Water Quality Parameters and Indices for IKPA River in AKWA IBOM State, Nigeria

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ABSTRACT

Hydrometric measurement of Ikpa river channel was carried out. Longitudinal and vertical measurements of flow were undertaken. Prior to these measurements, samples of fresh water from the river at various points and at different times were taken to carry out the quality analysis of the abstracted river water. From the samples, physical chemical bacteriological and microbial pathological analyses of the water samples were also carried out. Some of the samples indicated that high values of tested parameters compared with WHO standards. Odour although was found to be inoffensive. Dissolved Oxygen, DO had the values 1.10mg/l, 0.80mg/l, 1.20mg/l and 1.10 mg/l while WHO figure is 1.0 – 5.0 mg/l. Total Dissolved Solids have the values of 3.70 mg/l – 9.8mg/l with the WHO standard being 1000 mg/l. Acidity: -0.88 mg/l for the tested samples while WHO figure is 4.5 – 8.2 mg/l indicating that the water was not acidic. Total Coli form is 33.5 in 100ml. Average E – coli was found to be 19.5 so it rendered the water unfit for drinking. Calcium ions were found to be within acceptable limits. Turbidity figures rose from 22.60 to 26.90 NTU (Nautical Turbidity Unit) while WHO value is 5.0 NTU was exceeded. Suspended Solids values were found to be 1.0 mg/l – 17.70 mg/l while WHO values is zero. Vertical variability of flow was found to be sinusoidal rising to maximum values at two points located at about 60% and 85% of total depth from the channel bed. Reynolds number were determined at various reaches and in all the cases found to be below 500 suggesting the flow to be laminar. Froude number were also computed based on derived field data and were found to be below unity. This is an indication that the flow is subcritical. Putting all the values of velocity of flow and discharge together variations were observed significantly from zero at bottom to mean values of 0.7 meter per second and limiting value with mean average value of 24.66 cubic meters respectively for Ntak Inyang reaches. Similarly values were obtained for Ibiaku Uruan reaches and Mbiakong reaches as presented in the tables in the work. Equations pertaining to the pattern of flow were derived using regression analysis of field data. Similarly, the longitudinal flow was studied and equations of flow were reached at to enable estimation of velocity of flow and hitherto compute discharge using only channel depth as available parameter.

Keywords: Acidity, Analysis, Bacteriological,Dissovled Oxygen, Odour, E- Coli, Microbial, Pathological

IKPA RIVER MORPHOLOGY

THE FLOW ORIGIN

Ikpa River lies between latitudes 52 and 512 and longitudes 750E and 84E. The Watershed covers an area of approximately 315.9 Km (Ekong, 2008). It is located in a stretch of several communities spreading across four local governments of Akwa Ibom state viz. Ibiono, Itu, Uyo and Uruan.

There are several linking tributaries subsisting enabling Ikpa to take its course emptying into the Cross River estuaries, starting from the Ediene through Itam, Ntak Inyang, Nduetong Oku, Ikot Anyang, Use Offot, Mbiakong

Itam beach and terminating at Nwaniba. These towns for the purpose of the work form essentially the potent hydrometric centers. Eventually they might evolve to become stations of Hydrometric Network within the state and study areas.

Channel property will involve having cross-sectional and longitudinal profiling. For each of these data one will concentrate on the use of these data on the use of water resources management.

Ikpa River is situated about sixty (60km) kilometer from the coast of the Atlantic Ocean and is located approximately three kilometers (3km) from Uyo Central Area and relatively positioned on a stretch across four distinct local government areas of Ibiono, Itu, Uruan and Uyo, starting from Ediene in Ibiono through Itam, Ntak Inyang in Itu Local Government Area, Nduetong Oku, Ikot Inyang, Use Offot, Anua Offot, Ekpri Nsukkara in Uyo Local Government Area, then Mbiabong, Ibiaku Uruan, Ikpa terminating at Nwaniba where it empties into the Cross River Estuaries.

At Ntak Inyang two bridges are constructed across the Ikpa River Channel. The old bridge is a two-span bridge approximately 40m length while the newly constructed four span skewed across the channel about 60m – 80m length.

Another point that the river makes a crossing is at Nduetong, a junction of road leading to Ibiaku Uruan. The exists an old one span bridge on concrete masonry and 300mm deep steel beams running across the, 12.5m span of bridge while another major point is the Mbiakong bridge barky Brand constructed of two layer trusses pitched at regular intervals with metal streets to brace. The bridge length is 49.2m while width from one abutment to the other is estimated to the walkway girth is about 2.8m while the river trough both banks is estimates at 43.2m.

