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Investigation of Natural Attenuation of Flowing Stream

A Case Study of Opomulero Stream in Owo Local Government Area of Ondo State, Nigeria

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Abstract **– Stream flow samples were collected with distances downstream along Opomulero Stream in Owo Local Government Area of Ondo State. Three sampling points were carefully selected along the stream flow. The examined water parameters were Turbidity, Colour, Dissolved Solid, Hardness, Chloride, Iron, Phosphate, PH, Dissolved Oxygen, Calcium, Nitrate and Magnesium. A comparison of these parameters at the sampling point 1 and 3 shows that all the parameters exhibit trend of decrease in values downstream. Even though most of the parameters are within the WHO standard, this does not make the water from the stream potable unless proper water treatment procedures are applied. The paper calls for further research in the area of monitoring water quality.**

Keywords **– Attenuation, Turbidity, Sedimentation, Parameter, Downstream, Upstream.**

I. INTRODUCTION

In nature, water is in its pure form. Impurities get added to it as it percolates beneath the surface of the earth and also when it is used for human activities.

Water pollution can be defined as the presence in water, of some foreign substances or impurities (organic, inorganic, radiological or biological) in such quantity so as to constitute a health hazard by lowering the water quality and making it unfit for use. [7]

Running water is capable of purifying itself with distances through a process known as self purification (attenuation). This is the ability of rivers to purify itself of sewage or other wastes naturally [5]. On the other hand, [6] found out that certain streams are capable of adding – up more materials as they flow downstream from riparian inputs.

The attenuation of natural water system is a complete process that often involves physical, chemical and biological processes working simultaneously. The amount of dissolved oxygen (DO) in water is one of the most commonly used indicators of a river health. As DO drops below 4 or 5 mg/L the forms of life that can survive begin to be reduced. A minimum of about 2.0mg/L of dissolved Oxygen is required to maintain higher life forms [4].

Natural attenuation relies on natural processes to decrease or "alternate" Concentrations of contaminants in streams and groundwater. Scientists monitor these conditions to make sure natural attenuation is working. Monitoring typically involves collecting samples to analyze them for the presence of contaminants and other site characteristics [3].

When natural water supply is contaminated, nature may work in the following ways to clean it up:

- *Dilution:-* When sufficient dilution water is available in the receiving water body, where the contaminant as discharged, the concentrations of the contaminants decreases as they move through and mix with clean water.
- *Sunlight:-* Algae produces oxygen in presence of sunlight due to photosynthesis. Therefore, Sunlight helps in purification of stream by adding oxygen through photosynthesis
- *Current:-* when strong current is available, the contaminated water will be thoroughly mixed with stream water preventing deposition of solids.
- *Filtration:-* as large bits of debris wash along a stream bed, they often lodge on reeds or stones where they remain caught until high waters wash them into the mainstream again. Small bits of organic matter or in organic clays and other sediments may be filtered out by peoples or rocks along the stream bed.
- *Chemical process:-* Natural water courses contain many dissolved minerals and gases that interact chemically with one another in complex and varied ways. Oxidation reduction, dissolution-precipitation and other chemical conversions may alternately aid or obstruct purification processes of natural water systems.

In a study of the assessment of water quality in a tropical Nigeria City, [1] has reported variation in stream water quality; he further observed that none of the water quality parameters met the WHO standard for drinking water. Quality of water is of paramount importance because of its role to human health, aquatic life, ecological integrity and sustainable economic growth. Water is inextricably linked to the environment. Therefore, actions in the watershed impact on the water resources, which though indestructible unfortunately is easily polluted. The behavior of water in natural systems, its interactions and the variability of the processes that govern its presence and movement must be understood to manage water to meet its objective to support mankind, the species that inhabit the world and the existing and future environment. There is therefore a need to investigate (if any) the processes of attenuation of natural water systems with a view to making recommendations for the purposes of water resources management in the study area.

II. MATERIALS AND METHODS

Water samples were collected at selected upstream, mid and downstream points on the stream course during the day before sun set, using sterilized plastic containers. In collecting the samples, care was taken to obtain samples that are truly representatives of existing condition at the sampling points. In each case adequately rinsed, 2-litre

bottle was used for collection at a depth of about 0.3m. The samples were relatively kept in the dark and at low temperature, until it gets to the laboratory for analysis. The time elapsing between sample collection and analysis is very short.

All sampling containers with their stoppers were properly rinsed in distilled water and well labeled using different identification marks.

All tests were conducted in accordance with American society for Testing and Materials (ASTM) (2014). All necessary properties were established putting into consideration all relevant factors. Physical and Chemical tests were carried out on the samples.

