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The Effect of Wastes Discharge on the Quality of Samaru Stream, Zaria, Nigeria

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1. Introduction

Water is the most important natural resource in the world. Since without it life cannot exist and most industries would not function or operate (Tebbut, 1998). It is essential to life and in fact the basis of life, being so it was almost inevitable that the development of water resources preceded any real understanding of their origin and formation (Ward, 1975). However, water is a unique resource having no substitute with its quality and quantity varying over space and time, hence is finite. Water is equally one of the remarkable substance known which is found in vast quantities in nature; it could be in gaseous, liquid and solid state. There are nearly $14x10^8$ cubic kilometers of water on the planet but 97.5% of this is salty water, fresh water account for only 2.35% of the total. Many people depend on fresh water from lakes, rivers and streams for their water supplies, and these sources contain respectively only 0.26 and 0.006% of the total volume of fresh water (UNEP, 1994)

Water plays a vital role in the development of a stable community, since human being can exist for days without food but absence of water for a few days may lead to death. Water is an essential pre-requisite for the establishment of a stable community. In the absence of which nomadic lifestyle becomes necessary and communities move from one area to another as demand for water exceed its availability. Hence, it is therefore not surprising that sources of water are often zealously guarded over the century. Many skirmishes have taken place over water right (Tebbut, 1998). Water is used for drinking, cooking, sanitation, agricultural purpose, industrial purposes and also used for generating hydro-electric power e.t.c. The amount of water used for other purposes, apart from food preparation and cooking, vary widely and are greatly influenced by the type and availability of water supply.

Furthermore, these facts show how important water is to man, so if water is contaminated it poses a great health hazard to man causing various diseases, and one of the greatest avenue for the spread of diseases is through water. Therefore the presence of water in the environment does not suffice, rather how useful it is to man is what qualifies it as a resource to man. Considering that the utility of water is limited, evaluating in terms of quality, quantity and reliability of all the possible water sources becomes expedient. World Health organization (WHO, 1976) reported that 1.5 billion people worldwide drink filthy water, and this is thought to be increasing for about 20 million each year, up to 25,000 people die each day in the world from water related diseases. Waste water is a complex mixture of natural inorganic and organic material mixed with man-made substances. It contains everything discharged to the sewer, including material washed from roads and roots, and of course where the sewer is damaged groundwater will also gain entry (Edmund *et al*, 1976 and Gray, 2000).

The contamination of water can affect aquatic animals whose survival depend on the quality of water in which they live presently, aquatic life existence is being threatened by man's activities such as industrial waste, domestic waste, waste of animals and human discharge into the stream. These activities have been affecting river quality and in turn the living organisms in the stream (Vega *et al*, 1996).

Samaru stream, which takes its source from Samaru, Zaria, Kaduna state (Nigeria) is a headwater tributary of river Kubanni. The most noticeable problem in Samaru is the inadequate or lack of pipe sewer system. This obviously creates some inefficiency in the disposal of liquid and solid wastes. Refuse disposal is by open dump system. Soak away pit are used as a means of disposal of domestic wastes. All the aforementioned constitute a major pollution in the study area.

There is a network of open gutter which convey storm water away to the major drain running parallel to Zaria-Sokoto road. This drain discharge directly into the stream, this wastes water carries with it faeces, solid materials, ashes, and several other assorted materials which if not deposited along the course of the stream end up in Kubanni dam. These problems are aggravated during the rainy season and these wastes are transported and deposited in the river channel and subsequently into the Kubanni reservoir which may increase the incidence of water borne disease.

The aim of this research is to assess the effect of wastes discharge on the quality of Samaru stream, Zaria, Kaduna state, Nigeria. In order to achieve the aim, the following objectives are imperative, to:

1. Determine the effect of pollution on the quality of the Samaru stream.
2. Compare upstream and downstream water quality of the Samaru stream.
3. Give possible suggestions on measures to improve the quality of water in the Samaru stream.

2. Background to the study area

Zaria is located at approximately 11°3′ north of the equator and on longitude 7° 42′ East of the Greenwich meridian and at about 660m above sea level. It is the second largest city in Kaduna state after Kaduna town north ward along Kaduna-Kano highway (see fig.1 and 2). It has four (4) geopolitical zones (local government areas) including Zaria city local government, Sabon Gari local government area to the north, Soba local government to the east and Giwa local government area to the west.

Samaru is located in Zaria and situated in Sabon-Gari local government area of Kaduna state. It is located at latitude 11° 10′ north and longitude 7° 37′ east. The area is an extension of urban Zaria to the north along Zaria-Sokoto and Zaria Kaura Namoda railway line. It is also one of the major settlements that make up the urban Zaria. It is an educational and administrative settlement which brought about the establishment of new settlement for nonresidents of Zaria City. It grows as a result of the establishment of Ahmadu Bello University, which was established in 1962 and other institutes like Federal Institute for Chemical and Leather Research, Federal College of Aviation and Industrial Development Corporation.