Ikpa River Basin is a major tributary of the Cross River and bounded by latitudes $4^{o}20N$ and $5^{o}12N$ and by longitude $7^{o}31E$ and $8^{o}11^{1}E$ covering an area of $413.5km^{2}$ (Udosen, and Inyang, 2001).

A recent work undertaken in University of Uyo related to this area gave the extent of the study area to be between latitudes $5^{o}2^{1}N$ and $5^{o}12^{1}N$ then longitudes $7^{o}5^{1}E$ and $8^{o}4^{1}6$ Ekong (2008) giving the area of the water shed to i.e. approximately 315.16sq.km

Akwa Ibom and Cross River States are blessed in Nigeria for the establishment of Cross River Basin Authority by the Federal Government of Nigeria in 1975 among other four river basins in the country. Having visited the Cross River Basin Authority in 2004/2005 period, there exists little or no base data for streams/rivers within the basin catchment areas as occurrence is replicated anywhere one goes making efforts to establish information on base data.

Hence there arises the need for hydrometric planning strategy now. As the type of research is intensive and requires enormous funds, the initial concentration is set to commence with the Ikpa river watershed. Other watersheds will take their turn in due course.

Establishment of the initial stream flow. Data for rivers and streams with their corresponding base data for hydrometric measurement evaluation.

The results from the study will be useful in planning for sustainable development of Ikpa River for optimum benefit of communities in the catchments area.

Trained hydrographers competent to make stream-flow measurements and convert them into figures of discharge are scarce to come by hence, the entire personnel are selected amongst professionals, students, artisans and unskilled labour around the neighbouring communities. With the outlined significance of study, the work would afford the opportunity of simulating the data to deal with flood related issues, dam construction effects, retard and armoring by revetment. Channel pattern will be handled and then characteristics features identified.

In addition, relationships are established for prediction of flood events and adoption of necessary preventive and mitigating measures for protection of the river.

The study is limited to the channel known as Ikpa River, the stage and reach is between Ntak Inyang Bridge along Uyo Itu Highway Dual Carriage Way and Nwaniba Beach. At Ntak Inyang, the river channel was not free for navigation due to activities like bridge construction that was under construction then and river training at various segments. These included road dualisation and reconstruction of skewed multi span bridge. There is also fish pond resort center under construction at the moment. The study therefore confined itself within the period that the channel was finally open to traffic. Water samples were taken variously at five selected points and tested along the channel length. As the channel is very long, the time difference for the samples taken was more than an hour. The results will show the period of test and analyses made on these water samples for physical, chemical and biological indicators.

The flow measurement was carried out manually using floatation technique initially and flow meter (current meter) was later engaged in vertical flow variation measurement. The use of the VADA sonic sounder, ultrasonic flow meter bubble gauge, electromagnetic flow meter and echo sounder device would have ensured smooth accuracy. The use of high speed hydrometric measuring device fixed to traversing boat was highly impeded as the channel at very many points was winding (sinuous course), narrow, weeded and blocked by foliage, floating tree trunks or suspended across the channel and sometimes submerged or fully immersed in the water.

The work involved clear hydrometry and utilization of data so generated for the evaluation of stream flow characteristics. The actual hydrological cycles and meteorological recordings could not be carried because of project duration. Rainfall data used had been based largely on information kept by the Meteorological Services Station in Akwa Ibom State.

POTABLE WATER

Smith (2011) opined that potable water is water which is fit for consumption by humans and other animals. The alternative name for this is drinking water with reference to intended use. He said water could be naturally potable as in the case with pristine springs, or it may need to be treated for it to be safe.

The Udim Oti - Enwe in Utine, Okobo Local Government Area of Akwa Ibom Sate is a very good example of pristine spring water. The source is directly from the ground and flows on the surface clear, pure and quite good for drinking. The safety of such waters mentioned above must as a rule be tested or assessed free of potential contaminants.

