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DETERMINATION OF SELF PURIFICATION PROCESS IN THREE SELECTED STREAMS IN ANAMBRA STATE

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ABSTRACT

The determination of DO and BOD levels were carried out on samples of water collected from three selected streams in Anambra state using Winkler's method. The surface water bodies are Ezigbekwu stream in Achalla, Awka North Local Government Area, Ogobu stream in Aguluezechukwu, Aguata Local Government Area, and Ogbanta stream in Ajalli, Orumba North Local Government Area. Ezigbekwu stream gave a range of DO values from 24.5 mg /l to 37.1 mg/ l. Also, the BOD for Ezigbekwu ranged from 5.8 mg/l to 29.6 mg/l. Ogobu has DO values that range from 8.5 mg/l to 37.1 mg/l and BOD that ranges from 5.0 mg/l to 15.0 mg/l. Ogbanta stream which has a stretch of more than 2km had DO values that vary between 18.8 mg/l to 33.5 mg/l. These values were then compared with the highest desirable and maximum permissible levels set by the World Health Organization (WHO) and National Environmental Standards and Regulations Enforcement Agency (NESREA) for wastes to be discharged into natural water bodies. Most of the BOD values were below the maximum permissible limit of 40 mg/l and 30 mg/l respectively for both WHO and NESREA though they are above the standard level for potable water as stipulated by WHO. The DO values are mostly above the level critical for normal aquatic life (7.5 mg/l) indicating a nearby pollution source. The oxygen sag curves of the three streams were presented and they showed minor some differences . They were directly comparable to those of standard oxygen sag curve downstream. Thus characteristic decline and restoration of water quality of a stream can be expressed in terms of the DO and BOD levels. As these streams are water supplies for several communities along their courses in all the localities where they drain, the DO and BOD values will be useful in the design of treatment facilities as well as restoration facilities for these streams in the respective communities for the purpose of public water supply.

Keywords: Self Purification, Dissolved Oxygen, Biochemical Oxygen Demand, Stream

INTRODUCTION

It is a well known fact that flowing water bodies can recover rapidly from degradable, oxygen demanding waste and excess heat through a combination of dilution and bacterial decay. This natural recovery process work as long as pollutants do not overload the stream and drought or water diversions do not reduce their flows (Ajayi & Osibanjo, 1984;Miller, 1991;). Self purification of streams is determined because of the hazards that can result from low concentration of dissolved oxygen and to plan for stream restoration programme. The entire humanity especially developing countries is today confronted with the issue of water supply and status of aquatic life, hence it is a thorny issue in the front burner. Equally worrisome is the implication of consuming chemically treated water

. The current mood across the rural communities where streams drain is that of anxiety and uncertainty over the fate of these streams that supply water to them since those at vantage position have resorted to bore-hole water as alternative to water supply.Any physical, biological, or chemical change in water quality that adversely affects living organisms or makes water unsuitable for desired uses can be considered pollution (Ajayi & Osibamjo1984). The drop and rise in the concentrations of both dissolved oxygen (DO) and biochemical oxygen demand (BOD) determine the quality of aquatic life in a particular stream(Akamiwor et al., 2007). Fish and other aquatic animals depend on dissolved oxygen (DO) to live.

All surface water bodies and more especially those which occur in the neighborhood of human dwellings or passing between them are open to pollution. The polluting elements consists of organic and inorganic matter in solution of corpuscular element, varying from the smallest organisms to all kinds of debris and coarser refuse of man and animal, domestic garbage, insoluble inorganic substance such as sand, coal e.t.c.

The addition of these oxygen demanding wastes to water stimulates oxygen consumption by decomposers. During the process of biodegradation or decomposition, oxygen is used by micro organisms to metabolize organic compounds (Velz,1984). Therefore, the concentration of dissolved oxygen in streams and other water bodies decreases downstream, further downstream, the water may become so oxygen depleted that only the most resistant micro-organisms and invertebrates can survive, eventually most of the nutrients are used up, decomposer populations are smaller and the water becomes oxygenated again (Cunningham,2001). Another method of assaying population level is to measure dissolved oxygen (DO) content directly using an oxygen electrode. This automatic purification of polluted water through processes of dilution, sedimentation, oxidation-reduction e.t.c in sunlight is termed "self purification phenomenon" (Miller,1991).

