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# AN INVESTIGATION INTO THE COMPOSITION AND BACTERIAL LOAD OF THE EFFLUENTS OF A SECTION OF THE BOSSO RIVER, MINNA, NIGER STATE.

BY

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## ABSTRACT

*An investigation into the composition of the effluents of a section of the Bosso river was carried out over a period of three months. Results indicated that the effluents composition were of agricultural, domestic and industrial origins. It showed that the total viable count (TVC) and total coliform count (TCC) of bacteria were significantly higher where there were large effluents discharges than where there were less ($p < 0.05$). There was also a significant difference in bacterial viable and total counts (TVC and TCC) with respect to sampling occasions. The pooled stations results showed a positive significant correlation with biological oxygen demand (BOD) ($p < 0.05$). It was concluded that streams/rivers that traverse areas of active human population receive heavier load of effluents of domestic origins that enhance the growth and development of bacteria than otherwise. This suggests that such effluents carry health risks and should therefore be handled with the uttermost care.*

**Keywords: Composition, Effluents, Total viable counts, Total coliform counts.**

## INTRODUCTION

The term effluent refers to the waste materials loaded in water such that its natural ability for self purification can no longer cope with the situation (Nigeria Environmental study, 1991). Effluents are particularly loaded with chemicals and pathogenic micro-organisms (Beth, 1970; Baker and Farr, 1977) including bacteria. The degree of chemical and biological contamination reflects on the origin of the effluents, which may range from purely domestic sewage to principally industrial.

Bosso river, the river under investigation, is one of the several small rivers traversing Minna Municipality and is located in the Northern part of the municipality. The river's major sources of effluents are domestic, industrial and agricultural. Domestic effluents coming from its metropolitan catchment composed primarily of sewage from households. Industrial effluents come mainly from the mechanic and electrical workshop along the river and university laboratories. While agricultural effluents originated from the

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irrigation activities that take place along the river bank.

Bacterial constituent of effluents are micro-organisms that are of interest because of their importance in both causing disease and the role they play in removing the remains of dead animals, plants and other organic materials (Ebers & Steel, 1958; Murray, 1965 and Hirsch & Rodes-Rohriohl, 1983). They are small cells of the order of I 1m in diameter and are typical in other respects (Beth, 1970). The vast majority of bacteria are saprophytic living on decaying organic material wherever it is found chiefly in the soil but also in a multitude of other situations. Pathogenic species are quite common and are of serious health, economic and social importance (Buras et al., 1985; Steveson, 1988).

Murray (1965) observed that it is in their relation to disease that bacteria are best known to the medical profession and the public. Just as Mellowl and Hussain (1999) observed the effects of waste water spreading on the incidence of salmonella infection on children living on the fields of Marrakesh city, Morocco.

This study was aimed at determining a) the composition of the effluents and; b) bacterial composition received into the river because of its serious health risks both to fish and man.

## MATERIALS AND METHODS

### Description of study area and sites.

Bosso river is located in the Northern part of Minna municipality. It originated from a hill called Gbaiko hill. The river joins River Hanna locito, a tributary of River Tagwai. It runs from tnis confluence through the Bosso campus of the Federal University of Technology, Minna into the south western part of Minna (Fig. 1). Bosso River joins River Suka behind the university campus and the two rivers drain into River Gbako (Niger State water and Sanitation Board, 1980). The channel of the river which runs through the University is on a concrete floor constructed in 1991 to ease its drainage Ndana, 1995). A total of four sampling sites were chosen randomly to reflect the different aspects of sources of effluents for the purpose of the experiment. Site I was located before the University Campus premises, site II, located within the University boundaries while III and IV (fig. 1) were located after the University Campus. The sampling sites used during this work are described below.