The assertion that in developing countries, however quite a number of African countries and communities do not have access to safe water is too generalized to be true. The specific countries and particular communities where the occurrences had been identified could have been mentioned. In this paper Smith failed to cite examples of naturally occurring springs like Udim Oti - Enwe in Utine in Okobo Local Government of Akwa Ibom State, Nigeria; Udim Uteghe - Udung Afiang in Okobo Local Government Area, Udim Ukuko, Udim Ibotong Enweme and Udim Oro all in Urue Offong/Oruko Local Government Area of Akwa Ibom State. These streams are potentially flowing in perpetuity (perennial). They provide safe potable water for the community they exist.

There are few ephemeral streams and rivers which may provide water only during certain months of the year. The ephemeral river channel may have lots of water flowing through it during the rainy season but he dry as a bone in the late harmattan. The communities that settled in such areas where ephemeral streams and rivers exist suffer the kind of treatment mentioned in Smith's article. Clearly, this is not even a good citation as there are barely any community and catchments that do not have borehole water nowadays.

There is also pure water in sachets sold every where cheap for household use which contain no bacteria chemicals, metals and are healthy drinking water always.

WATER QUANTITY AND SHORTAGE

Wadsworth (1992) asserted that although the whole world has plenty of fresh water, some regions still experience water shortage. Rain does not fall evenly over the earth- some regions are almost all year round dry (arid) while others remain

too wet. Some regions that may get enough rain may seriously have a spell and some other regions may be flooded with excess rain. Some people have water shortage because the people might have managed their supply poorly. It was common practice that people formed settlement where water was prevalent – near streams, springs, rivers and lakes etc. cities grow and factories spring up. The cities and factories dump their waste into lakes and rivers, polluting them.

Shortages do occur when the people do not make full use of their supplies. They have plenty of water but they do not have adequate storage facilities and distribution system to cope with demand. In places where people have water manually in jars and basins from commercial pools, streams and rivers located away from their homes experience shortages inevitably (Wads Worth, 1992).

WATER QUALITY AND POLLUTION

Whether world has enough water fit for drinking depends on how much of it is available and accessible in terms of location of water points and affordability and the quantity worth fetching. The potable water problems of the industrialized world are very different. The industrialized countries have minimal threat of the quality of water exposed to the public; whereas in the developing nations, there still exist spots of identified insufficiencies in quantity and quality of potable water for their citizenry to grabble with. In the later, scarcity still remains major challenge (Barbaraz and Uwe, 1988).

Water pollution becomes a threat to urban water supply – the degradation of the water environment (source and main) by man's activities. This is not limited to the discharge of industrial and municipal wastes, effluents but also to direct and indirect damage to the water environment. Any discharge in natural waters may cause a change in the chemical or physical condition or biological content of water in a water supply that prevents or limits further use of the water or impairs man's aesthetic enjoyment of the water is grouped under pollution. Furthermore, when a water sample does not comply with the standard set up for consumers by the relevant regulatory bodies like NAFDAC and the World Health Organization (WHO), though water quality varies from one country to another (Fogel, 1980) such a sample is said to be polluted from source.

More often construction works and other operations are carried out or across and or adjacent to rivers and water courses to the extent that damage to the natural environment ensues. In the event of this, it is regarded that such operations shall be conducted in a manner to prevent muddy water and eroded materials from entering the streams and water courses by construction of intercepting ditches, bypass channels, barriers, settling ponds or by other approved means. Excavated materials or other construction materials could be stockpiled or deposited near, or on stream banks, lakes, shore lines,

WATER STORAGE

Natural water storage or channel lakes, rivers and oceans serve the purpose of water sports, fishing, or picnicking. Storage of water is very vital especially in large cities and urban centers. Hence construction of reservoirs or man-made lakes, typically created by building dams across rivers (some also occur naturally). Reservoirs even out of fluctuations in a water supply by storing water when it is abundant and releasing it later especially when water supply diminishes during drought.

Water towers remain very familiar sight along nearly every highway in America help to make sure that water deliveries remain relatively constant even during peak water use times. Their main purpose however is to elevate the water level high enough to provide adequate water head (pressures) throughout a distribution system (NAS, 2008).

As demand for water increases so does the need for new reservoirs. But a number of factors – including high evaporation rates, damage to fish and ecosystems, and decreasing availability of land for dam construction have made building additional dams less desirable in the United States. In Nigeria, dams are constructed mainly in the north- these

are:- Goronyo dam in Sokoto, Saminaka dam in Kaduna, Hadeija Samora dam in Bornu and Biu dam near Potiskum in Yobe States to mention but a few.

