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Effects of Agricultural Activities on the Water Quality of Orogodo River, Agbor Nigeria

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Abstract: The paper assessed the effects of agricultural activities on the water quality of Orogodo River. The study included 100 farmers that were chosen randomly from Agbor and Owa communities to answer questions concerning agricultural practices in terms irrigation (methods and frequency) and the types of fertilizers. It was clear that most of the farmers employ irrigation methods and fertilizers that have the potential to cause water pollution. Five sampling stations were identified along the length of the river to determine the physico-chemical characteristics of the water body. Variations of the parameters along the length of the river were attributed to runoff from farmlands and the ability of the river to undergo self-purification. At sampling station A, physico-chemical parameters were found to be within the safe limits for drinking water. At sampling stations B, C and D physico-chemical parameters show a high level of pollution. These higher levels of studied parameters can be attributed to farming activities along the bank of the river. At point E the water sample was of good quality showing that the river body has high degree of self-purification.

Key words: Fertilizers, agriculture, farmers, pollution, irrigation

INTRODUCTION

The pollution of water bodies from pollutant transport through surface run off and uncontrolled discharge of untreated and partially treated sewage and domestic wastes has been reported severally[1-3]. Agricultural activities have also been reported to affect water quality of a river[4]. Some of the identified effects of agricultural production processes on any river body include; nutrient enrichment, deterioration of the water qualities, destruction of spawning grounds for aquatic and marine life and general fish kill.

Orogodo River, which is enclosed within latitude $5^0 43^1$N and $5^0 30^1$N and longitude $6^0 20^1$E and $6^0 12^1$E, takes its source at Mbiri village at an elevation of 150 m above sea level. Orogodo River serves as a major source of water for drinking, bathing, fishing and recreation for the community people. This is so because, hydrogeology of the area does not favour easy drilling of borehole for ground water[5].

Agbor and Owa communities through which Orogodo River traverses are agricultural communities producing mainly food stuff (yams, corn, vegetables, cassava, plantain and fruits) and the rearing of animals (goats, cows and pigs). Agricultural activities in the area are carried out along the bank of the river. Agricultural wastes (corn cobs, cassava peels, livestock manure, fertilizers, pesticides etc) are discharge directly into the river or as runoff. Agricultural waste as a contributing factor to poor river water quality of the Orogodo River has been a source of concern to the inhabitants of Agbor and Owa communities in Delta State, Nigeria. However, no study has been conducted on this major resource (Orogodo River) to establish the extent agricultural activities from the farmland affect the water quality of the river. This paper therefore reports the results of studies conducted on the Orogodo River to establish the effects of agricultural wastes discharge on the water quality of the river and to provide a framework for environmental management in relation to agricultural activities to achieve a good practical guide specifically with Orogodo River.

MATERIALS AND METHODS

Assessment of agricultural practices: In order to collect information on agricultural practices of the area, a well-structured questionnaire which focused on (i) irrigation methods (ii) irrigation frequency and (iii) type of fertilizers was developed. The information about farming practices were consistent with earlier report[4].

Population and sample: The population for the study consisted of local farmers in Agbor and Owa communities in Ika South Local Government Area of Delta State. Using purely random procedure, the researchers draw a sample of 100 farmers from the estimated 700 farmers, that farm along the bank of the Orogodo River. The

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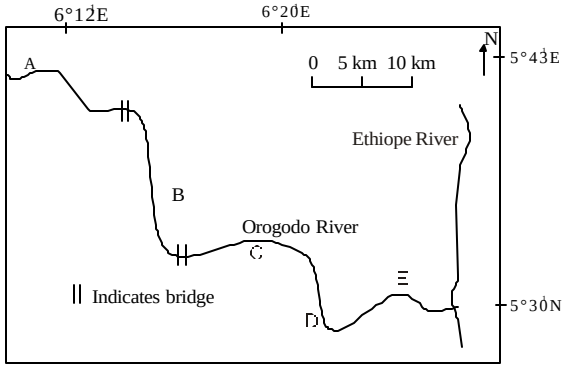

Fig. 1: Sampling points along the length of Orogodo River.

A: Upstream, about 100m from the source of the river.
B: About 2km down stream.
C: About 3.5km down stream.
D: About 5.5km down stream.
E: At the point of discharge into River Ethiope.

sample size is consistent with the number recommended for the size of the chosen population[6].

Data collection procedure: The researchers physically contacted respondents. The randomly selected respondents were issued with the questionnaire designed for the study. Completed questionnaire was retrieved from the participants through the same source. The survey was carried out between June and July 2005.

Assessment of the physico-chemical characteristics of orogodo river: In order to determine the water quality of Orogodo River, five sampling points were identified along the length of the river (Fig. 1).