### SITE I

Located North-Eastern of the University Bosso campus is free from domestic wastes, and concrete channels, hence, it served as the control for the investigation. The

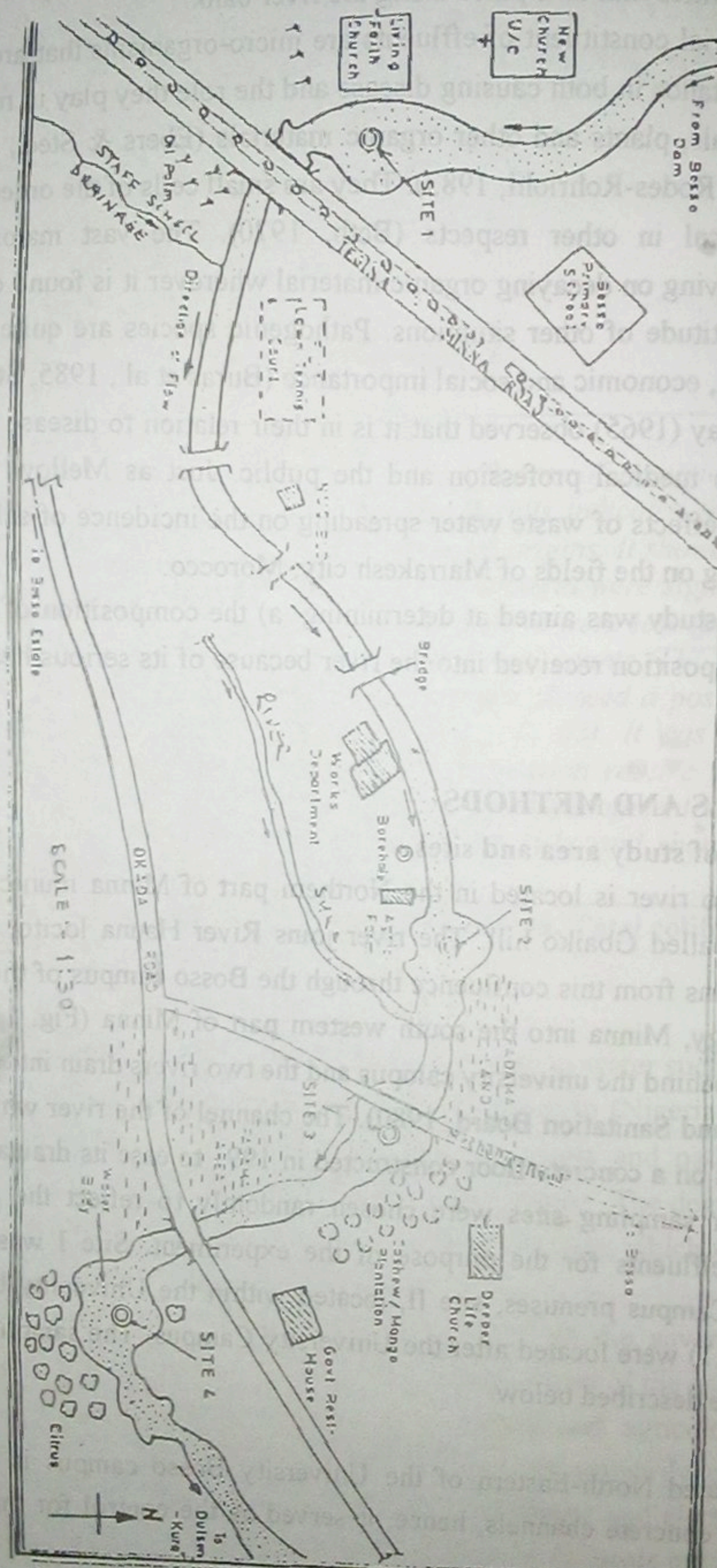


**Figure 1: Identification of Resource Sites along the Course of Bosso River.**

site is about 400 metres away from the bridge across Minna-Zungeru road. No serious human activities was observed during the investigation. However, the area is mostly covered by sandstone, silt, aquatic weeds and trees such as *Magnifera indica, Adansonia digitata, Parkia biglobosa* and few others. This site does not have a concrete floor but has sandy-mud sediment on the bottom.

**SITE II**

This site is located South-West of the University about 200 metres from the beginning of the concrete channel behind most of the University campus buildings. The site receives effluents and wastes from the university laboratories, the Staff School and the residential quarters which flow on the concrete substratum downstream. The University demonstration farm is located directly opposite the site. There are no farming activities along the bank but a lot of human and cattle wastes form the bulk of the effluents in the area.

