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Surface and Ground Water Pollution in Abata Ogun Agricultural Wetland

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Abstract
An assessment of the effect of organic and inorganic fertilizer application on Abata Ogun agricultural wetland was carried out in this study. Sampling were taken from stream and wells during the raining and dry seasons. Samples were subjected to analyses of major cations and anions, biochemical oxygen demand, dissolved oxygen, chemical oxygen demand and bacteriological parameters such as E-Coli. In addition pH, temperature, and electrical conductivity were also determined.Cation concentration was in the range of 0.40-19.20mg/l with calcium recording a high value of 19.20mg/l. This is an indication of hardness of water. Low dissolved oxygen exists in the range of 7.20 to 12.80mg/l. Higher values of C.O.D 112.60mg/l when compared with values of B.O.D 74.90mg/l is an indication that activities of microbial organisms are prominent. E-coli values for surface and ground water is high ($1.2 \times 10^4 \mu sm^{-1}$), an indication that the water is not fit for domestic use. Electrical conductivity was high in the range of 37 to 92 $cfuml^{-1}$. The stream flowing through the wetland has a discharge of $0.3m^3/s$ and a flow velocity of 1.3 m/s and deposits sediment load along the stream. High values of PO_4 in well water 4.37 mg/l is an indication that leaching occurs.The study highlight the much needed awareness on the part of local residents, farmers and environmental health authorities to curb dangers inherent in consumption of contaminated ground water and to encourage bio-fortified farming.
Keywords: pollution, water quality, Abata Ogun Agricultural wetland.

1. INTRODUCTION

Information to help farmers select economically and environmentally sustainable crop management practices involving various combinations of tillage, crop rotation, fertilizer and manure management practices is needed to prevent contamination and/or degradation of soil and water resources (Verma et al., 1995). Domestic, agricultural, municipal and industrial water demands are growing rapidly throughout the developing world under the combined influence of population growth, burgeoning industries and urbanization. An attempt at overcoming the water shortage problem is reflected in widespread and uncoordinated tapping of ground water by individual property owners with shallow hand dug wells and sometimes borehole (Omosehin, 1987). Augmentation of water requirements with streams, springs and ponds is also a common feature of peripheral urban settlements of developing countries (Sangodoyin, 1989). The movement of trace metals and metalloids between the soil, plants, water and even the atmosphere is part of a complex and intricately inter-related bio-geochemical cycling process in nature. It is affected by several factors that are both natural and anthropogenic. The bio-geochemical path ways of metals from such natural and anthropogenic sources through the atmosphere, terrestrial and aquatic systems as well as the eventual trophic transfer into the environmental media and human is an intertwined complex system. In addition to the natural weathering – pedological (geogenic) inputs under terrestrial settings, anthropogenic activities such as mining and smelting industries, sewage sludge application and the use of mineral fertilizers are said to be significantly responsible for elevated trace metals concentrations in soils (Devkota and Schmidst, 2000; Frost and Ketchum, 2000; Adriano, 2001; Sigh et al, 2004; Mapanda et al, 2004). Also, intensive agricultural activities, especially vegetable production, create pressures with respect to the use of fertilizers and pesticides as well as contaminated irrigation water, which also contribute to the source of contaminant trace elements in soils (Huang et al, 2006). However, soil is not only a medium for plants growth or a respiratory of waste materials but also a source of emission of many contaminants to atmosphere, ground water and plant (Chen et al., 1997, 2008).

In addition, there is also the possibility of transfer into other environmental media, most especially shallow groundwater systems through infiltration- induced leaching. Trace element contaminations have become an important environmental issue in many parts of the world due to their non biodegradable nature and long persistency within the different environmental media (Raghunath et al., 1999; Gallego et al., 2002) Consequently, predicting the mobility and bio availability of trace elements in soil has been of increasing concern for many decades, both in agricultural and environmental studies due to possible toxic effects of bio - accumulation in plants and vertical leaching/transport into shallow groundwater system (Li et al., 2004, Cui et al., 2005; Liu et al., 2006a, b).This study is aimed at investigating the interaction between trace metal leaching and infiltration from agricultural amendments on surface and ground water quality in Abata Ogun agricultural wetlands.