An alternative approach, then now is managed underground storage, which involves capturing water from a source, storing it in an underground aquifer, and then pumping it back up through wells for use. Managed underground storage systems do not require the requisition of large amount of land that surface reservoirs do, and loss of water through evaporation is not a problem. Nevertheless, underground storage does pose some challenges. Among them are the generally high cost of design, construction, and monitoring and the potentials for contamination from chemical reactions between the water and aquifer materials (Excerpts – Prospects for Managed Underground Storage of Recoverable Water, 2007).

The world's freshwater supplies are under increasing pressure to provide for both human and ecosystem needs. When a city builds a new dam, the resulting artificial lake renders severe impacts on the aquatic species above the dam and along the river. Discharging untreated waste water into ecosystem can affect species downstream. Draining wetland area leaves the watershed more vulnerable to erosion and flooding.

WATER QUALITY

COLLECTION OF SAMPLES FOR WATER ANALYSES

Data collected involved the following:

Water samples at five (5) locations distributed along the river course. The approximate length of the river segment under consideration is 19.9 kilometers. From the originating point at Ntak Inyang/Odiok Itam to the next point of Nduetong Oku the estimated measured length is about 620 meters.

The approximate length from origin to Mbiakong Beach Bridge is 9.62 kilometer; to Ikpa Beach the distance is about 2.0 kilometers from Mbiakong and 11.62 kilometers from Ntak Inyang/Odiok Itam. The water samples were collected from the mentioned five positions and the ambient temperatures taken.

METHOD OF WATER SAMPLE COLLECTION

At the centre of river point, a worker participant dived into river bottom, with corked bottle in hand. He opened the bottle cover on reaching the bottom. Keeping bottle upright made upward swim to the surface gradually until sample bottle was full. He now delivered the filled bottle to an assistant inside the boat while he struggled his way trusting himself into the anchored boat. Temperature of the water sample was taken immediately and recorded. At other locations unspecified samples of sediment deposits were scooped from the bed of the river at goings using buckets. These samples were placed in polythene bags bought for this purpose. There was no foreign matter allowed to settle or be allowed to be entrapped in the bags while samples were being stored for analysis.

WATER SAMPLE COLLECTION POINTS

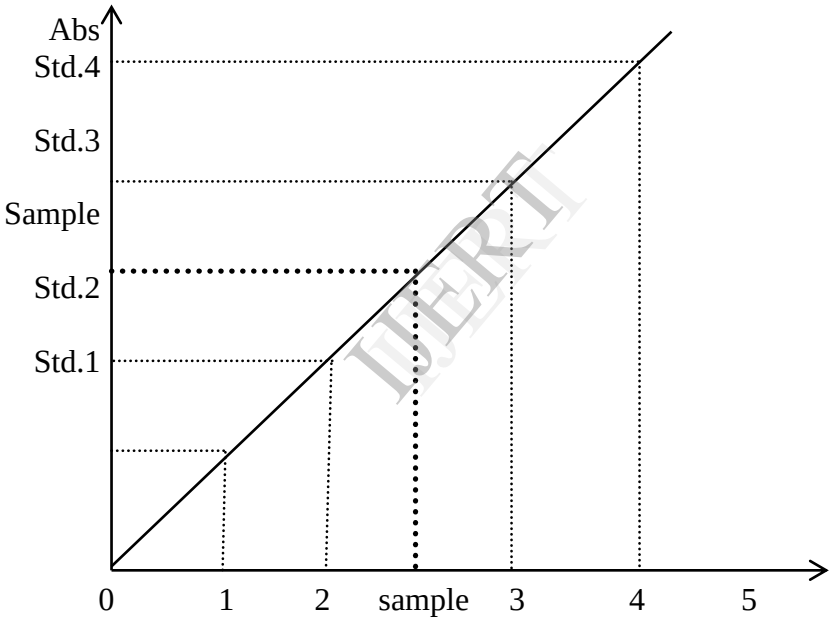
Samples of the following river were taken at various points along its course starting from:

1. Ntak Inyang upstream and downstream locations
2. Junction of Ibiaku Uruan Road and Nung Oku
3. Mbiakong Birley Bridge junction about 10 kilometers from initial point
4. Ikpa Beach
5. Nwaniba Beach estuary

MONITORING OF SAMPLE TEMPERATURE

The temperature of the stream at the time of collecting the water samples were taken and compared with room temperature at the time of analyzing and altering the samples. The essence of the temperature was to provide useful information on the aquatic life studies and pollution level among other things. The results of analyses are recorded in the subsequent chapter, (chapter four) of this work.