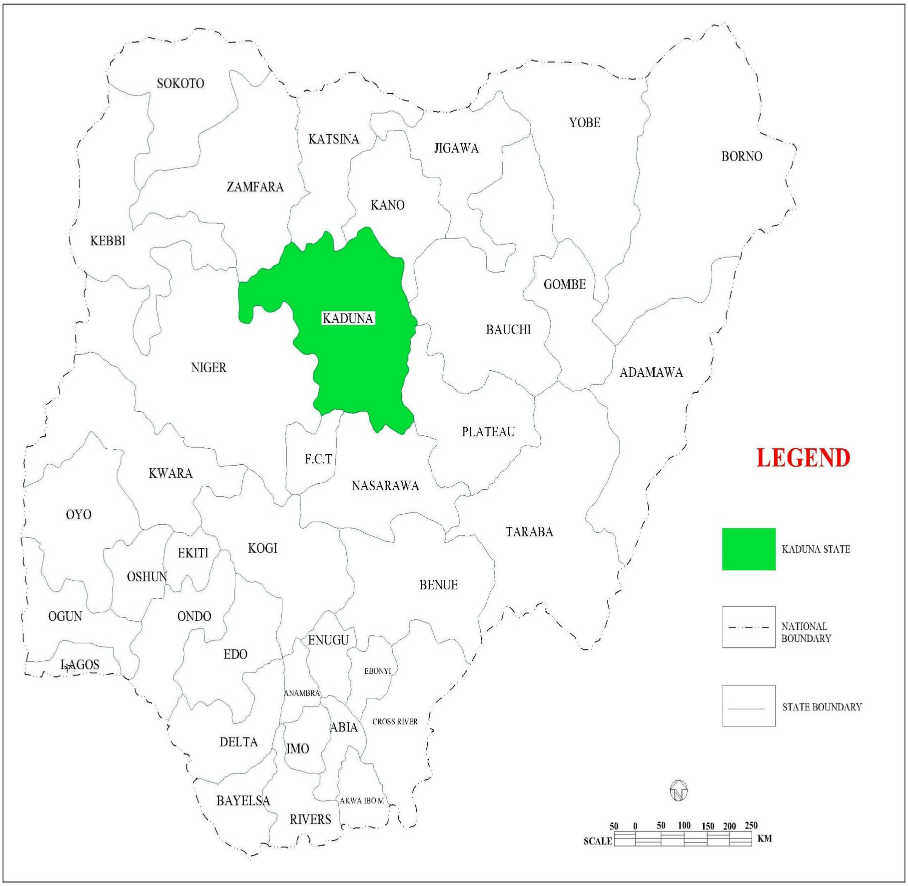

Fig. 1. Map of Nigeria showing Kaduna State

The Kubanni River has its source from the Kampagi hill in Shika near Zaria. It flows in a Southeast direction through the premises of Ahmadu Bello University. The Samaru stream which is one of the tributaries of Kubanni River has a stream length of 1.05km within an area of 2.28km^2 and has drainage density of 0.4605 km/km^2.

The climate of the study area is a tropical savanna climate, with distinct wet and dry seasons (Aw climate Koppens classification). Zaria experiences six (6) months of rainy season and six (6) months of dry season. The rainy season is from May to late October, while the dry season is from early November to April, this is as a result of the interplay of the two dominant air masses within the region i.e. the tropical continental air messes (cT) and Tropical maritime air masses (mT) (Iguisi and Abubakar, 1998).