2.0 MATERIALS AND METHODS

2.1 STUDY SITE:

The study site was Abata Ogun agricultural wetland (Figure 1) situated on the north west of Saki, about 184 km from Ibadan, the state capital of Oyo State. Spring tributaries join the main stream which flows through the wetlands. Two hand dug wells within the wetlands serves the farmers in the area. While one well far away from the farmland serves as domestic water for residents in the area. The study area is about 20ha of cultivated land. Farming activities are carried out all year round. Agricultural amendments (organic manure, Inorganic fertilizer, herbicides and pesticides) are used to replenish lost nutrients for better crop yield. These contaminants get into the wells by leaching and percolation.

2.2. SAMPLING AND PHYSICO CHEMICAL ANALYSIS:

Springs and shallow dug wells within the catchment of the agricultural wetland were sampled in dry and wet seasons respectively to assess seasonal variation. Streams were sampled upstream, mid stream and downstream. Three samples were taken at each sampling points. The width, depth and cross sectional area of stream channels were determined. Discharge was obtained by surface flow method of obtaining average velocity (Trivedy and Goch, 1986)

Sampled wells were labeled W_1 and W_2. The control well was labeled W_c. Each sample was collected and analyzed same day for pH values, total alkalinity, temperature, electrical conductivity, dissolved Oxygen, Chlorine demand, sulphate, biochemical oxygen demand and salinity.

Analyses were carried out in accordance with procedures outlined in standard methods APHA, AWWA and WPCF (1985). Analyses of the trace elements composition was carried out using induced couple plasma optic emission spectrophotometer (ICP OES) method. Data were subjected to Analysis of Variance (ANOVA). Results were compared with FEPA (1991) and WHO (1971) standards.