Geotechnical investigation was carried out at the Ntak Inyang, Odiok Itam end of the river course. The exercise was done by the company that handled design and construction of a three span bridge across the river. The essence of the investigation had been as it usually does to determine the stratification and engineering properties/characteristics of the subsurface, geophysical and geomorphologic formations of the subsurface soils. The result of that work is presented in the appendix of this work. Methods of tests used varied extensively. Full description of the methods is not presented but a general outline is stated below:



BRAND: UNICAM SOLAR, 969 AAS
Fig. 1 Atomic absorption Spectrophotometer

WATER ANALYSIS

Various analyses were carried out on samples drawn at several locations as indicated in section thus:

(a) Physiochemical analysis

(b) Bacteriological analysis

Those were confined only to the test carried out by on 17th July, 2008. The reports were completed on 17th July, 2008 precisely and the indications are as presented below which will be compared with the one's taken subsequently in April, 2010 to give dispersal arrangement and consistency in either contamination or prevalence rate of significant values.

BACTERIOLOGICAL ANALYSIS OF WATER SAMPLES

APPARATUS AND TEST ANALYSIS

Some of the apparatus/instrument used in the water analyses is:

1. Anaerobic jar, Autoclave 2.Oven 3.Incubator
4. Petri dishes 5. Conical Flask 6.Slides

Pipettes and Test Tubes

MEDIUM: The media used in the culture varied from organism to organism. Examples of that are: For E-Coli, (E.M.B). Eosin Methylene Blue is used combined with 2.8 grams per 100ml of Nutrient agar. Potuto Sextrose Agar was used for Fungi.

PREPARATION: 3.9 grams of it was dissolved in 100ml of water. For E.M.B. used on E-coli, the preparation was 5.2grams of the medium per 100ml of water.

MONITORING: Salmonella Shigella agar was used to monitor the presence of salmonella and shigella but there was no growth after 48hrs 6.3grams of the Agar was carefully weighed and heated to dissolve for about 15 minutes Nutrient Broth was used for streptococcus pyogenes. 1.3grams of it was weighed and dissolved in 100ml of waters. All media were sterilized at 121^{o}C at 15PSOi for 15 minutes using Autoclave.

PHYSICOCHEMICAL ANALYSIS EQUIPMENT/APPARATUS

1. Atomic absorption Spectrophotometer UNICAM SOLAR 969 series
2. Flame photometer Jenway PFP7
3. Titration

PREPARATION OF SAMPLES

The working standards of each element tested were 1mg/l with whose absorbencies the concentrations of elements in samples were calculated.

ATOMIC ABSORPTION SPECTROPHOTOMETER – AAS – UNICAM SOLAR All the elements **Ca, Mg, Cu, Fe, Cd, Ni, Cr, Co** and **Pl** on the table were determined using Atomic Absorption Spectrophotometer UNICAM SOLAR 969 Series. Atomic Absorption is the process that occurs when ground data atom absorbs energy in the form of light of a specific wave length and is elevated to an excited state. The amount of light energy absorbed by the selected element at a specific wavelength will increase as the number of its atoms on the light path increases.

The relationship between the amount of light absorbed and the concentrations of analyzed elements present in a known standard solution can be used to determine unknown concentration.

TABLE 1: VELOCITY DISTRIBUTION WITH DEPTH, DISCHARGE, LOG OF DEPTH, SQUARED OF DEPTH, LOG OF DEPTH SQUARED AND LOG OF VELOCITY SQUARED

Depth (h) (M)	0	0.5	1	1.5	2	2.36	2.5	2.65
Velocity (V) (M/S)	0	0.22	0.95	0.98	0.94	0.75	0.55	0.60
Discharge (M^3/S)	0	1.76	16.06	26.24	35.25	34.43	27.06	31.8
Log of depth (H)	0	-0.30	0	0.18	0.30	0.37	0.40	0.42
Squared of depth (h^2)	0	0.25	1	2.25	4	5.57	6.25	7.02
Log of depth (H^2)	-	0.0906	0.0	0.031008	0.0906	0.139063	0.158356	0.179137
Log of velocity squared (V^2)	-	0.43	0.000496	0.000077	0.00072	0.01561	0.06741	0.049217