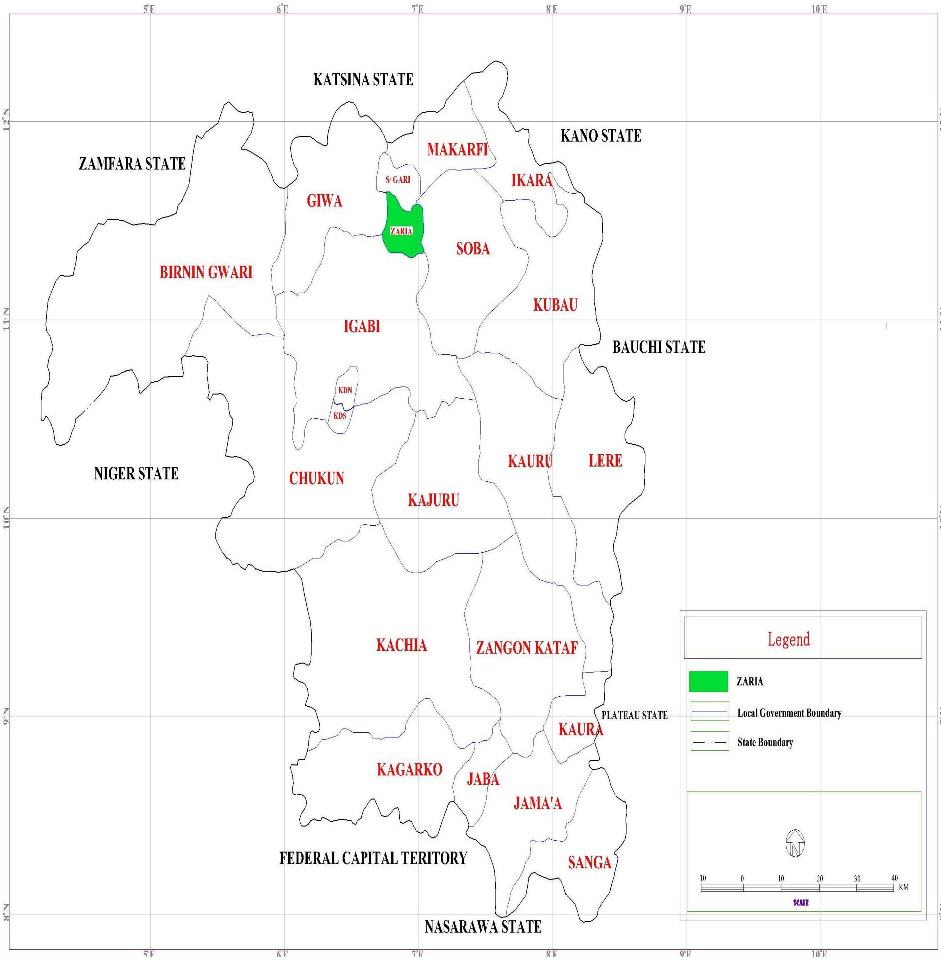

Fig. 2. Kaduna State map showing Zaria local government

The tropical continental air masses (cT) within originates from the Sahara desert and a dry cold wind comes along with it, it is dust ladden and blows from a north eastern direction while the Tropical maritime air masses (mT) originates from the oceans and blows from south western direction. It is warm and moist and therefore capable of bringing the information of rain in the Zaria region. The continental air masses are responsible for the harmattan haze in the region.

The mean daily maximum temperature is at the peak in April and about 39^{o}C while the mean minimum temperature rises from its lowest value in December to January to its highest in July to August (Ojo, 1982).

The geology of the Zaria region is underlain by crystalline metamorphic and igneous rocks of Precambrian to lower Palaeozoic age occurring on the basement complex rock. A major part of the rock is of high grade of metamorphism mainly gneisses which suffered intense folding and granitization and has remained stable for millions of years. Others are migmatites, older granites and more recently meta- sediments (Quartz, schist, laterites and alluminium). The rate and depth of weathering is quite irregular with variabilities but thorough, ranging from as deep as 60m to as shallow as 10m (Mortimore, 1970; Wright and McCurry, 1972).

The soil type of the study area is alluvial soil, also the area constitute dark vertisol referred to as "fadama" soil (Hausa) this soil is classified as hydromorphic soil. The fadama soil is usually found in the upstream and downstream of the stream system, while the alluvial soil is predominately at the middle of the stream. The soil composed of fine grey–brown sands, clay, red sand and gravel. The upper parts of the soil are a mixture of quartz, mica and windblown particles from the savannah harmattan.

The region generally falls within the Guinea Savannah vegetation. The climax climatic vegetation of the area ought to be northern Guinea Savannah, but because nearly all vegetation within the stream system has been degraded due to man's activities such as intense cultivation, fuel wool felling, the real climax vegetation is almost absent. What is seen presently are few scattered trees interspaced with tall tree grasses about 1-15m and 2-5m respectively? Trees found here includes *Isorberlina doka*, grass type includes *Adropogonaea spp*, *Schizachirium semiberbe* and *Monocynbium ceresti (*Nyagba,1986)

The drainage system focuses on River Galma and Kubanni River. River Galma is a major tributary of River Kaduna and Kubanni River, on which Ahmadu Bello University Dam is situated, is seasonal and supply water to Ahmadu Bello University and its environs. Samaru stream flows in north south direction through the main campus of Ahmadu Bello University Zaria, situated along a valley west to Samaru village into the Kubanni River (see fig. 3).

3. Materials and methods

The primary sources include results derived from the laboratory analysis of water quality of the water samples taken from upstream and downstream of the Samaru stream. This analysis includes the physico-chemical test analysis and the bacteriological test analysis. The physicochemical test analysis includes pH, colour and total dissolved solid while the bacteriological test analysis includes the biological oxygen demand (BOD), dissolved oxygen (DO) and chemical oxygen demand (COD) by using sterilized sample bottles. The samples were collected for 30 days consecutively within the month of August and September. The samples were collected, in the morning and evening (7.00am and 6.00pm) in order to observe any variation.

The samples collected were analysed in the laboratory of the Department of Water Resources and Environmental Design, Ahmadu Bello University, Zaria. The water samples collected from two points namely, upstream and downstream were analyzed, using standard procedures, within an hour of collection in other to avoid unpredictable change in the sample (WHO, 1971; WHO, 1976).

