Research Journal of Agriculture and Biological Sciences, 4(3): 251-256, 2008

Impact of Non-point Pollutants on the Physicochemistry of Orelope Stream, Onabamiro, Ago-iwoye. Southwest Nigeria

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Abstract: The Orelope stream, Ago-Iwoye was investigated for the impact of non-point pollutants on its physicochemistry. The biochemical oxygen demand (BOD) and chemical oxygen demand (COD) at all sampling sites were higher than permissible levels allowed by the Federal Environmental Protection Agency (FEPA) and Ogun State Environmental Protection Agency (OGEPA) for freshwater. The BOD (256mg/L) and COD (667mg/L) obtained at the sampling site C (dumping site) showed the highest severity. The dissolved oxygen (DO) of the stream was low at all sampling sites, the highest severity correlates with sampling site C (the dumping site). The concentration of Lead (Pb) at all sampling sites was higher than the permissible level for freshwater[13], the value of 0.05 ± 3.00 obtained at sampling site C was the highest. Barium was recorded only at sampling site A, which coincides with the abandoned fish pond and its value was higher than the WHO[13] standard. Lead contributed more significantly ($p<0.05$) to the heavy metal concentration of the stream and is highly positively correlated with alkalinity (0.98), pH (0.88), total dissolved solids (0.90) and hardness (0.68) of the stream ($p<0.05$). The means of acidity, alkalinity, conductivity, pH, chloride, chromium, copper, cadmium, lead, magnesium, total dissolved solid, nitrate, nitrite, phosphate and sulphate were significantly different at all sampling sites ($p<0.05$) with sampling site C recording the highest means of all these parameters. Visual appraisal of the stream revealed that eutrophication and ecological succession is gradually taken place, thereby decreasing the volume of the stream especially at the location of the dumping site (sampling site C).

Key words:

INTRODUCTION

Water is an essential resource upon which the survival of man depends, usually the sighting of any village or dwelling of man or the growth of a community is hinged, on the availability of potable water for various domestic and developmental purposes. Aptly put by Elueze *et al*,[4], the quality of available water is essentially an index of the living standard .

Water is a medium of all life activities, which at cellular level occurs in aqueous solution and as rightly put by Odiete[8], water is perhaps the most valuable, most abundant and the most essential natural resource to man and living organisms. Nevertheless, man's activities have not justified the immense importance of water to sustainability of life. But sad to say that mans activities has not justify the immense importance of water to sustainability of life judging by the way we treat water.

Though nature's water is seldom sterile, as soon as it condenses as rain, water begins to gather impurities, but much of these natural impurities are not sufficient to render the water unwholesome. The major problem delimiting the use of water resources are anthropogenic activities, which resulted in the generation of toxic substances. These become dissolved or suspended in water or are deposited on the waterbed, thus the water become polluted and its quality deteriorates.

In Ago-Iwoye a rural town in Nigeria, the major source of pollution or contaminants of water are of Non-point origin. These are polluted run off from water washing over land, picking along with it arrays of contaminants including engine oil from mechanic workshops and broken down vehicles, sand from roadways, farmland nutrients, domestic trash such as food cans, polythene bags, old tyres, plastics, polystyrene foam and other such litters. Another major source of contamination to streams in Ago-Iwoye are leachates from indiscriminate waste dumps, along with these are feacal contaminations from both animals and man. A casual observation and recollection showed that the depth and width of Orelope stream in Ago-Iwoye has diminished considerably compared to what it used to be in 1988, which is an indication of eutrophication.

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In view of its importance in serving the domestic need of the Onabamiro quarter of Ago-Iwoye, its potential aesthetic value to the town as a whole, and a breeding ground for water birds, it is necessary therefore to investigate the present quality of Orelope stream.

This present study aims at establishing the impact of non-point pollutants on the quality of Orelope stream by assessing its physicochemical parameters and suggesting measures for improving the quality of the stream.