TABLE2: SAMPLE NUMBER: 3 DATE COLLECTED: 30-11-11

Source	S/N	PARAMETERS	RESULT	N.S.D.W.Q	W.H.O	REMARK
Ikpa River Ntak Inyang Beach	1	Physical Appearance	Not clear		Clear	
	2	Colour	10		300TCU	
	3	Odour	Unobjectionable		Odourless	
	4	Temperature (^{0}C)	Ambient			
	5	Salinity	0.40		0.04	
	6	Electrical conductivity (µS/cm)	1000			
	7	Dissolved solid (mg/l)	600		1000	
	8	Iron (fe) mg/l	0.3		1.0	
	9	P^H	5.5-8.5		6.0-9.0	
	10	Residual chlorine (cl_2) mg/l	0.3-0.35		0.2-0.5	
	11	Nitrate (No_3) mg/l	1.4		6µg/l	
	12	Nitrite (No_2) mg/l	0.2		6 µg/l	
	13	Manganese mg/l	-		0.2	
	14	Ammonia (NH)mg/l	-		1.5	
	15	Suspended solid mg/l	15		50	
	16	Sulphate ($S04^2$) mg/l	100		250	
	17	Phosphate ($P04^3$) mg/l	3.5			
	18	Total hardness mg/l	200		500	
	19	Acidity mg/l	45-8.5		4.5-8.5	
	20	Alkalinity mg/l	100-200			
	21	Methyl Alkalinity mg/l	100-200		95	
	22	Copper	1		1	
	23	Lead	0.01		0.05	
	24	Zinc	3		3.0	
	25	Mercury	0.001		0.001	
	26	Fiaride	1.5		1.6	
	27	Dissolved oxygen (0_2) mg/l	1.0-5.0		10	
	28	Barium (mg/l)	0.8		700 µg/l	
	29	Cadmium (c_d) mg/l	0.013		0.003	
	30	Silica (Sio_2) mg/l	18			

TABLE 3: SAMPLE No 4: DATE COLLECTED: 30-11-11

SOURCES	S/N	PARAMETERS	RESULT	N.S.D.W.Q	W.H.O	REMARK
Ikpa River Nduetong	1	Physical Appearance	Not clear		Clear	
	2	Colour	11		300TCU	
	3	Odour	Unobjectionable		Odourless	
	4	Temperature (^{0}C)	Ambient			
	5	Salinity	0.35		0.04	
	6	Electrical conductivity (µS/cm)	1000			
	7	Dissolved solid (mg/l)	500		1000	
	8	Iron (fe) mg/l	0.3		1.0	
	9	P^H	6.5-8.5		6.0-9.0	
	10	Residual chlorine (cl_2) mg/l	0.3-0.35		0.2-0.5	
	11	Nitrate (No_3) mg/l	55		6µg/l	
	12	Nitrite (No_2) mg/l	0.2		6 µg/l	
	13	Manganese mg/l	-		0.2	
	14	Ammonia (NH_3)mg/l	-		1.5	
	15	Suspended	15		50	
	16	Sulphate ($S04^2$) mg/l	101		250	
	17	Phosphate ($P04^3$) mg/l	3.6			
	18	Total hardness mg/l	500		500	
	19	Acidity mg/l	45-8.5		4.5-8.5	
	20	Alkalinity mg/l	100-200			
	21	Methyl Alkalinity mg/l	100-200		95	
	22	Copper	1		1	
	23	Lead	0.02		0.05	
	24.	Zinc	2		3.0	
	25	Mercury	0.001		0.001	
	26	Flouride	1.6		1.6	
	27	Dissolved oxygen (0_2)mg/l	1.0-5.0		10	
	28	Barium mg/l	0.6		700 µg/l	
	29	Cadmium (c_d) mg/l	0.002		0.003	
	30	Silica (Sio_2) mg/l	20			

The water quality results are presented for physical, chemical and micro biological tests carried out on the water samples collected from the river.

WATER ANALYSIS

The results are as presented on the tables 4.4 – 4.7 General result of the bacteriological and chemical analyses of samples showed significant growth of coli form and presence of heavy metals in amount beyond WHO allowable values making the water unfit for drinking.

PHYSICO-CHEMICAL ANALYSIS DISCUSSION

Report of physiochemical analysis shows that water from Ikpa River generally has low PH values, a little lower than W.H.O. standard. The samples showed the figures of 5.60, 538, 5.88, 5.86 and 5.86 respectively as presented in the table 4.4 and 4.5. The WHO standard gives the value allowable in the interval of 6.5 – 8.5mgl/l.