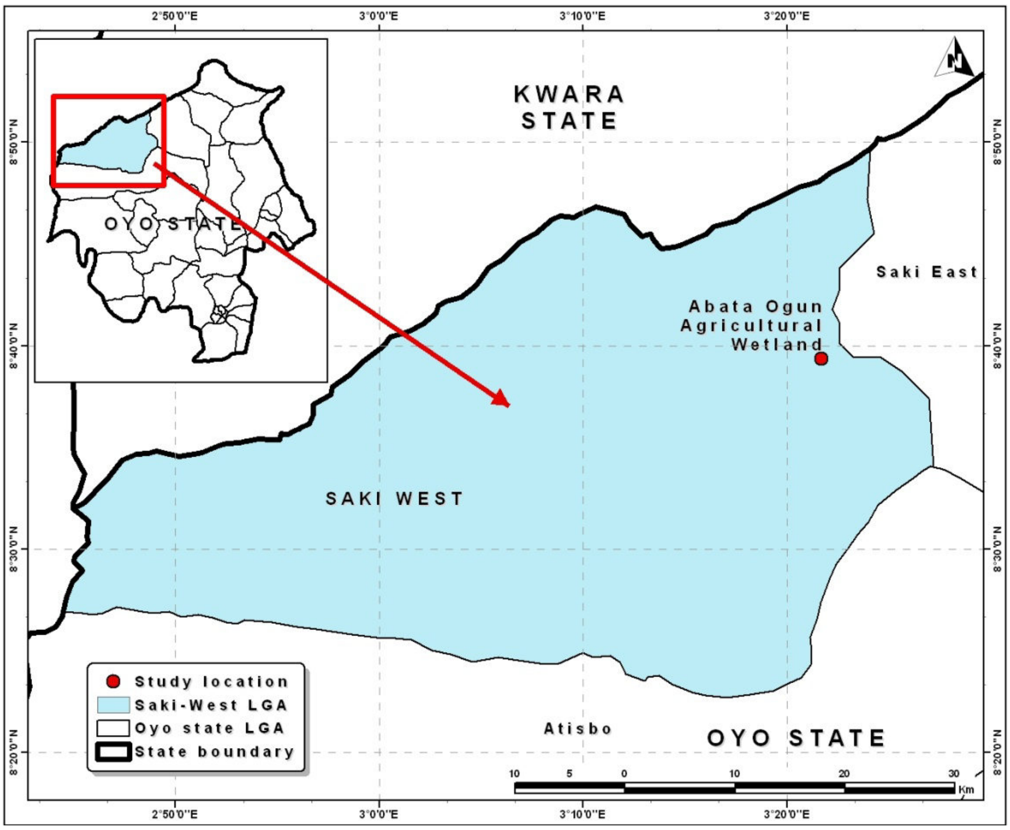

Fig.1. Site location where investigation was carried out

3.0 RESULTS AND DISCUSSION

Summary data of anions and cations for sampled wells and streams points during the raining season necessary for interpretation of results are presented in Table 1 and Table 2 respectively. Table 3 and Table 4 focuses on the anions and cations of sampled wells and streams during the dry season. Information on the physicochemical characteristics as well as bacteriological parameters during the raining season and dry season are presented in Table 5 and 6 respectively.

Abata Ogun agricultural wetland has a flowing stream which is clear and free of particles across the farmland before joining another stream at downstream. Upstream is a velocity of 1.3 m/s and a discharge of 0.3 l/s which indicates the stream is a low flow stream which allows the settlement of particles. The temperature of the flowing stream ranged between 19^{o}C and 21^{o}C and pH was on the increase down the stream. Studies have shown that pH has profound effect on water quality. It affects metal solubility, alkalinity and water hardness. Aquatic lives are also sensitive to pH variation, because most of their metabolic activities are pH dependent (Haines, 1981, Chen and Wang *et al*, 2002). Ca values midstream was 6.92 mg/l at pH of 6.7.

The concentration of NO_3^- during the dry season decreased from 1.82mg/l to 1.28mg/l along the river due to dentrification processes. The nitrate concentration of the well within the farm was higher (4.07mg/l) than that of the control well (0.48 mg/l) outside the farm due to excessive application of fertilizers with the aim of increasing the yield.

Wells within the farm had high (18.53 mg/l) concentration of SO_4. A peak of 36.6 mg/l was recorded for the wells during the raining season when compared to a record of 2.4 mg/l during the dry season, which may be attributed to leaching. While concentration of SO_4 decreased down the stream due to topography.

Chloride concentration midstream (226 mg/l) and W_2 (360 mg/l) for raining season where above the WHO standard for drinking water. There is tendency to affect taste and initiate corrosion in hot water systems.

Strong concentration of phosphate (4.79mg/l) exists in stream water during the dry season. This could result in eutrophication. Strong chloride concentration exists mid stream and in wells (W_2) while well W_1 had high sulphate value. Weak nitrate concentration may be attributed to denitrification process. Calcium concentration increased (2.66-2.7mg/l) laterally due to leaching resulting from inflow of wastewater into the stream. Calcium concentration in the well was high at both seasons. Concentration of magnesium increased (2.94-3.2mg/l) along the stream during the rainy season and decreased during the dry season. Strong concentration of magnesium exists in W_1 and W_2 when compared to control Wc

Potassium concentration was strong (12.53mg/l) upstream and weak downstream (4.12mg/l) while weak concentration exists in W_1 and W_2 when compared to control. Sodium concentration was strong (7.01-8.26mg/l) along the stream during the rainy season due to leaching.

Dissolved oxygen concentration decreased from upstream (11.2mg/l) to downstream 7.9mg/l. Weak dissolved oxygen concentration exists in wells 7.2 – 8.6 mg/l. weak dissolved oxygen concentration affects aquatic life negatively and encourages microbial activities making the stream unfit for drinking and other domestic use (Ukpong 1991, Mouret *et al* 1993). Biochemical Oxygen Demand upstream, midstream and downstream were 34.9, 75.8 and 55.7mg/l during the raining season. Biochemical oxygen demand upstream, midstream and downstream were 74.90, 80.50 and 61.67 during the dry season. Biochemical oxygen demand for wells were generally strong in both seasons (table 6).

From table 5 and 6, chemical oxygen demand for stream and wells where higher than Biochemical oxygen demand values. Hence water from stream and wells are not suitable for drinking in accordance with the interim effluent limitation guidelines FEPA (1991).

Table 1: Characteristics of major anions in sampled wells and streams in the raining season.