Statistical analysis of the data collected, including average means and correlation matrices was done by using the SPSS package.

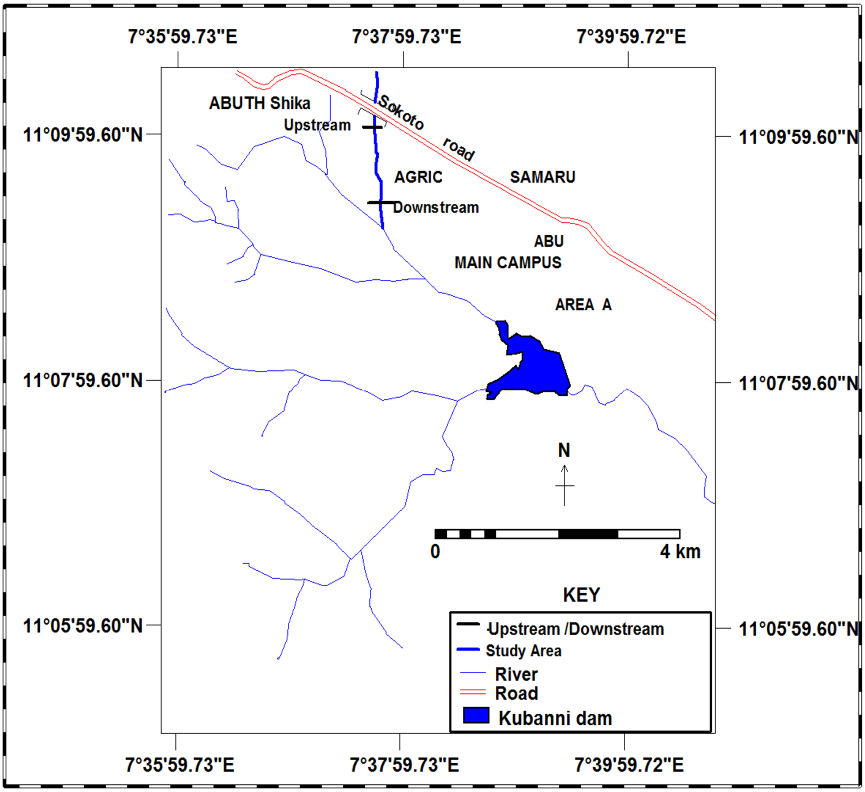

Fig. 3. Sumaru stream showing the upstream / downstream points of data collection. Source: Adapted and modifed from Zaria SW topographivc map

4. Results and discussion

4.1 Upstream variation in water quality

Water samples were collected and tested at the upstream section of the channel using several parameters including pH, colour, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD). These samples were collected both at the early part of the day (7am) and at the later part of the day (6pm). The mean values for each of the parameters at the different times period of the day over 30 days are summarized in table 1.

Parameter	Mean Upstream	
	7am	6pm
pH	7.25	7.23
Colour	15.97	22.9
DO	6.98	6.76
BOD	2.22	2.25

Table 1. Upstream mean values of parameter

4.1.1 Upstream variation in pH

From the result obtained the upstream mean pH value for the early part of the day was 7.25 while the later part of the day recorded a mean value of 7.23. This indicate that there is no much difference in upstream pH value for both morning and evening period, they are within the range of neutrality. This low variation in both time periods is further exemplified by the trend line graph shown in figure 4a.

4.1.2 Upstream variation in colour

From the derived result the upstream mean colour value for the early part of the day was 15.97, while the later part of the day recorded the mean colour value of 22.9, giving a range of 6.95, which indicate a wide variation for both time periods (morning and evening). This wide variation is further revealed by the trend line graph in figure 4b, which shows a wide and haphazard distribution over the time period.

4.1.3 Upstream variation in dissolved oxygen (DO)

The DO has a mean upstream value of 6.98(mg/l) recorded in the morning while 6.76(mg/l) was the mean value recorded for the evening period, this gave a low range of 0.22(mg/l), this means that there is no significant variation in DO upstream for both morning and evening. These trends are confirmed in figure 4c.