A characteristic decline and restoration of water quality can be detected either by measuring dissolved oxygen content or by observing the flora and fauna that live in successive sections of streams. In addition, the quantitative impact of the oxygen demanding wastes discharged into streams on water quality can be expressed in terms of the biochemical or biological oxygen demand (BOD), a standard test of the amount of dissolved oxygen consumed by aquatic micro-organism over a five-day period (Olorode and Fagade,2012).

LOCATION AND ACCESSIBILITY

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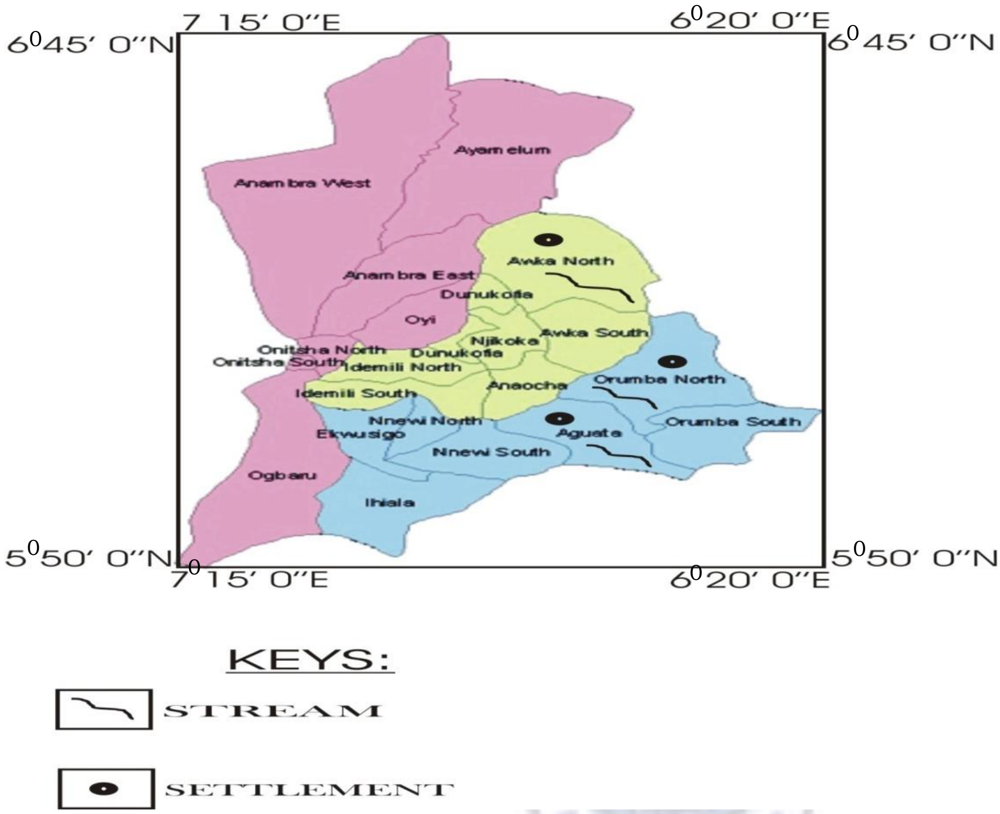

Fig.1 Map of Anambra State showing Local Government Areas where samples were collected