Sample code	$S0_4^-$ mg/l	No_3^- mg/l	Cl^- mg/l	$P0_4^-$ mg/l	$C0_3^-$ mg/l
Ups	1.24	0.534	108.00	0.005	18.30
Ms	2.47	0.356	226.80	0.005	12.20
Ds	3.46	0.303	165.60	0.009	12.20
W1	18.53	0.178	118.80	0.01	18.30
W2	3.34	0.926	360	0.022	12.20
Wc	2.48	0.068	97.20	0.002	6.10

Table 2: Characteristics of major cations in sampled wells and streams in the raining season

Sample code	Ca^{++}mg/l	Mg^{++}mg/l	Kmg/l	Namg/l
Ups	2.66	3.23	5.54	8.26
Ms	2.79	2.99	5.60	8.11
Ds	2.87	2.94	5.39	8.22
W1	2.86	2.96	7.23	8.74
W2	2.93	2.1	5.43	19.31
Wc	3.89	3.01	3.21	7.28

Table 3: Characteristics of major anions in wells and streams in the dry season

Sample code	$S0_4^{2-}$mg/l	$N0_3^-$mg/l	Cl^-mg/l	$P0_4$mg/l	$C0_3^-$mg/l
Ups	12.25	6.18	1.82	93.65	0.59
Ms	6.10	4.69	1.28	79.22	4.73
Ds	12.21	3.95	0.72	43.26	0.51
W1	36.60	4.09	1.46	216.04	2.20
W2	12.24	0.74	1.56	93.64	4.37
Wc	6.14	0.49	0.45	57.63	0.69

Table 4: Characteristics of major cations in wells and streams in the dry season

Sample code	Ca^{++}mg/l	mg^{++}mg/l	k mg/l	Na mg/l
Ups	2.15	0.40	12.53	7.01
Ms	1.92	0.69	7.46	7.72
Ds	1.04	1.16	4.12	5.01
W1	1.81	1.57	4.63	7.11
W2	1.77	1.63	6.96	10.52
Wc	5.45	0.48	4.74	6.45

Table 5: Physicochemical and bacteriological characteristics of wells and streams in the raining season

Sample code	Temp ^oc	pH	DO mg/l	BOD mg/l	COD mg/l	EC µs/m	E-coli Cfu ml^{-1}
Ups	19	6.50	11.20	34.90	90.40	69.80	$0.8x10^4$
Ms	19	6.7	10.47	75.80	86.70	80.90	$1.0x10^4$
Ds	19	6.50	7.90	55.70	81.5	82.60	$0.5x10^4$
W1	21	6.40	8.60	60.45	77.90	60.70	$0.6x10^4$
W2	21	6.48	8.10	52.90	60.60	48.50	$0.4x10^4$
Wc	22	6.38	7.20	48.90	62.80	51.00	$0.1x10^4$

Table 6: Physicochemical and bacteriological characteristics of sampled wells and streams in the dry season.

Sample code	Temp ^oc	pH	DO mg/l	BOD mg/l	COD mg/l	EC µs/m	E-coli Cfu ml^{-1}
Ups	20	6.26	12.10	74.90	112.60	71.00	$1.0x10^4$
Ms	20	6.66	12.60	80.50	104.90	90.00	$1.2x10^4$
Ds	20	6.66	8.60	61.67	88.40	91.00	$0.7x10^4$
W1	22	6.30	9.40	76.40	94.80	49.30	$0.8x10^4$
W2	22	6.42	8.40	58.90	92.80	37.80	$0.8x10^4$
Wc	23	6.30	7.60	51.40	58.50	110.8	nil

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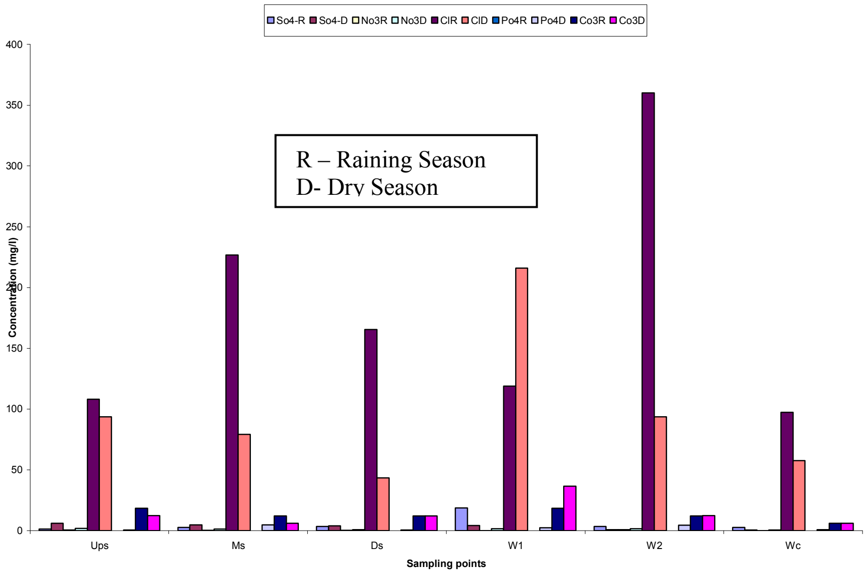