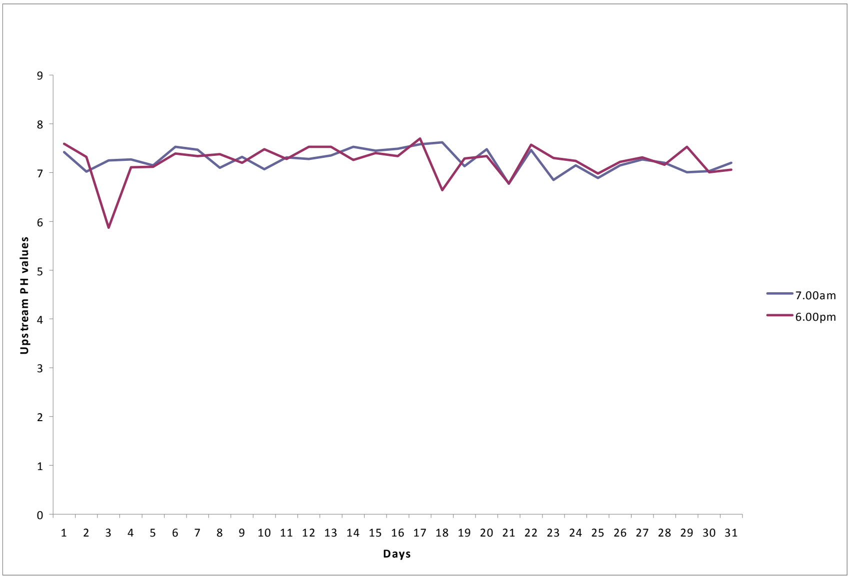

Fig. 4a. Upstream trend in pH for 30 days

4.1.4 Upstream variation in BOD

The result obtained reveals that upstream mean value for Biological oxygen demand is lower in the morning with 2.25(mg/l) than that recorded for the evening period with

2.5(mg/l), giving a range of 0.03mg/l indicating that there is low variation in BOD in both morning and evening. This low variation is depicted in the trend line for both morning and evening; this is shown in figure 4d.