III. Results and Discussion

Table 1: Summary of Physical and Chemical tests result on the water samples

S/NO	TESTS	W.H.O. Water Quality Standard Values (Sources: WHO, 2011)	SOURCES		
			UPSTREAM	MID	DOWNSTREAM
1	Temperature (o^c)	Cool temperature values	24	25	24
2	Turbidity (N.T.U)	< 1.0	45.4	40.4	30.5
3	Colour (T U C)	< 15.0	45	40	20
4	Odour	Unobjectionable	Deep odour	Deep odour	Deep odour
5	Dissolved Solid(mg/L)	< 600	220	230	235
6	Hardness (mg/L)	500 – 1000	140	120	120
7	Chloride(mg/L)	200 – 300	220	220	210
8	Iron(mg/L)	< 0.30	1.5	1.4	1.4
9	Phosphate(mg/L)	50	40	45	38
10	PH	6.5 – 8.5	6.5	6.0	5.5
11	Dissolved Oxygen (ppm)	Very high level not accepted	0.89	0.87	0.87
12	Calcium (mg/L)	100 – 300	40	35	0.38
13	Nitrate	50	0.46	0.45	0.38
14	Magnesium	50 – 80	50	48	48

Results of the tests of selected water samples are presented in Table 1. From the table, it is observed that the Temperature values of the water samples varied between 24^0c and 25^0c. In appearance, the water samples from the stream are not clear. The colour values range between 20TCU – 45 TCU, these values obtained are quite high compared with the WHO standard. This may be as a result of the stream been close to a dumping site, the quantity of fumes and colloidal particles washed away from the waste deposits are quite high. The colour decreases with distance from the source of pollution. This could be explained in terms of natural sedimentation of the colloids and filtering of the fumes particles by the vegetation on the banks of the river and through the solid particles in the river.

All samples have turbidity values higher than tolerable or permissible WHO limits, these can be attributed to the sediments and suspended solids especially during high discharge values. Little sedimentation process could put the level of this physical characteristic under a desirable control. This is evident in the decrease in turbidity with distance away from the point of pollution.

Dissolved solid values between 220mg/l - 235mg/l. Though it is within the WHO limits, it is observed that the total dissolved solids increase in value with the length of river course; the stream water picks up substances which are soluble gases as it moves downstream.

The values of hardness obtained ranges from 120mg/l - 140mg/l. the lowest value of the hardness is from the mid and downstream and the highest value from the upstream

The Chloride, Iron and Phosphate contents range from 210mg/l to 220mg/l, 1.4mg/l and 38mg/l to 40mg/l respectively, which are all lower than the WHO limits. The slight decrease in all these contents could be explained as done before, in terms of the physical process of dilution and sedimentation in the stream.

From the table 1, it is observed that PH values gotten from the tested water samples ranges from 5.5 from the downstream to 6.5 from the upstream section. There is a slight trend of decrease in the PH with distance, this is likely due to dilution, dispersion and advection of the water as it flows downstream.

The dissolved oxygen content (DO) varies from 0.87ppm to 0.89ppm, which is acceptable. The indication of less sewage pollution of the stream could account for this. This may also explain why there is no particular trend in the DO values with distance.

The values of Calcium, Nitrate and Magnesium contents obtained from the water samples show slight trend of decrease with distance as it moves downstream.

Table 2: Self Purification Attributes of Water Samples

S/No	Parameters	Values at Source (Sampling Point 1)	Value at the Mouth (Sampling Point 3)	Difference in Values (Pt. 1& 3)
1	Turbidity (N.T.U)	45.4	30.5	+14.9
2	Colour (TCU)	45	20	+25
3	Dissolved Solid(mg/L)	220	235	-15
4	Hardness (mg/L)	140	120	+20
5	Chloride(mg/L)	220	210	+10
6	Iron(mg/L)	1.5	1.4	+0.1
7	Phosphate(mg/L)	40	38	+02
8	PH	6.5	5.5	+0.1
9	Dissolved Oxygen (ppm)	0.89	0.87	+0.02
10	Calcium (mg/L)	40	35	+05
11	Nitrate	0.46	0.38	+0.08
12	Magnesium (mg/L)	50	40	+02

Source: Author's computation

From table 2, it is observed that all the parameters tested except for Dissolved solid show trend of decrease in value as the stream moves from upstream (sampling point 1) to downstream (sampling point3).

IV. Conclusion and Recommendation

The decrease in the measured parameters of the sampled water could only be explained in terms of the processes of natural attenuation usually occurring downstream in flowing stream. These processes are mainly dilution, dispersion, advection, sedimentation and microbial digestion by the bacteria. Therefore, the processes of natural attenuation can be said to operate in the study area. Although most of values of the parameters tested were found to be within the WHO water standard, the people living around the vicinity of the stream should be discourage in drinking the raw water unless proper treatments are applied. But the raw water can be used for other domestic purposes like, washing of clothes wetting of vegetable gardens and other small irrigation purposes.

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