MATERIALS AND METHOD

Study Sites: The study area was located at Onabamiro in Ago-Iwoye a town in Ijebu North Local Govt Area of Ogun State, Southwest Nigeria. The Orelope stream is a natural stream whose source is the Ololo stream. It flows North-eastward at a moderate rate. Three sampling sites were demarcated on the stream Site A is an earthen fish pond dug directly in the flow path of the stream, Site B is the exit point where the stream emerges from the pond to continue its flow, Site C is the portion of the stream flowing past a local dumpsite.

Sampling: Raw water samples were collected from all sampling sites A, B and C in the early hours of the day, before domestic activities picked up and subsequent interruption of the natural state of the stream, and transferred to the laboratory.

Physicochemical Analyses: The analyses was conducted at the sewage plant laboratory of the Lagos State Environmental Protection Agency (LASEPA). The water appearance was by visualizing. The water temperature measured in-situ using a thermometer. The pH was measured using the pH meter. Color was assessed by means of colourimeter. Total dissolved solids (TDS) was measured using the TDS meter. The turbidity was measured using the turbidimeter. The acidity, alkalinity and total hardness were measured by titrimetry. Conductivity was measured by conductivity meter. The chemical oxygen demand (COD), biological oxygen demand (BOD) and dissolved oxygen (DO) were determined by titrimetry/dissolved oxygen meter. The concentrations of ammonia(NH_3), nitrite (NO_2^-), nitrate (NO_3^-), phosphates (PO_4^{3-}), chloride (Cl^{2-}) and sulphates (SO_4^{2-}) were determined spectrophotometrically. The concentrations of calcium (Ca^{2+}) and Magnesium (Mg^{2+}), were measured by titrimetry. The concentration of barium (Ba), chromium(Cr), copper (Cu), cadmium (Cd), iron (Fe), lead (Pb) and cyanide (CN) were measured spectrophotometrically

RESULTS AND DISCUSSION

Results: The results of the physicochemical analyses are presented in Tables 1-4. The results were compared to the WHO guidelines for safe recreational water environment[13].

Table 1 shows the physical parameter of the stream: temperature, acidity, alkalinity, colour, conductivity, pH, total dissolved solid, hardness. The temperature of the stream is highest at site A (25.45 ± 0.80). The color of the stream is the same at the three sampling points. The pH is highest at point C (7.83 ± 2.65).

Table 2 shows the (DO), (BOD) and (OD) of the stream. The dissolved oxygen (DO) is highest at point A (7.51mgL^{-1}) and lowest at point C (4.60 mgL^{-1}). The Biological Oxygen Demand (BOD) is highest at point C (256 mgL^{-1}). The Chemical Oxygen Demand is also highest value at point C (667 mgL^{-1}).

Table 3 shows heavy metal concentration at the three sampling point of the stream Barium is observed to be highest at point A (0.123 ± 0.00) calcium is highest at point A (0.85 ± 0.00). Chlorine is highest at point B (1.82 ± 2.89). Chromium is highest at point C (1.45 ± 1.15). Copper is highest at point A (6.65 ± 1.00). Cadmium is highest at point C (4.67 ± 5.77). Iron also is highest at point A (3.14 ± 1.00). Lead is highest at point C (4.58 ± 1.00). Magnesium is highest at point A (13.76 ± 1.00).Cyanide was observed to be absent in all the three points.

Table 4 shows the chemical parameters of the stream at the sampling points. Detergent contaminants are only present at point C (3.32 ± 5.77). The Total Dissolved Solids is highest at point C (92.00 ± 1.73) Ammonia is observed to be absent in all the points except at point C (3.32 ± 5.77). Nitrate in the stream is present in an increasing order from point A to C (1.09 ± 5.77, 2.57 ± 0.00; 3.86 ± 1.00 respectively). Nitrite is highest at point C (4.40 ± 0.00).

Discussion: Though the result of this study showed that the pH, Total dissolved solids(TDS) of the stream at all sampling points were within the acceptable limits of World Health Organization[13] standard, the color of the water, which is light brown indicated that the stream is unclean (Fig 2, 3 and 4) and contaminated with impurities.