Plastic containers used for samples collection were pre-treated by washing with dilute hydrochloric acid (0.05M) and later rinsed with distilled water. The containers were later sun-dried. At the collection points, containers were rinsed with relevant samples twice and filled with samples and then corked tightly. Samples were collected on weekly basis within the wet season of August and September 2005.

Adopting different methods of classifying the extent of pollution of rivers[7-10], the following parameters were analyzed; pH, temperature (^{O}C), turbidity (NTU), conductivity (µs/cm), total suspended solids (TSS) (mg/L), dissolved oxygen (DO) (mg/L), biochemical oxygen demand (BOD) (mg/L), total dissolved solids (TDS) (mg/L) nitrate (NO_3^-) (mg/L), phosphate (PO_4^{3-}) (mg/L) and Sulphate (SO_4^{2-}) (mg/L). Fast changing parameters (pH, temperature, turbidity, conductivity, DO, BOD and TDS) were measured in-situ using a multi-parameter water quality monitor (Orion Model 1260). At the determination of any of this parameter, the instrument was properly checked and calibrated before and after use. TSS was determined using weight loss technique. PO_4^{3-} and NO_3^- were determined using Brucine colourimeter technique. SO_4^{2-} was determined using turbid metric technique. All methods of analysis were consistent with known standards methods[11-13].

RESULTS AND DISCUSSION

Collected data from field work survey concerning agricultural practices mainly, irrigation methods, irrigation frequency and types of fertilizers were analyzed and results are as presented in Fig. 2-4. Note that, of the 100 farmers contacted, 100% response rate was achieved and hence no data was treated as missing.

From the results, it was clear that the type of irrigation in Agbor and Owa communities (along the bank of Orogodo River) that was mostly employed by the farmers was surface (64%). This was followed by surface and flood (18%), flood (11%) and surface and drip (7%). Figure 2 pictorially illustrates the irrigation methods on a pie chart. Regarding the irrigation frequency needed by farmers to cultivate their lands Figure 3 show that 78% of the farmers carry out daily irrigation. 16% showed irrigation scheduling was decided according to plant need while 6% of the farmers carry out irrigation weekly.

On the type of fertilizer employed by farmers 81% use livestock manure while 7% uses NPK 15:15:15. 6% of farmers use MgO (Magnesium Oxide) and 6% also used Urea (Fig. 4).

According to obtained results about irrigation types and it's frequency, it was clear that most farmers practice methods that will certainly results to water logging and eventual runoff of farmland into Orogodo River. It has been observed that farmers, growers and ranchers that employed irrigation methods of flooding and surface created a situation that resulted to the pollution of water resources[14].

The results obtained for the five sampling stations during the study period for the studied physico-chemical

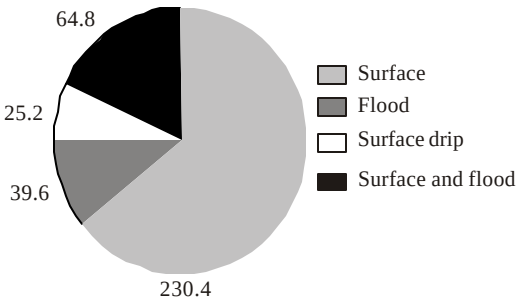

Fig. 2: The relation between farmers and methods of irrigation.

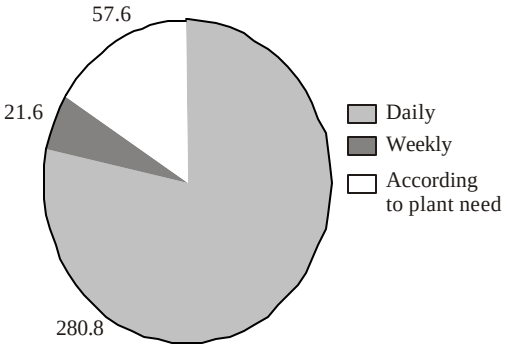

Fig. 3: The relation between farmers and irrigation frequencey

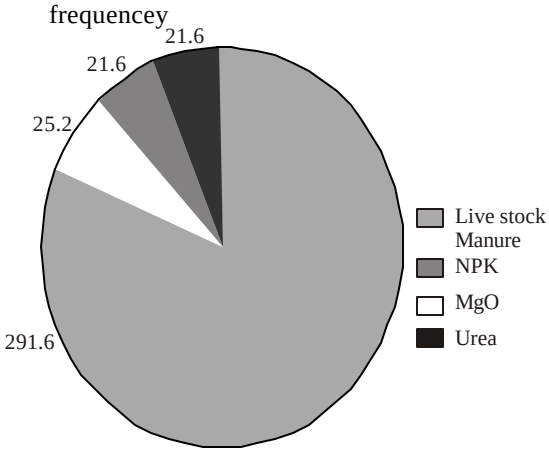

Fig. 4: The relation between farmers and fertilizer types

parameters are shown in Table 1. From the result, water sample collected at point A showed an excellent quality comparable to the quality of drinking water standard[11-13]. This stems fromthe fact that the source of Orogodo river is ground water and ground water is often superior in quality to surface waterbecausenaturalprocesses such as filtration and adsorption, biodegradation, ion exchange and dispersion may reduce concentration of contaminants to a great extent[15,16]. Also, at point A, the effects of agricultural, human and industrial activities on the water quality are eliminated