Figure 2

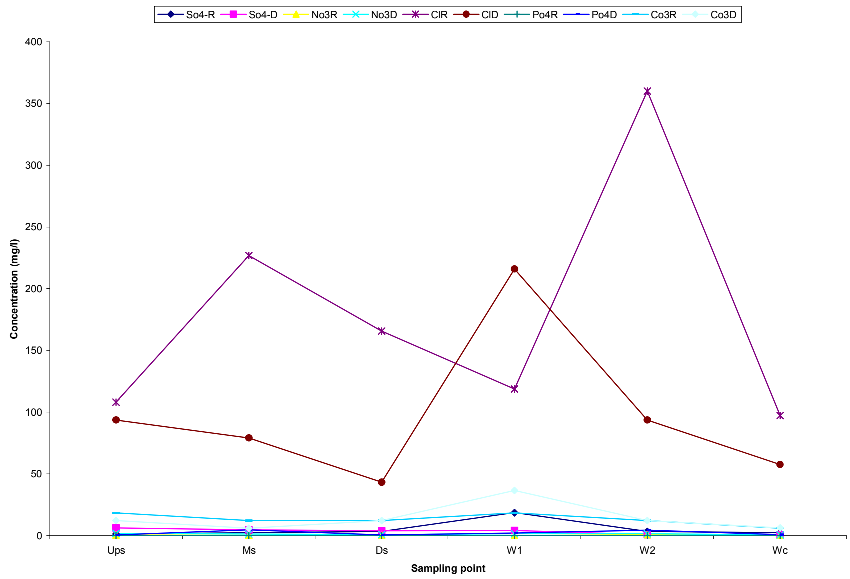

Figure 2 & 3: Variation in Chemical concentration in sampled wells and streams.

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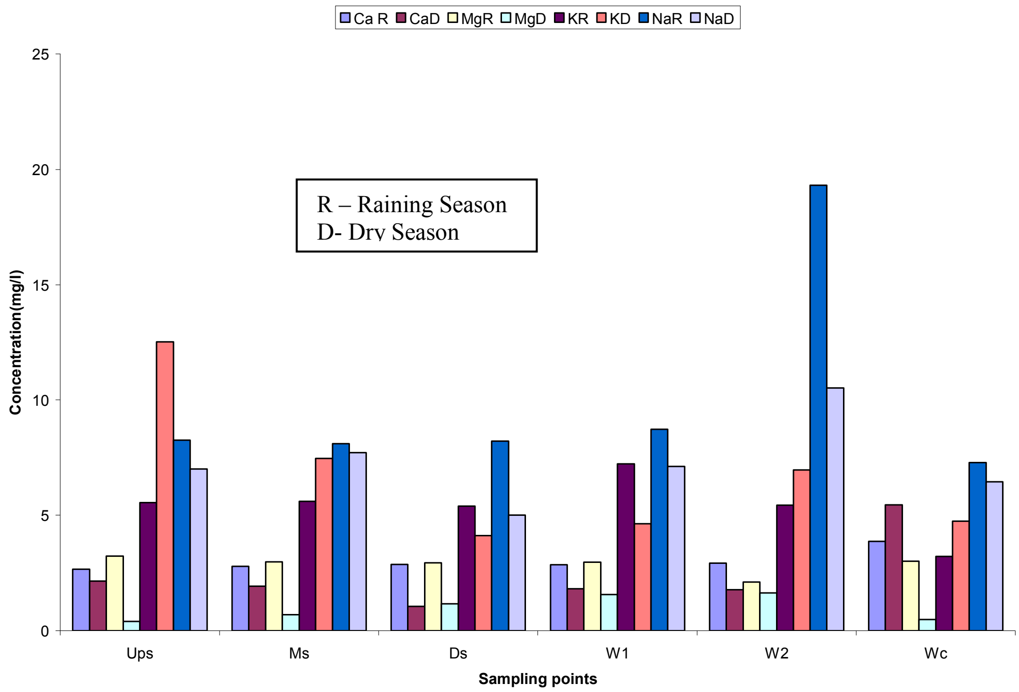