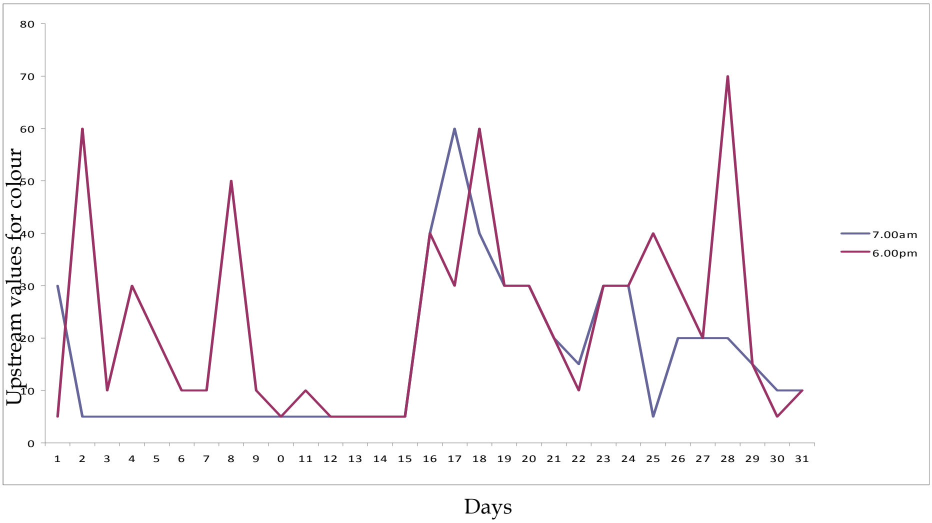

Fig. 4b. Upstream trend in colour for 30 days

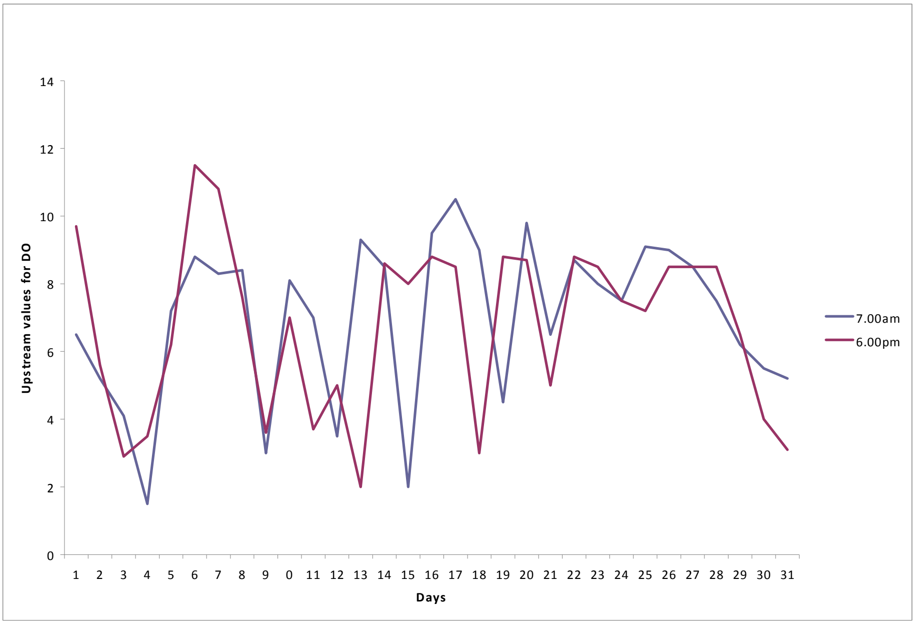

Fig. 4c. Upstream trend in Dissolved Oxygen for 30 days

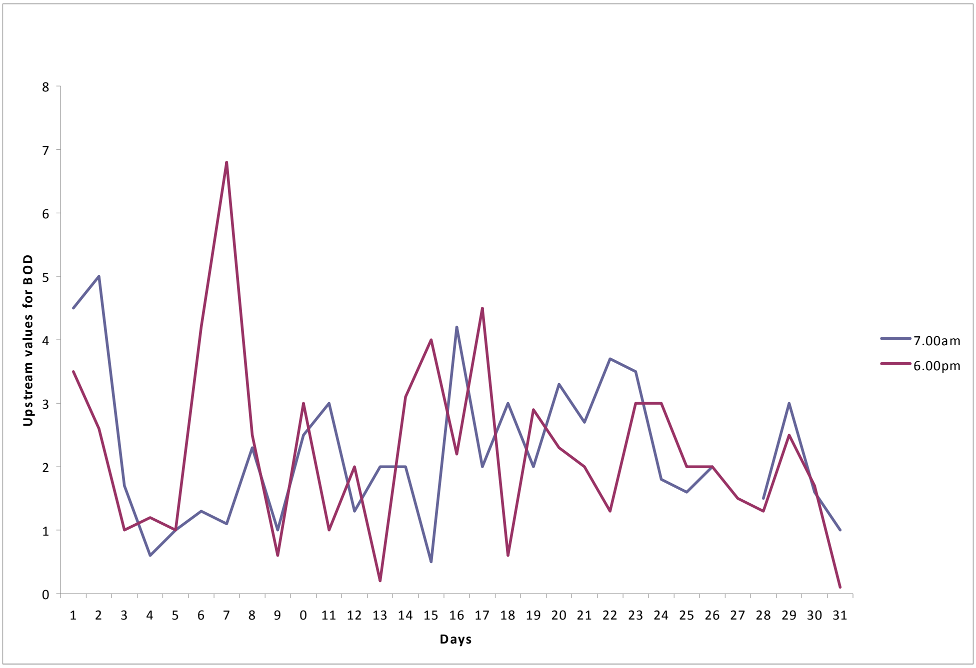

Fig. 4d. Upstream trend in BOD for 30 days

4.2 Downstream variation in water quality

Water samples were collected and tested at the downstream section of the channel using same parameters. These samples were collected both at the early part of the day and at the late part of the day. The mean values for each of the parameter at different time period of the day over 30 days are summarized in table 2.

Parameter	Downstream Mean	
	7am	6pm
pH	7.20	7.28
Colour	16.61	18.06
TDS	162.42	154.09
DO	6.71	6.83
BOD	2.15	2.69
COD	568.45	567.74

Table 2. Downstream mean values of parameters

4.2.1 Downstream variation in pH

From the result obtained, the downstream mean pH value for the early part of the day was 7.20 while in the later part of the day it was recorded as 7.20; this shows that there is no significance difference between the downstream (morning and evening), they fall within the neutrality level, giving a range of 0.08 which is relatively low. This low variation is further revealed by the trend line graph in fig 5a.

4.2.2 Downstream variation in colour

The downstream mean value of colour in the early part of the day was 16.61 while in the later part of the day it was recorded as 18.06, this shows that it was higher in the later part of the day, giving a range of 1.45 which is relatively high. This variation is depicted in the close trend line graph for both morning and evening as shown in fig 5b.

4.2.3 Downstream variation in dissolved oxygen (DO) mg/l)

From the result obtained it was observed that the mean DO was higher in the later part of the day i.e. 6.83 mg/l, while in the early part of the day it was 6.71 mg/l. Given a range of 0.12 which is relatively low, means there is no significant variation in dissolved oxygen downstream for both morning and evening. This low variation is further revealed in the trend line graph shown in fig 5c.

