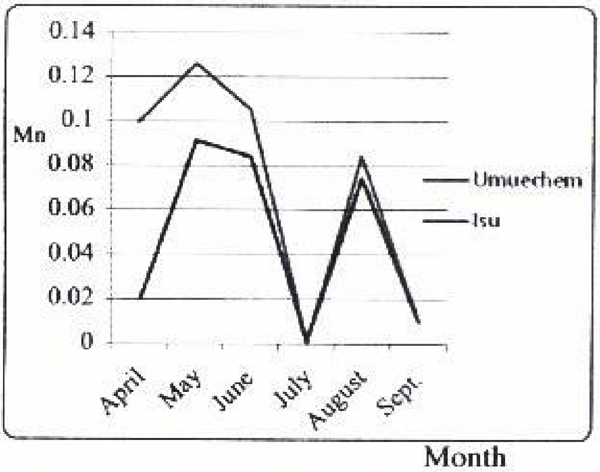
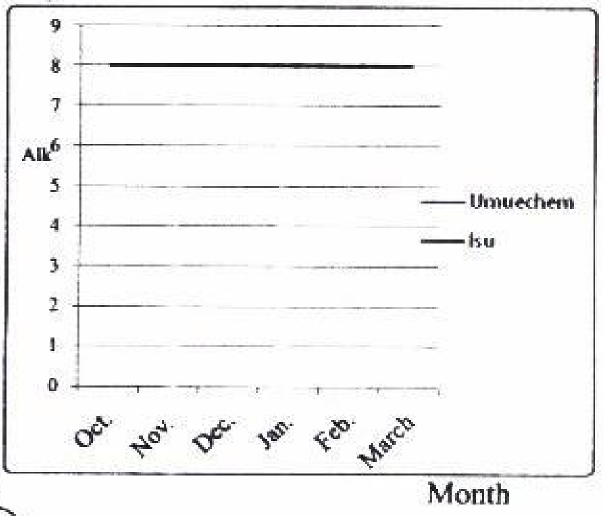


Figure 3: Seasonal variations in concentration of Manganese at the sampling points.

ii) **Alkalinity**

Dry Season



Wet Season

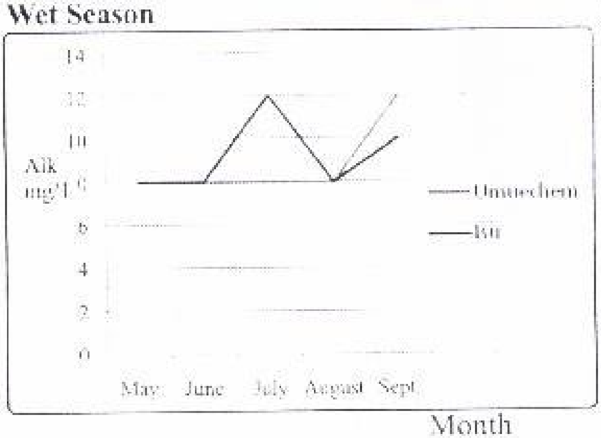
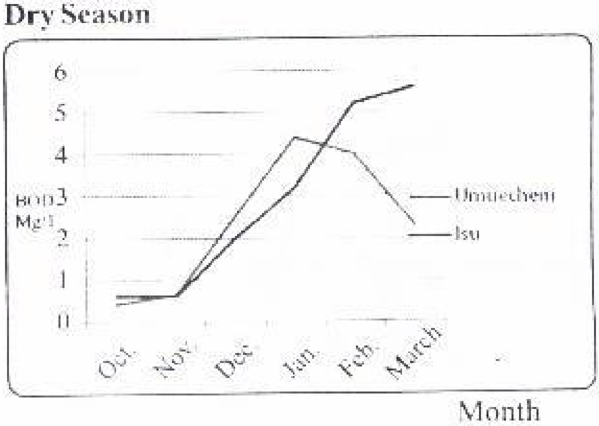