Figure 4

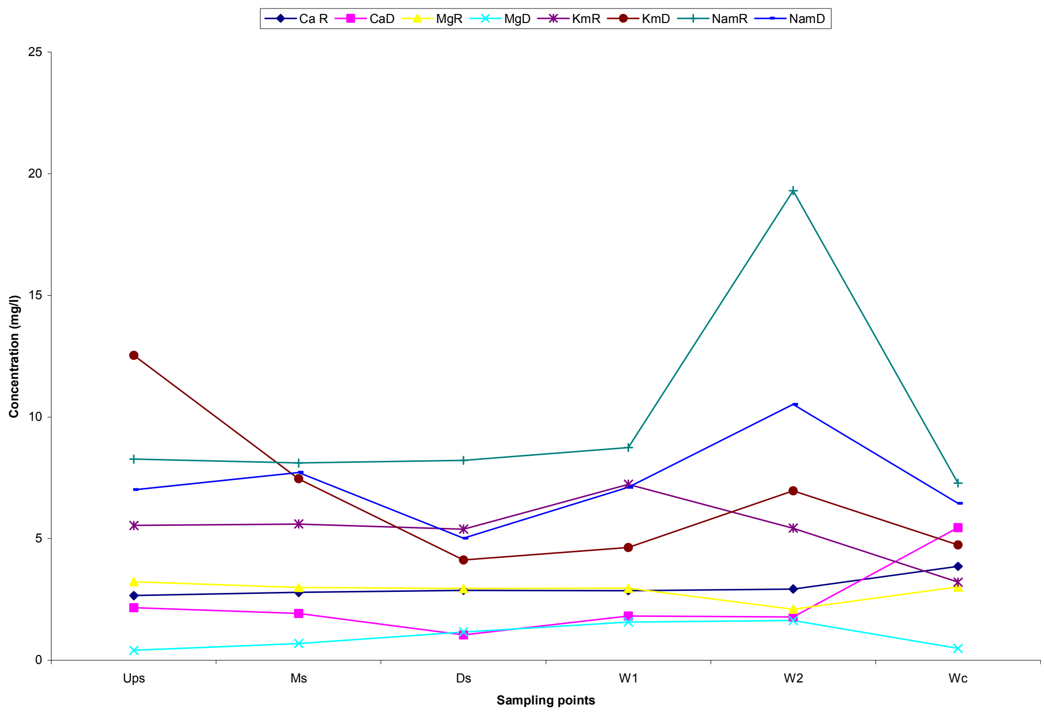

Figure 4 & 5: Variation in trace elements concentration in sampled wells and stream.