THE WATER APPEARANCE/COLOUR (HU-HAZEN UNIT)

The value of 7.H.U. indicates that the water is slightly brownish and has high turbidity level.

ODOUR

The odor detected is inoffensive at the time of sample collection indicating that there was no physical contamination beyond limit.

DISSOLVED OXYGEN (DO)

The levels of dissolved oxygen in the samples indicated from the table are 1.10mg/l, DO of 80mg/l 1.20mg/l and 1.10mg/l respectively. Comparing with WHO figures of 1.0 – 5.0mg/l. obviously they are within allowable limits which are very good.

TOTAL DISOLVED SOLIDS (T.D.S)

The values as shown on the table are 5.30mg/l, 3.70mg/l, 9.80mg/l and 9.20mg/l. The WHO figure is 1000mg/l. The values indicate that TDS is very low even though the figures have shown fluctuation and there seem to be increase after the Ibiaku Uruan junction with Ikot Oku. The little increase at Ikpa Beach and Nwaniba Beach could be because of quarrying activities going on along the vicinity and the fact the rain water deposit from the metro polis has been on the increase from that point. It is a known fact therefore that the dumping of waste motor parts and other substances via the tributaries of the river could lead to the increase. Nevertheless, the figure is not alarming and stays within allowable WHO values.

OTHER METALS

(i) **Magnesium:** BD, BD, 2.00 and 32.0mg/l with WHO figure 50-150mg/l. B.D. – Below detection. The other two figures are still within limits.

(ii) Manganese Level 0.11mgl, 0.02mgl, 0.04mgl, 0.03mgl and WHO stand and is 0.10mgl.

Manganese level is slightly high at Ntak Inyang Bridge point at the time of sampling. It is not known why this is so but we have information that at certain periods the rubber estate situated near the area empties or discharges effluent from the factory/estate into the river channel.

(iii**) Copper Cu^{++} 12.30mg/l, 7.50mg/l, 8.20mg/l and 8.60mg/l**

WHO indicator/standard **Cu^{++}mg/l = 1.58**

There is high prevalence of copper in the river water throughout its course. The initial value has been very high **12.30mg/l** compared with **WHO** limit of **1.58mg**/l. This makes the water to have high pollution level from copper.

Acidity: The values from all the samples such **as 0.64, 0.68, 0.80 and 0.88mg/l** are very low compared with WHO values of **4.5 – 8.2mg/l.** These are acceptable.

Calcium Hardness (Ca^{2+}): The WHO standard stakes **75.0mg/l.** The samples show **56.00mg/l, 62.00mg/l, 40mg/l and 34.00mg/l** being within acceptable values.

Temperature: The temperature of the samples varied from 18^{o}C to 20^{o}C at the time of collection although before the samples reached the laboratory for actual analyses the temperatures increased from 18^{o}C/20^{o}C to 26.20^{o}C, 26.30, 26.10 and 25.70^{o}C. There were no lathing elements to keep the samples but bags were placed in the car and the collected were placed at the floor of transporting vehicle.

Suspended Solids: The values for suspended solid were as shown on the table **13.00mg/l, 17.00mg/l, 1.0mg/l and 3.00mg/l.** These figures are very high compared with WHO figure of no (zero) prevalence at all. The water needs to filter constantly before use domestically even industrially in many cases.

Turbidity: The WHO allowable value for Turbidity is 5.0NTU was completely exceeded on the tested samples that recorded the figures of **23.90, 22.60, 26.90, 26.30 NTU** (Nautical Turbidity Unit).

Electrical Conductivity US/cm: The values obtained at the test represent **12.24, 8.82, 21.50 and 20.40.** These figures are significantly small when compared with that of WHO which 1000Us/cm but the here the industrial standard approved by NAFDAC in consonance with the standard organization of Nigeria this allowable value is staked at 2500 Us/cm which even makes it convincing that the values for electrical conductivity are low and insignificant.

Further Comment and Analyses: The conduct of the tests on water samples were repeated on April, 24th 2010. The results of both physiochemical and bacteriological analyses of the water samples are again presented in another table 4.4.15(a) and 4.4.15(b).

Bacteriological Analysis: Arising from the test results generally, significant growth of coli form bacteria makes the water unfit for drinking.