Figure 4 Seasonal variations in concentration of Alkalinity at the sampling stations.

iii) Biological Oxygen Demand

Dry Season



Wet season

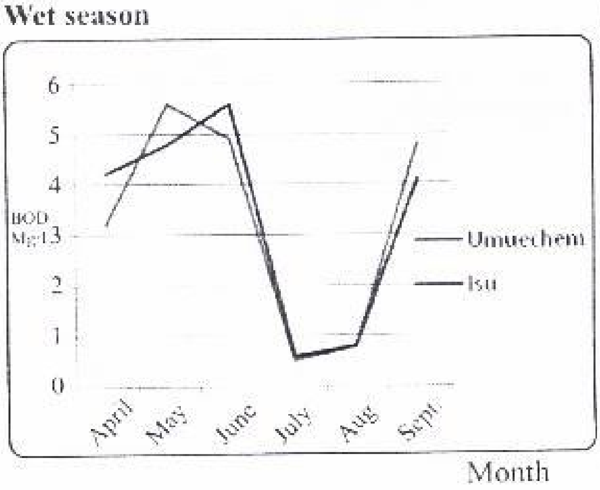
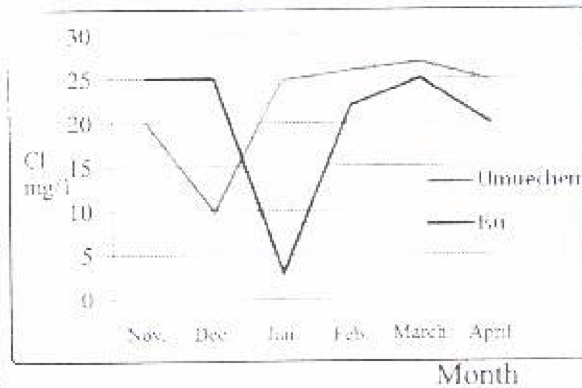


Figure 5: Seasonal variations in BOD at the sampling stations.

iv) Chlorine

Dry Season



Wet season

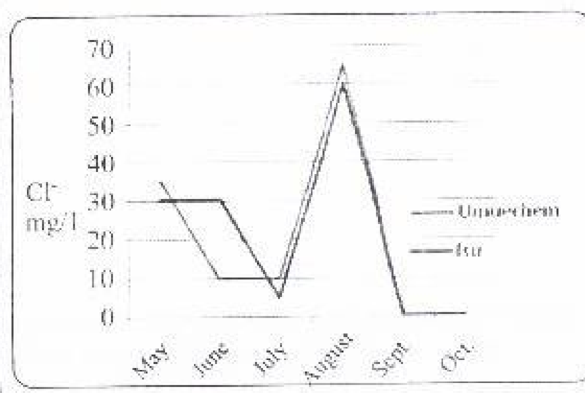
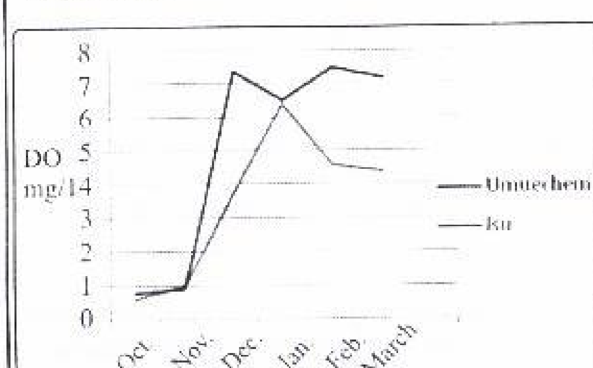


Figure 6: Seasonal variations in Chlorine concentration at the sampling stations.