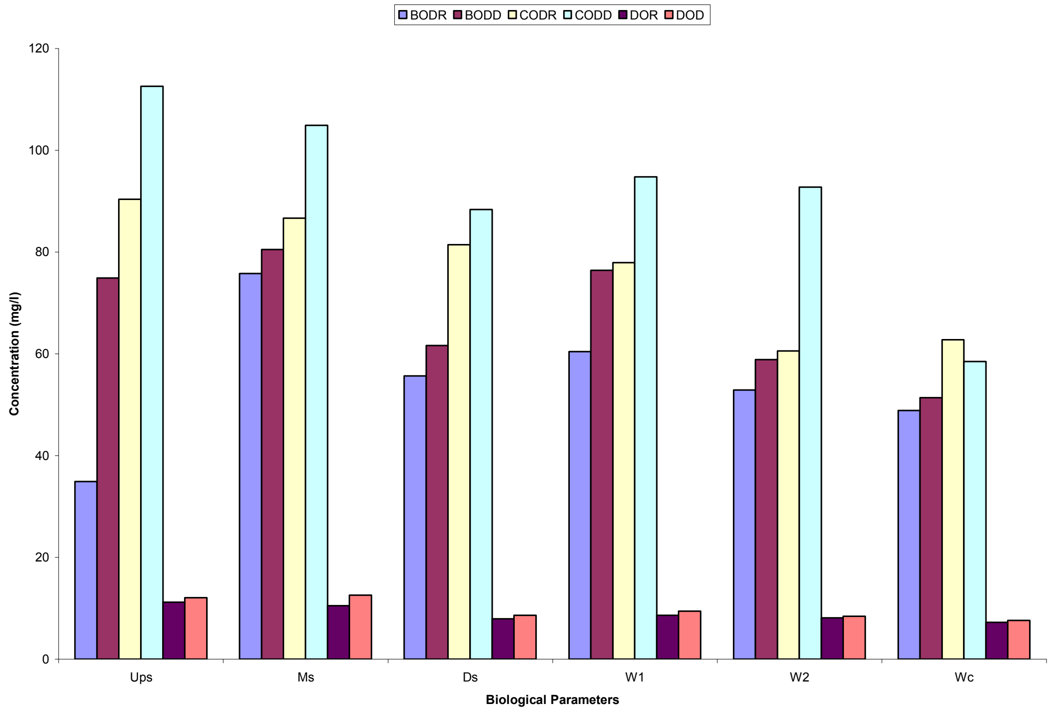

Figure 6

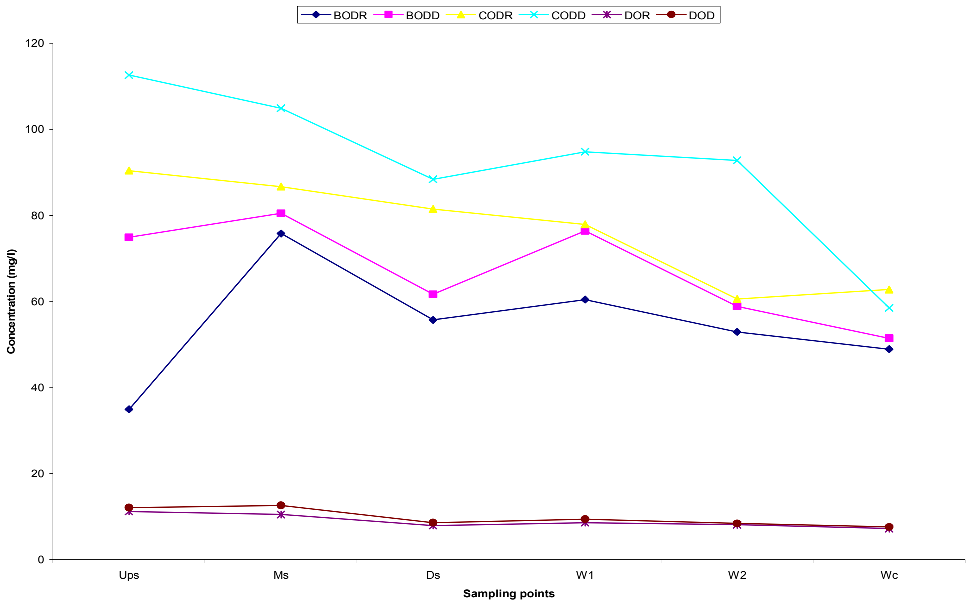

Figure 6 & 7: Variation in Biological Concentration in stream and wells

E-coli values were stronger midstream ($1.2x10^4$) during dry and wet season. This shows the effect of farming activities was towards the midstream. E-coli values increased during the dry season for sampled wells. This may be due to the effect of dilution during the raining season. Electrical Conductivity values were below FEPA (1991) standards for wells and stream. Low EC values signify low level of conducting ionic species. From figure 6a&b, the biological parameters are well pronounced compared to the concentration of major metals (cations and anions). This is a reflection that organic manure was the major soil amendment used in the study area. The organic manure is directly connected to bacteriological activities.

4.0 CONCLUSIONS

Pollution in the form of leachate and runoff were confirmed with elevated levels of phosphate which could lead to eutrophication of the stream. Samples analyzed were above preferable level for drinking water and were within FEPA interim effluent limitation Guidelines, hence could be used for irrigation. It is obvious from our results that there exists excessive usage of organic manure.

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