Anambra is a state in southeastern Nigeria; it is bounded by Delta state to the west, Imo state to the south, Enugu state to the east and Kogi state to the north. It lies within longitudes $6^0$45′0″ and 7°15′0″E of the Greenwich Meridian and latitudes 6°20′0″N and 5°50′0″N of the Equator (fig.1). Anambra state extends southwards as far as Ihiala and North wards as far as Achalla. The state is traversed by several tarred and untarred roads including the Onitsha-Enugu express way, Ekwulobia-Ndiokpaleze-Ajalli road, Ekwulobia-Oko-Umunze road.
The three streams, Ogobu, Ogbanta and Ezigbekwu, where the water samples were collected are located respectively at Aguluezechukwu, Ajalli and Achalla town. Aguluezechukwu and Ajalli are located in the southern part of the state while Achalla is located in the northern part of the state (fig.1)

CLIMATE AND VEGETATION

The climate is of humid tropical type with alternating distinct seasons (rainy and dry seasons) and intermittent harmattan period that does not last for a long period. Shedding of leaves marks the onset of the harmattan period.
Most of the precipitations are characterized by heavy thunderstorm and come during the rainy season (April to October) while peak temperatures are recorded between the months of January and March (dry season). The mean annual rainfall is high close to 2000mm and mean temperature of about 25^0C (Metrological Centre, 2013). The rainfall, usually accompanied by thunderstorms and large run-off volumes

is of significant environmental importance. It initiates deep weathering and leaching of soils and rocks in the area, the high intensity of rainfall and large volumes of run-off accelerate erosion activities and degrade the soils.

The rainfall pattern in the area is typical of rain forest belt. During the rainy season, the rainfall may occur as violent downpours accompanied by thunderstorms, heavy flooding, soil leaching, extensive sheet outwash, ground water infiltration and percolation. Rainfall plays a major role in the environmental status of an area.

Anambra area encompasses two broad ecological zones; the tropical rainforest belt and the derived savanna woodland:

Tropical Rainforest Belt: this zone covers most of the state, often exceeding 150 species of plants such as iroko trees, mango trees and cashew trees e.t.c, per hectare

Derived Savanna Woodland: this zone is as a result of the persistent moderating effect of human by way of cultivation, grazing and urbanization which has made some parts of the area to be characterized by the presence of tropical rainforest tree species in association with grassland species typical of the savanna of northern Nigeria. In some places, up to 60% of the vegetative cover is grass.

TOPOGRAPHY

There are two N-S trending sand ridges passing through Anambra state, the Ebenebe-Umunze-Umuna and Awka-Ekwulobia-Orlu. These sand ridges interrupt the otherwise monotonous flat landscape of the Anambra- Imo River basin complex (Obi et al.,2001). Each ridge land form has a steep scarp slope that faces towards the west. The ridges topography flattens out and into the plains of the cross river towards the southeast. Enugu Cuesta, the third sand ridge is however outside Anambra state and runs from Enugu area down to Awgu, all in Enugu State(Obi,2000).

DRAINAGE

Ogobu and Ogbanta streams which drain southern part of Anambra state rise in the upper dip slopes of the Enugu Cuesta and flow in the general easterly and then northwesterly direction to join the Mamu trunk river. The third stream, the Ezigbekwu which drains northern part of Anambra state, rise in the uppermost dip slope of the Enugu Cuesta and eventually flow into Anambra River. The drainage pattern is generally dendritic with some trellising, thus reflecting the gentle dip of the bedrock

The drainage pattern broadly reflects underlying lithologic character. Sediment yield from the Anambra Basin is relatively high on account of the ease of erosion of some of the underlying lithostratigraphic units notably the Ajalli Formation and Bende-Ameke group. The hydrologic character most commonly displayed by the streams and rivers of the basin is regime seasonality, following the dry-wet rhythm of the seasons. During the rainy season from May to October, they are all in flood. They drain large areas covered by lateritic soils. The human activities in this area loosen reddish brown particles and this imparts a deep brown colour to the water bodies during the rainy season.

The streams and rivers flow in relatively wide and incised channels that they hardly ever fill up even in the peak rains. They are thus said to be under fit which is consequence of ease of incision into the highly erodible substratum.