v) Dissolved Oxygen

Dry season



Wet Season

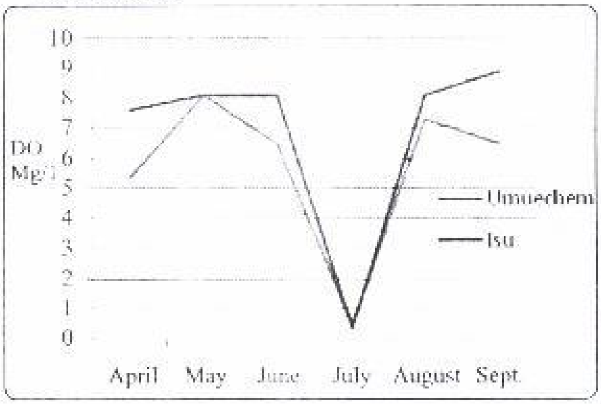
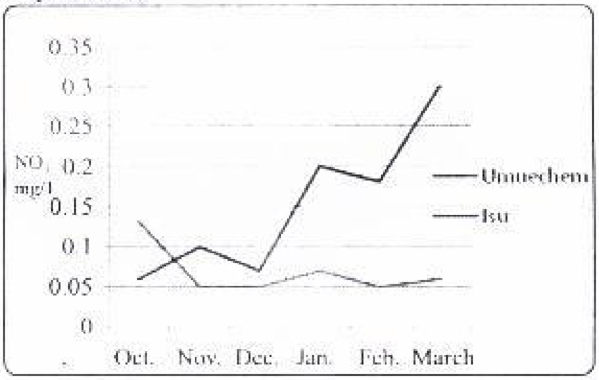


Figure 7: Seasonal variations in Dissolved Oxygen at the sampling stations.

vi) **Nitrate**

Dry season



Wet season

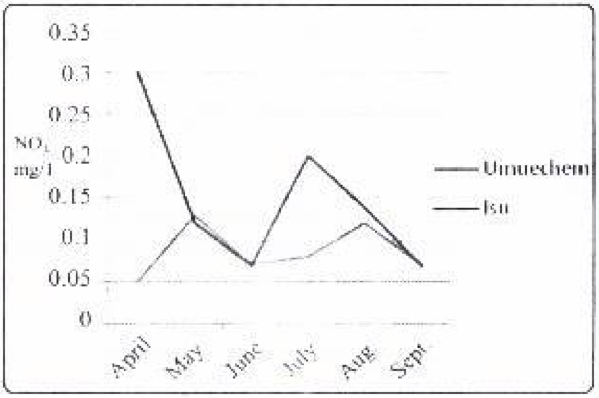
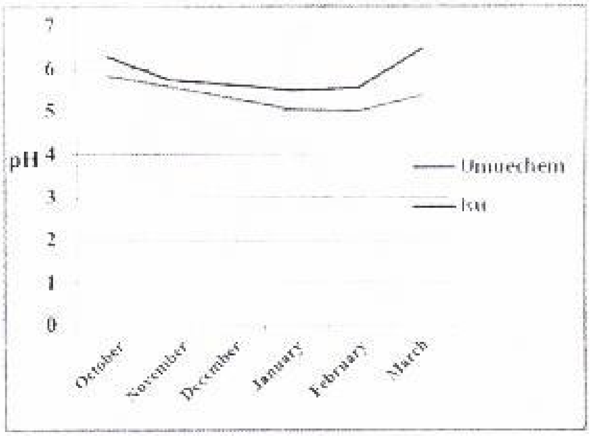


Figure 8. Seasonal variations in the concentration of Nitrate at the sampling stations.