The water quality at sampling stations B, C and D corresponds to a polluted stream as values of measured parameters exceeded that of standards for drinking water. Within these sampling stations, the water samples are slightly acidic with pH ranging between 5.10 and 6.10. The acidic pH may have resulted from humic acid (HA) formed from decaying organic matter (leaves, corn cobs, cassava peels etc). Temperature of the water samples varied between 28.4°C and 29.6°C. Turbidity values ranged from 21 NTU to 29.4 NTU. The relatively high levels of turbidity could be attributed to the presence of decaying organic matter. Electrical conductivity values ranged from 6775 µs/cm to 8197µs/cm. Decomposing vegetable matter have been reported to rapidly release potassium (k+)[17,18].

The mean DO levels in the sections, B. C and D of Orogodo river were generally found to be below that can maintain aquatic life [19]. DO in water is usually depleted, if organic matters undergoing biological degradation is present. The relatively high levels of BOD (21-38.2 mg/L) can be attributed to the presence of decaying organic matter. These values are comparable with those reported for other water bodies in the Niger Delta[20]. BOD has been a fair measure of cleanliness of any water on the basis that values less than 1-2 mg/L are considered clean, 3 mg/L fairly clean, 5 mg/L doubtful and 10mg/L definitely[21].

The mean TSS and TDS values within sections B, C and D ranged between 198 mg/L and 221 mg/L and 1869 mg/L and 2078 mg/L respectively. The mean nitrates, phosphates and sulphates levels in sections B, C and D of the Orogodo river were generally higher than the levels upstream. This suggests that agricultural activities in the area great influence the quality of the river. The effect of leached fertilizers on water environment and its health implications has been reported[22]. Phosphates and nitrates are important nutrients to plant bloom and the eutrophication of lakes rate of plant growth observed in the river.

At point E (which is about 200m to the point of discharge into River Ethiope), the water quality has fairly good quality considering the low conductivity, low

Table 1: Mean and Standard Deviation of some physico-chemical parameters of Orogodo River

Sampling Stations	Parameters										
	pH	temp	turb.	cond	TSS	DO	BOD	TDS	NO_3^-	PO_4^{-3}	SO_4^{-2}
A	6.9±0.10	25.7±1.23	0.8±0.73	41.8±9.78	1.72±0.06	6.8±1.12	0.81±0.09	41±0.71	ND	ND	ND
B	6.1±0.40	28.4±2.10	29.4±1.37	6775±871	221±8.09	3.19±0.18	31±1.78	1869±201.9	23±1.13	17.91±1.79	36.8±2.07
C	5.2±0.31	29±2.21	28.5±1.41	7169±1081	201±8.09	2.95±0.21	21.0±1.63	2078±197.9	21.4±1.21	28.67±2.08	30.9±2.16
D	5.1±0.30	29.6±1.91	21±1.07	8177±1108	198±10.70	2.17±0.21	38.2±1.58	1967±128	28±1.52	19.91±2.09	35.6±2.08
E	6.83±0.13	27.3±1.45	5.1±0.97	71±103	21.9±1.98	4.95±0.92	4.71±1.17	68±3.71	9.70±1.01	5.18±0.79	21.7±2.01
WHO	6.5-8.5	25-30	1	3000	10	7.5	10	1	10	5	500
FMENV	6-9	25-30	5	4000	10	77	10	5	10	5	500\

ND = Not detected

BOD, high DO and low values of nutrients (SO_4^{2-}, PO_4^{3-} and NO_3^-). This shows that between points D and E, the river showed high degree of self-purification. Similar observation has been reported[23, 24].

In developing countries poor designed or managed irrigation is the main source of non point pollution of river bodies[4]. According to obtained results about irrigation and fertilizers type, it was clear that the farmers practice of using flood and surface irrigation certainly lead to pollutant loading of the receiving body (Orogodo river). In view, of the aforementioned, we suggest that farmers should be educated to change farm irrigation practices to control run-off. The effects of educational efforts towards more environmental awareness has been reported[4]. In addition, the present situation can be improved if more attention is paid to drainage and better water management.

Conclusion: It can be concluded from the results of this study that at sampling point A, Orogodo River belongs to class 1, that is excellent water quality. However at point B, C and D the values of the measured parameters correspond to rivers under very heavy pollution from non point sources of agricultural operations, through the release of animal waste run-off and control other human activities to ensure that run off water have a minimal effect on the water quality of Orogodo River.

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