The areas Ogobu, Ogbanta and Ezigbekwu streams drain lie within the Anambra-Mamu drainage basin. The drainage basin forms an extensive tract of undulating lowland flanking the dip slope of the Enugu Cuesta. The Anambra-Mamu drainage river system dominates the areas studied.

MATERIALS AND METHOD

The research work was executed in three major phases: Preliminary Studies, Field work and Laboratory analysis.

Preliminary Studies

Literature on the regional drainage pattern of the Anambra basin was reviewed in order to obtain a substantial idea of the drainage configuration and the dominant drainage system of the areas. Geologic maps were studied to have an overview of the geological formations. Also topographic map was used to ascertain the physiographic features in the areas where the streams drain.

Field Work

Reconnaissance survey of the areas commenced early August 2016 and lasted for about one week, during this phase of the field work, arrangement for a field guide and assessment of possible problems that could hinder the progress of detailed field work were considered. Detailed field work began second week of August and lasted for about two weeks during which direction of flow and vegetation type were noted. Samples were collected systematically in airtight bottles at various horizons and labeled for detailed laboratory analysis.

Laboratory Analysis

Representative water samples collected from respective streams were sent to Spring Board Laboratory, Awka, Anambra state for proper analysis in airtight bottles. Winkler method which uses titration to determine both the DO and BOD as quickly and carefully as possible was used. A 300ml glass was filled to brim-full with water sample. After adding reagents, titration followed until the endpoint was reached. The concentration of dissolved oxygen in the sample is equivalent to the number of milliliters of titrant used. Each ml of titrant (Sodium thiosulfate) added while titrating equals 1mg/l dissolved oxygen. Thus, the total number of milliliters of titrant used equals the total dissolved oxygen in the sample in mg/l (Bruckner,2021).

Sample Handling and Preservation

Sample bottles were not opened before analysis and all the analysis began within six hours of sample collection. This is because biological activity continues after a sample has been taken. This was done in order to reduce the change in samples.

Laboratory studies involved testing for the biochemical oxygen demand (BOD) and dissolved oxygen (DO) content of the water samples in the laboratory. The BOD was calculated from the difference between the initial and final DO after five days of incubation at 20^0c.

Table 1: Streams Sampled, Number of Samples and Sampling Points

Sample name	No of samples	Point. A	Point B	Point C	Point D
Ogbanta	3	Sources	1.5km	2km	-
Ogobu	4	Sources	5.2km	6km	8.5km
Ezigbekwu	4	Sources	1km	4km	4.2km

RESULT AND DISCUSSION

Table II: DO and BOD Values for Ezigbekwu Stream

	Sources	Point B	Point C	Point D
Distance (Km)		1	4	4.2
DO values (mg/l)	24.5	29.6	37.4	31.6
BOD values (mg/l)	9.8	17.4	29.6	5.8

Table III: DO and BOD Values for Ogobu Stream

	Sources	Point B	Point C	Point D
Distance (Km)		5.2	6.0	8.5
DO values (mg/l)	37.1	25.8	32.8	8.5
BOD values (mg/l)	15.0	11.8	12.0	5.0

Table IV: DO and BOD Values for Ogbanta Stream

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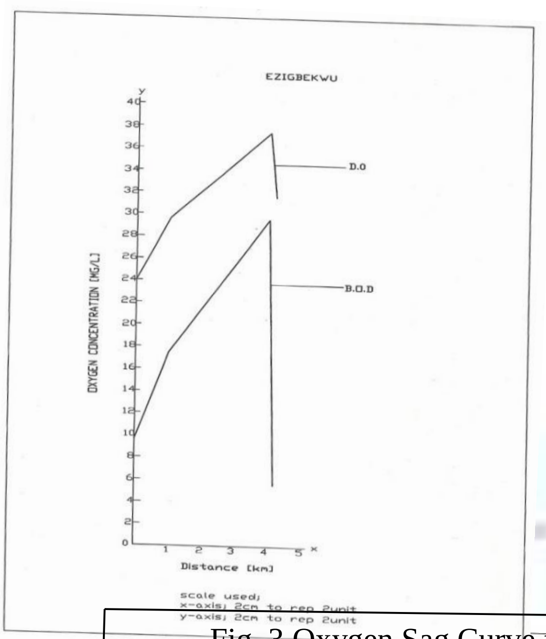
	Sources	Point B	Point C
Distance(Km)		1.5	2.0
DO values (mg/l)	18.8	27.4	33.5
BOD values (mg/l)	12.0	12.4	12.4