vii) **pH**

Dry season



Wet season

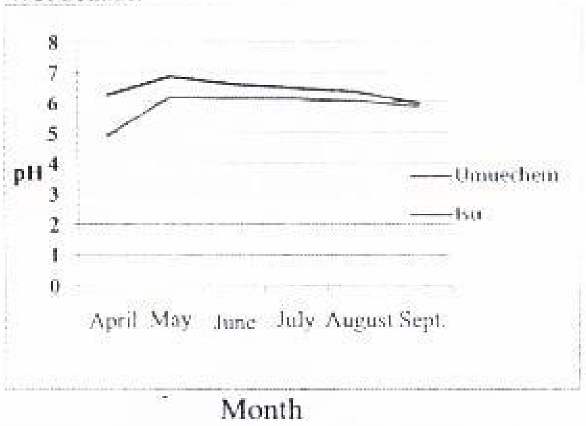
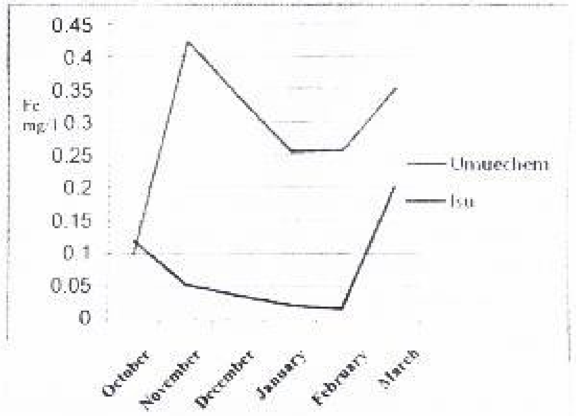


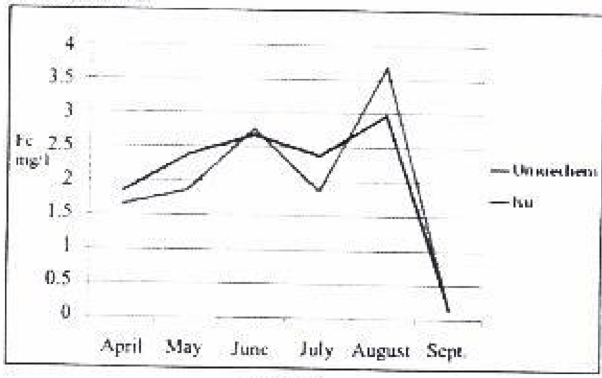
Figure 9.Seasonal variations in pH values at the sampling stations.

viii) Iron

Dry Season



Wet season



Month

Figure10. Seasonal variations in Iron concentration at the sampling stations.

4.0 CONCLUSION

Otamiri River has been studied at two different locations for possibility of use to augment groundwater supplies to the adjoining communities. The study was carried out in both dry and rainy seasons. The result shows that the river is deeper at Umuechem (2.742m) than at Isu (2.396m). Discharge and seasonal variation in volume were in the same order. Water velocity was higher at Isu (0.86m/s) than at Umuechem (0.29m/s). At all the stations, the water temperature was uniform at 27^{0}C in both seasons. Heterotrophic bacterial load was at acceptable level in all the stations. However, Total Coliform Bacteria and Faecal Coliform Bacteria were high; exceeding WHO acceptable limit in all the stations. This could be due to direct disposal of wastes into the river. Values of Total Hardness of the water in all the stations showed the water to be soft in both wet and dry seasons. The concentrations of most physico-chemical parameters were within WHO acceptable limit in both dry and rainy seasons although Mg and Fe were high. Alkalinity values for the water is uniform at 0.05mg/l. BOD for the stations ranged from 0.2 to 6.5mg/l. Dissolved Oxygen varied from 0.4 – 9.7mg/l. However these quality deficiencies can easily be corrected by any standard water treatment plant.

The results further showed that Otamiri River can actually serve as a raw water source for semi-urban water supply. The station at Isu, with a discharge rate of 972.34m^3/s (84,010,176m^3/d), demonstrated suitable hydrologic/hydrodynamic characteristics to serve as a location for the raw water intake structures. However, the water in its present state is unfit for human consumption. Treatment (physical, chemical and microbial) will be necessary.

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