Average Total Coli forms 33.5 Average Escherichia Coli (E-Coli) in 100ml water 19.5. Arising from the standards stated below the prevalence is high and renders the water unfit for drinking. The native have been drinking the water for so many years and it is not gathered whether they suffer any form of peculiar sickness as a result of this the contaminated water source. Pathogenic organisms are not to appear in the indicator as zero appearance is recommended. Hence the water is not recommended for domestic use.

Table4: Micro-Biological Standards

S/N	TEST	SPECIFICATION
1.	Parasite and Pathogenic organisms	Nil
2.	Total plate Bacteria Count	100 cfu/ml
3.	Escherichia Coli (in 100ml water)	Nil
4.	Streptococcus faecalis in 50ml of water	Nil

Source: NIS 345: 1997

Table 5: Classification of Rivers According to BOD

S/N	QUALITY CLASS	BOD CO_2 ABSORPTION IN MG/L PER 5 DAYS	REMARKS
1.	Very Clean	1	
2.	Clean	2	
3.	Fairly Clean	3	
4.	Doubtful	5	
5.	Polluted	10	

Reference: Higgins and Burns (1975

Table 6: Comparison of the Properties of Oligotropic and Eutrophic Waters

S/N	PROPERTY	EUTOPHIC WATERS	OLIGOTROPHIC WATERS
1.	Appearance	Fairly clear, green, low light penetration	Very clear, highlight penetration
2.	Hardness	Often Hard	Usually soft
3.	Odour and Taste	Often, but not always foul	None or "peaty"
4.	Fish	None or coarse	Present-often salmon and trout
5.	Oxygen Contents	Low, variable with season and depth	Near Saturation
6.	Treatment for Water Supplies	Slow filtering, may block sand filters	Easily filtered

Higgins and Burns (1975)

Morphological and Microscopic Analysis of samples

On culturing both the morphological and microscopic characteristics of the four samples were found to be similar. This observation confirms the fact that the water samples were from the same source - the river channel of Ikpa River.

Bacteriological Analysis (2)

The results of the analysis are given on the table 4.4.15(b). The Total Heterotrophic Count were found in very close range while total coli form count was nil in the samples except the samples from Ikpa Beach Station which was very insignificant figure of 0.2 x 10^5cfu/ml. Similarly the Total Heterotrophic Fungal Count THFC was also about the same range at the same sample and spot. This ranges from 0.1 x 10^5cfu.ml to 0.3 x 10^5cfu/ml. All of them were Aspergillums SPP other than Ibiaku Uruan Junction Bridge station which contained Fusarium and Rhizopus. The entire cultures were plated in duplicates as shown on table 4.5 and 4.6

Fungi Isolation

The fungi units isolated were:

1. Aspergillums fumigatus – Mbiakong Bridge Station
2. Aspergillums Carbonaceous
   Aspergillums fumigatus } Nwaniba Beach
3. Fusarium and Rhizopus – Ibiaku Uruan Bridge Station
4. Phi opus – Ikpa Beach Station

Bacteria Isolated

The Bacteria isolated in the process of testing were as follow:

1. Mbiakong – Streptococcus pyogenes, chromo bacterium violaceum, micrococcus (these are facultative anaerobes which survive anywhere but not for too long).
2. Ikpa Beach Station – Escherichia Coli, Bacillus SPP, Micrococcus.
3. Ibiaku Uruan – Chromo bacterium, violaceum, pedicocci, staphylococcus aureus.
4. Nwaniba – Bacillus Spp and Micrococcus.

As stated before these pathogenic organisms are not to appear in water since zero appearance is recommended. Hence the water is not recommended for any domestic use directly. Treatment of water primarily by boiling and filtering is advocated and the choice of using reverse osmosis for its purification process could make for semi industrial/ commercial venture to tackle the problem of potable water in the communities.

CONCLUSION

The results of the study on Ikpa water quality are useful to give wide spread spectrum of portability of the stream. The results of the tests conducted shown earlier enable advice and early sensitization to be carried out on the people in the community and state at large being the users of the stream as drinking source and navigable channel. Arising from these results, treatment becomes inevitable to remove the pathogens and other microscopic organisms found in the water. Reverse osmosis is recommended for complete purification process. The community in collaboration with the Local Government Authorities can undertake primary liming process in order to correct the p^H value. The problem of turbidity and the presence of trace elements can be removed by coagulation. Furthermore, real chemical disinfection by chlorination is recommended.

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