kwu Stream

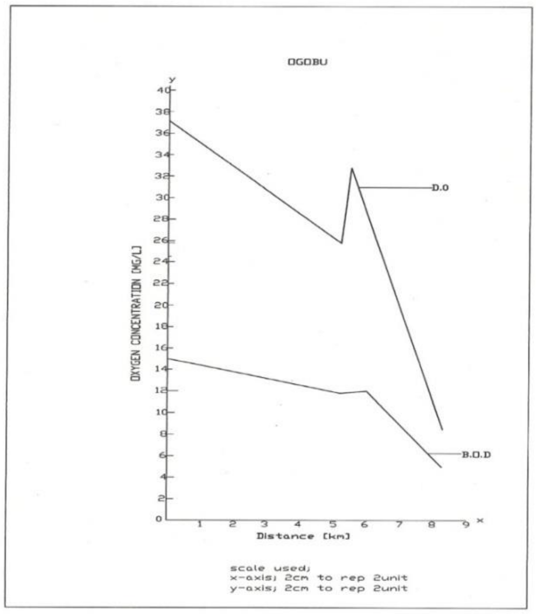


Fig. 3 Oxygen Sag Curve for Ogobu Stream

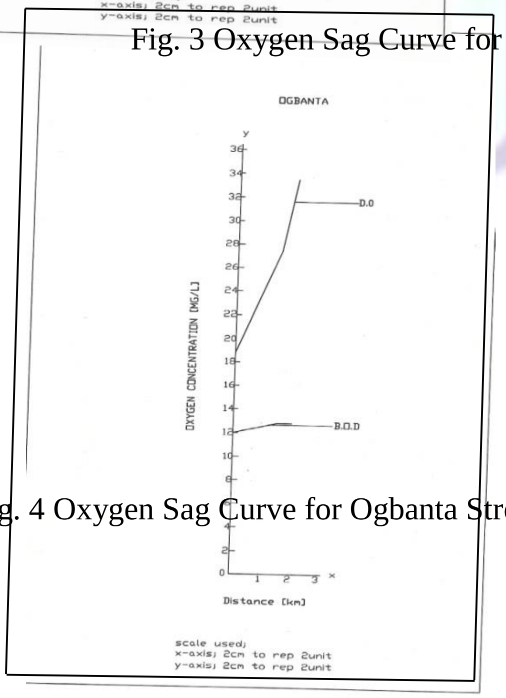


Fig. 4 Oxygen Sag Curve for Ogbanta Stream

TABLE V:World Health Organization (WHO), (1996) and National Environmental Standards and Regulations Enforcement Agency (NESREA), (2009), Permissible limits for Physico-Chemical Characteristics of Water

Parameter	Permissible	Limits
	W.H.O	N.E.S.R.E.A
DO	7.5mg/l	Not stated
BOD	40mg/l	30mg/l

Table VI:Classification of BOD Ezemonye (2009)

BOD	1-2	Clean water
	3-4	Moderately clean
	>5	Pollution sources is nearby

DISCUSSION

A critical analysis of Table II reveals that Ezigbekwu stream which stretches over a distance of 4.2 km gave a range of DO from 24.5 mg/l to 37.4 mg/l also the BOD for Ezigbekwu ranged from 5.8mg/l to 29.6 mg/l. Ogobu stream had DO values that ranged from 3.5mg/l to 37.7 mg/l and BOD that ranged from 5.0 mg/l to 15.0 mg/l (Table III). Ogbanta stream which has a stretch of over 2km had DO values that vary between 18.8 mg/l to 33.5 mg/l and the BOD values that ranged between 12.0 mg/l to 12.4 mg/l (Table IV). The graphs of DO and BOD are shown in (Figs. 2, 3 and 4)