The value of COD (667 mgL^{-1}) and BOD (256 mgL^{-1}) at sampling point C of the stream were higher than that obtained at sampling points B and C (Table 2). The higher BOD and COD obtained at point C indicate the presence of large amount of organic matter, which was as a result of the dumpsite located here. Wastes from this dumpsite have greatly encroached into the stream at this point (Fig 4).

Table 1: Means of the physical parameter of Orelope stream at points A, B and C.

Parameters	Sampling sites		
	A (Mean ± SD)	B (Mean ± SD)	C (Mean ± SD)
Temperature (^{0}c)	25.45 ± 0.80	24.15 ± 0.73	24.37 ± 0.55
Acidity (mg/l)	0.17 ± 2.89	0.18 ± 10.18	0.10 ± 0.00
Alkalinity (mg/l)	1.18 ± 2.89	1.20 ± 0.00	1.67 ± 0. 12
Color*	1.00	1.00	1.00
Conductivity (mg/l)	131.00 ± 1.73	136.30 ± 1.15	160.00 ± 1.00
pH	7.47 ± 2.08	7.68 ± 8.72	7.83 ± 2.65
Hardness	1.20 ± 0.00	1.40 ± 0.00	1.40 ± 0.00
Total Dissolved solids (TDS)	77.30 ± 1.15	85.30 ± 3.05	92.00 ± 1.73

*

Table 2: The (DO), (BOD) and (COD) at sampling points A, B, C of Orelope stream.

Parameters mg/L	Sampling sites		
	A (Mean)	B (Mean)	C (Mean)
DO mgL^{-1}	7.51	6.38	4.60
BOD mgL^{-1}	132	133	256
COD mgL^{-1}	320	360	667

Fig. 1: Sampling site A of Orelope Stream (The pond formed by the impoundment of the stream)

Furthermore BOD and COD at all sampling points were higher than permissible level of 10 mgL^{-1} and 20 mgL^{-1} respectively allowed by Federal Environmental Protection Agency[5] and 12 mgL^{-1} and 30 mgL^{-1} respectively allowed by Ogun State Environmental Protection Agency[9]. This therefore showed that Orelope Stream, Onabamiro in Ago–Iwoye is heavily polluted by domestic wastes.

The low Dissolved Oxygen (DO) of the stream at all sampling sites which is due to exhaustion by degrading microbes will affect the survival of aerobic organisms[12] and only organisms that tolerate low level of DO will survive in the stream.

The concentration of Lead (pb) at all sampling points was higher than the permissible level allowed for freshwater[13] (Table 3) and the value obtained at sampling point C was higher than that obtained at B and C. This correlates with the observation that such wastes as batteries, insecticides, paints, rubber, lubricating oil are dumped into this stream periodically and especially at sampling point C. Barium was absent at all sampling points of the stream except at point A

Fig. 2: Sampling site B of Orelope Stream showing a non-point pollution

Fig. 3: Sampling site C of Orelope Stream (the point adjoining the dumpsite)

and its value at point A is higher than the WHO[13] standard. The presence of Barium at this point, which is the pond aspect of the stream is an indication that the fishes in this pond will not be fit for consumption since barium could have accumulated in their tissue over time along with Lead (pb). The consumption of such fishes could lead to accumulation of these metals in the blood of the consumers and results in deleterious health effects such as increased blood pressure, difficulty in haeme biosynthesis.

Though the nutrient supplying anions such as nitrate, nitrite ammonia sulfate and phosphate were present in the stream at all sampling points within the limits[13] (Table 3,4), their concentrations were high enough to encourage heavy growth of grasses and other plants in most parts of the stream.

The means of acidity, alkalinity, conductivity, pH, chlorine, chromium copper, cadmium, lead, magnesium, Total dissolved solid, nitrate, nitrite, phosphates & sulfate are significantly different at the different sampling points ($P < 0.05$) with point C (dumping site location) having the highest means of all these parameters stated above. It could therefore be categorically stated that the stream has a higher load of

Table 3: Mean heavy metal concentration at sampling points A, B and C of Orelope stream.