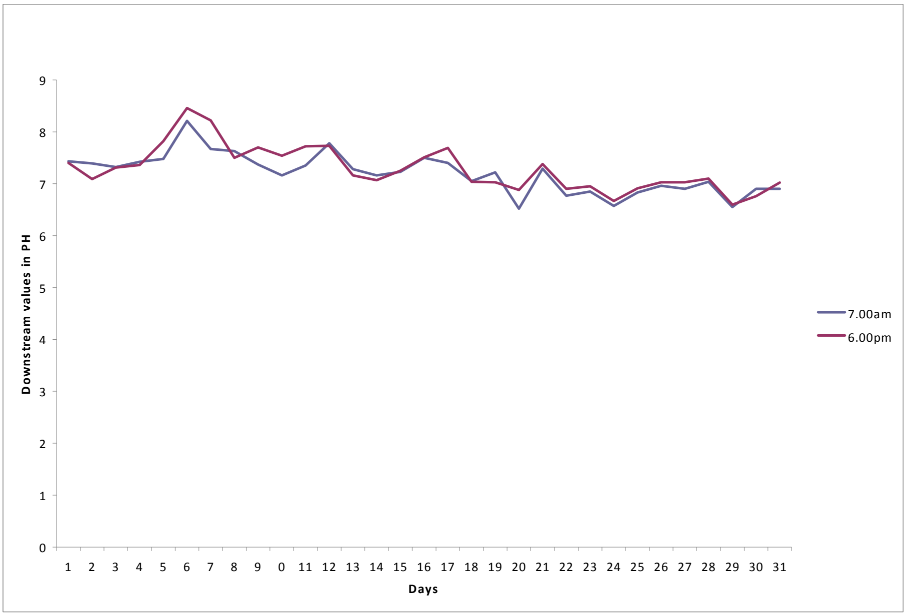

Fig. 5a. Downstream trend in pH for 30 days

4.2.4 Downstream variation in biological oxygen demand (BOD) (mg/l)

Mean BOD downstream value was 2.15 in the morning while 2.69 was the mean value recorded for the evening. This gave a range value of 0.54 which is relatively low. The trend line graph is presented in fig 5d.