On the basis of DO values, the dissolved oxygen concentrations from Ezigbekwu stream showed that the upstream (source) area had DO value that is less than the DO value downstream and increased slightly midstream. Though the DO value in both upstream and downstream areas of this stream could sustain normal aquatic life, the water is not safe for drinking since the maximum permissible limit for drinking water is 7.5 mg/l (WHO, 1996;1992). The water samples from the Ezigbekwu stream have BOD values that are above the permissible limit of 5mg/l for potable water. Water from this stream is not potable though the BOD values are still within the WHO and NESREA permissible limit (Table III) for wastes that are dumped into water bodies. The water samples from Ogobu stream show DO values that are above the maximum permissible limit of 7.5 mg/l for drinking water. However, it can support normal aquatic life. Upstream, the BOD value is highest and declines gradually downstream. The BOD values reveal that, though the BOD values of water at both upstream and midstream indicate a nearby pollution source (Ezemonye, 2009), the water in these areas has the BOD values that are below the maximum permissible limit of 40mg/l and 30mg/l for both WHO and NESREA respectively (Table III). Downstream the water is moderately clean with BOD value of 5 mg/l and is fit for potable use. In the upstream (source) area, Ogbanta stream gives DO value of 18.8 mg/l though the water can support normal aquatic life, it is not potable since the values exceed the maximum WHO permissible limit of 7.5 mg/l for drinking water. The BOD values of water samples from Ogbanta stream do not vary much owing to the non-accessibility of the midstream and downstream areas because of heavy vegetation. The BOD values show nearby pollution source (Ezemonye, 2009) and are below the maximum permissible limit for oxygen demanding wastes.

As BOD is the amount of oxygen required for the biological decomposition of dissolved organic solids in water sample to occur under aerobic conditions after 5 days at temperature of 20^{0}c, a high BOD indicates the presence of large amount of organic pollution caused by microbial organism, in water (USEPA,2012). Also micro-organisms living in oxygenated waters use dissolved oxygen through oxidation process releasing energy which is used for growth and reproduction. Populations of these micro-organisms tend to increase in proportion to the amount of food and oxygen available. Fish and aquatic insects may die when oxygen is depleted (below 7.5 mg/l) by microbial metabolism (WHO 1996, NESREA, 2009). Further down the stream, the population of these organisms reduces and as more oxygen dissolves in the flowing water normal aquatic life returns (self purification). High levels of DO are therefore necessary. Both DO and BOD measurements make it possible to determine whether the oxygen content in a stream is below or above the level critical to sustain aquatic life as well as whether the water is fit for drinking. The drop and rise in both DO and BOD levels are called the oxygen sag curve (Figs.2, 3 and4).The curves show various sections of the standard Oxygen Sag curve.

CONCLUSION

A characteristic decline and restoration of water quality can be detected either by measuring the dissolved oxygen content or by observing the flora and fauna that live in the successive sections of streams as well as the BOD of the streams, as these streams are water supplies for several communities along their courses in all the localities where they drain. The DO and BOD values will be useful in the design of treatment facilities as well as restoration facilities for these streams in the respective communities for the purpose of public water supply.

A management plan to restrict the dumping of wastes into these streams is needed in order to reduce the impact on water quality and population related health problems. This can be achieved through effective waste management strategy.

RECOMMENDATION

Biodegradable waste should be carefully controlled to avoid environmental pollution. Sewage should be rightly channeled to prevent contamination of streams and also, water gotten from streams should be adequately treated before consumption. The WHO guideline for drinking water quality must be strictly adhered to for sustainable and quality life.

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