Parameters mgL^{-1}	Sampling sites		
	A (Mean ± SD)	B (Mean ± SD)	C (Mean ± SD)
Barium	0.12 ± 0.12	0 ± 0.00	0 ± 0.00
Calcium	0.85 ± 0.00	0.80 ± 0.00	0.80 ± 0.00
Chromium	0.10 ± 0.51	0.01 ± 1.00	0.01 ± 1.15
Copper	0.07 ± 1.00	0.02 ± 1.73	0.12 ± 5.77
Cadmium	0.00 ± 5.77	0.00 ± 1.15	0.05 ± 5.77
Iron	0.03 ± 1.00	0.03 ± 1.54	0.05 ± 1.75
Lead	0.01 ± 0.00	0.02 ± 1.00	0.05 ± 1.00
Magnesium	13.76 ± 1.00	5.76 ± 0.00	5.57 ± 3.00
Cyanide	0.00	0.00	0.00

Table 4: Mean chemical parameters of sampling points A, B and C of Orelope stream.

Parameters mgL^{-1}	Sampling sites		
	A (Mean ± SD)	B (Mean ± SD)	C (Mean ± SD)
Ammonia	_	_	0.03 ± 5.77
Nitrate	1.09 ± 5.77	2.57 ± 0.00	3.86 ± 1.00
Nitrite	0.73 ± 3.00	2.40 ± 0.00	4.40 ± 0.00
Phosphate	1.09 ± 1.07	1.88 ± 1.00	2.28 ± 1.00
Sulphate	0.19 ± 0.00	0.85 ± 0.12	1.18 ± 0.35
Chloride	1.80 ± 2.87	1.98 ± 2.85	1.50 ± 0.00

pollutants at sampling point C, which is as a result of the impact of the dump site at this point. But it must be quickly noted that the means of some of pollutants at sampling point B of the stream is at par with that at point C ($P < 0.05$).

The contribution of lead to the heavy metal concentration of the stream is quite significant ($P < 0.05$) as indicated by the analysis of variance. The pearson correlation revealed that lead concentration is very high and positively correlated with alkalinity (0.95), conductivity (0.10), pH (0.88). Total Dissolved Solids (0.90) are highly positively correlated with hardness (0.68) of the stream ($p< 0.05$). Although the concentration of nutrient supplying anions nitrates ,nitrites, phosphates and sulfates are not higher than the permissible level given by WHO[13], as stated earlier, they still correlated very highly and positively with alkalinity, conductivity, pH, TDS, Hardness and lead concentration ($P < 0.05$).

This observation is a good indicator of a stream that is highly loaded with nutrient with the suitable physicochemical parameters for eutrophication and ecological succession taken place gradually at the stream (Fig1), especially in the area where the dumpsite is located (Fig. 3).

Conclusion: It is evident from this study that increased population density of Ago-Iwoye and the resultant poor land use planning, as well as lack of adequate hygienic infrastructural facilities and waste disposal units has considerable influence in the contamination of Orelope stream.

This study provides useful data on the present contamination outlook of this stream, the basis of which pollution control and monitoring strategies and urban environmental planning could be formulated for the study area.

Recommendation:

- There is the need for the responsible authority to provide adequate waste disposal facilities that will prevent the indiscriminate dumping of domestic wastes into the stream.
- There is the need to make the existing environmental edict/legislation more effective through appropriate enforcement and incentive.
- Public enlightenment campaigns aimed at raising the level of awareness and re-orienting the attitude of the populace, in respect of environmental pollution problems are necessary.
- A comprehensive plan to sanitize the Orelope

stream should include cleaning operation aimed at removing debris and wastes within the stream, and periodical monitoring of the water quality.

- The present "eye-sore" state of the Orelope stream system negates the aesthetic importance and recreational values of stream. Therefore, re-construction of the stream features will add to the aesthetic values of the community where the stream is located.

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