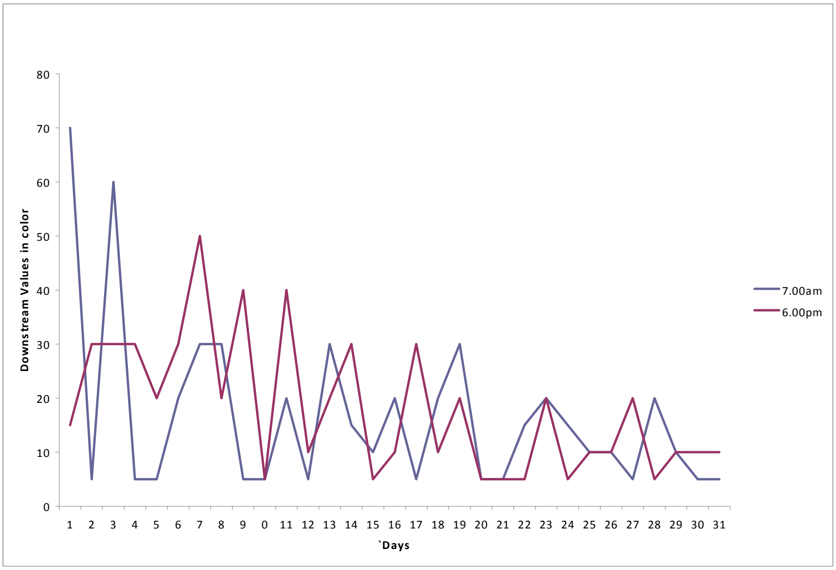

Fig. 5b. Downstream trend in color for 30 days

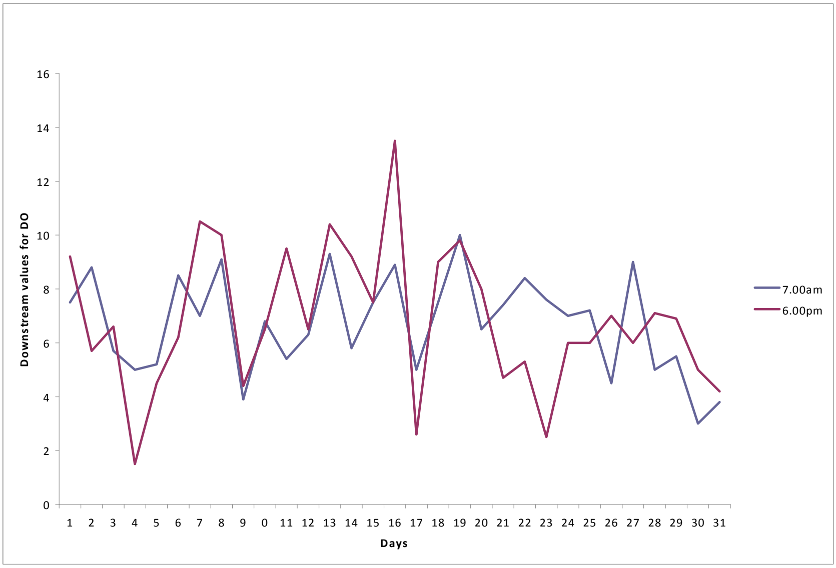

Fig. 5c. Downstream trend in DO for 30 days

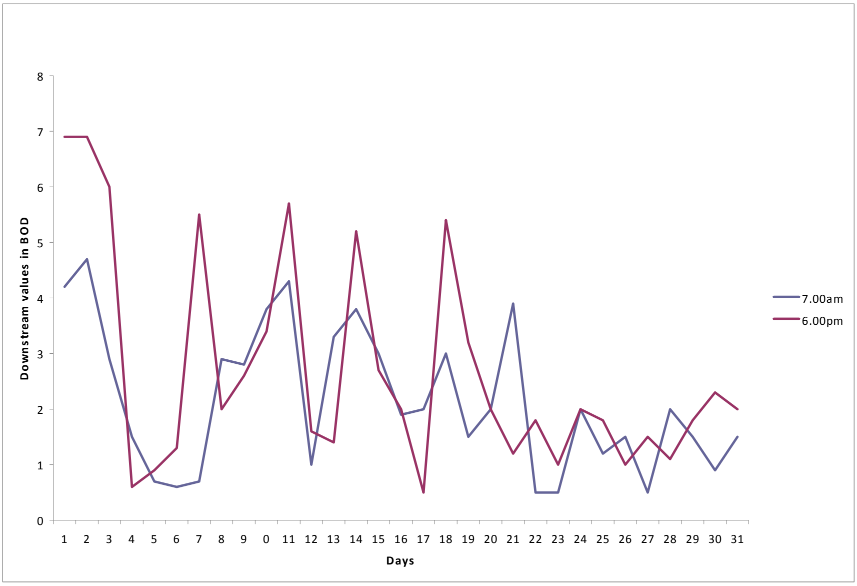

Fig. 5d. Downstream trend in BOD for 30 days

4.3 Upstream-downstream trend for the morning and evening

The upstream and downstream values for the early part of the day were correlated for the various parameters to examine the relationship between the upstream and downstream trend for each parameters at the early part of the day. From the correlation carried out, it was observed that the upstream and downstream trend for all the parameters were all positively correlated but weak with the exception of total dissolved solid (TDS) and BOD which have correlation co-efficient r values of 0.7219 and 0.5915. This shows that for an upstream increase in any of the parameters there is also a downstream increase for such parameters and vice-versa (see table 3).

Parameters	**r^2**	**R**
pH	0.0827	0.2876
Colour	0.0041	0.0640
TDS	0.5211	0.7219
DO	0.0736	0.2713
BOD	0.3499	0.05915
COD	0.1212	0.3481

Table 3. r^2 and r value for upstream – downstream relationship in the morning.

The upstream and downstream values for the later part of the day were correlated for the various parameters to examine the relationship between the upstream and downstream trend for each of the parameters at the later part of the day. From the correlation carried out, it was observed that the upstream and downstream trend for all the parameters were positively correlated but weak with the exception of TDS which has a correlation coefficient (r) value of 0.7198 (Table 4).

Parameter	r^2	R
pH	0.0149	0.1221
COLOUR	0.0261	0.1616
DO	0.0447	0.2114
BOD	0.0283	0.1682

Table 4. r^2 and r values for upstream – downstream relationship in the evening

5. Conclusion and recommendation

The result obtained from this study infers that the Samaru stream is still well oxygenated and can be said to be safe. However, the safety of this stream is being threatened by the continuous deposition of wastes into it from Samaru. This is why it can be classified as Class 2 as presented by Audu (2002) which can be said to be of doubtful water quality and needing improvement especially as it is found to be of low aesthetic quality.

Similarly the pH values observed from the study falls within the maximum permitted limit of 6.5 – 8.5 as specified by the Nigeria standard for drinking water quality. On the other hand the colour levels observed in the study is above the maximum permitted level of 15 as specified by the Nigerian standard for drinking water (NIS, 2007).

Parameters used in this study which were found to be positively and strongly correlated upstream and downstream suggest that there is no significant difference in the upstream and downstream water quality of the Samaru stream.

Based on the results obtained from the study the following recommendations became imperative.

1. Other water quality parameters, in addition to those observed in this study should be tested during the dry season to check the pollution, such as nitrate, ammonia, calcium and sulphate because of human habitation due to the discharge of waste water and agricultural practises.
2. It will be of significance to carry out another study collecting water sample both in dry season and rainy season's so as to critically examine the variation between the two seasons.
3. Location of domestic, industrial and agricultural wastes should be made far away from water bodies, this will greatly reduce the amount of wastes reaching the water bodies.
4. There is need for public enlightenment on the need to protect our environment and the benefit to be derived therefrom through the mass media such as radio, television and newspaper.
5. Control of the farming activities within the catchment should be fully implemented to avoid concentration in flow of organic and inorganic materials into the rivers.

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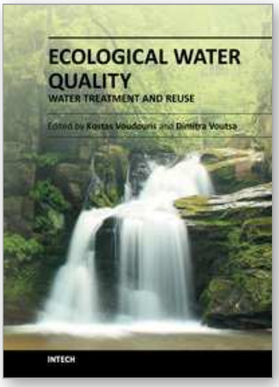

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This book attempts to cover various issues of water quality in the fields of Hydroecology and Hydrobiology and present various Water Treatment Technologies. Sustainable choices of water use that prevent water quality problems aiming at the protection of available water resources and the enhancement of the aquatic ecosystems should be our main target.