**SITE III**

Situated after Mypa Road bridge along the road linking the Minna-Zungeru road with the Okada Road, that is linking the municipality with Bosso Estate. The site receives effluents from the main channel and the channel coming from Bosso town through a single wide drainage just before the bridge. Irrigation activities also take place along the banks. The area is covered mostly by trees and crops such as *Magnifera indica, Manihot esculenta, Zea mays* and *Amaranthus* sp. respectively. The substratum is made of muddy and silty materials.

**SITE IV**

This is the last site of the study area located immediately after the Okada Road bridge where lots of irrigation activities were taking place during the period. Cultivation of maize, *Zea mays* and vegetables *(Amaranthus* sp) are predominantly carried out here. Also, petty sellers of these food items are stationed at the opposite end of the site. The area is covered with trees and grasses such as elephant grass *(Andropogan sp)* along the channel of the river. The left-over of some of the vegetables are thrown into the river at this point. Besides, there are wash-outs of inorganic fertilizers used on the irrigation farms, the substratum is muddy.

## FIELD OBSERVATIONS AND SAMPLING

**Water sampling.**

Water sampling was carried out weekly at the four sites using 250ml sample bottles. The water samples were taken in replicates by dipping the glass bottles into the water. These were then packed into polythene bags. A total of 44 samples were taken during the period one week sample was not recorded due to late start.

**Physico-chemical parameters.**

Some of the physico~chemical parameters determined in the field were temperature using the ordinary Thermometer, water samples were fixed for subsequent dissolved oxygen (DO) determination and Biochemical oxygen demand (BOD).

## LABORATORY ANALYSIS

**After field sampling, the following analyses were carried out in the laboratory.**

**Dissolved oxygen (DO).**

Oxygen content was determined immediately in one of the samples using the modified winkler-azide method (APHA, 1980) and Lind, 1979).

**Biological oxygen demand (BOD).**

This was carried out according to APHA (1980), Lind (1979) and Baird et al, (1995).

**Determination of total viable count (TVC) and total Coliform count (TCC).**

Total viable count was adopted in order to ascertain the population of bacteria per ml. of the sample while the total coliform count accounts for the faecal bacteria present in the sample per ml. The latter exhibits the amount of faecal load present in the effluents of the river. The total viable count for bacteria and coliform populations in all the four designated sites were therefore determined according to the method described by Anson and Ware (1975). Agar and Samples were prepared, inoculations and bacterial counts were carried out.

**Experimental design and statistical analysis.**

A randomised complete block design with replicates of the water samples collected from each site using hand for dipping the glass bottles into the water was adopted.

Data obtained were subjected to analysis of variance procedure of Snedecor and Cochran(1967) and little and 'Jill (1978) at 5% level of significance. Where there was a difference Duncan. Multiple Range Test for variability was used to determine whether the differences were significant. They were also subjected to correlation regression analysis.

## RESULTS

The results obtained from the investigation conducted in the Bosso River from the period between February, 1996 to April, 1996 are as follows:

### Composition of Effluents.

The constituents of the effluents identified were wastes generated by the population that were allowed to pass untreated in to the river. These wastes were categorised into:

i. Domestic wastes comprising of human wastes, animal wastes, garbage, papers, etc.

ii. Industrial wastes mainly from motor mechanic and electrical workshops and the University laboratories which probably includes toxic compounds not ascertained by the investigation.

iii. Agricultural wastes, these include pesticides nitrates, phosphates, though not identified but believed to be present as a result of sprays and fertilizer application due to the agricultural activities going on around the banks.

### Bacteria total viable count (TVC).

The results of the total viable count (TVC) shown in Fig. 1. TVC was found to increase with time during the first few weeks of the sampling period. The mean values showed increased variation from site I to IV as reflected in the values for the Sites respectively (Fig. 1). The highest mean value of bacteria (TVC) was obtained at site IV and the lowest value was obtained at site I (control). The combined values recorded at sites II and was found to be higher than those at Sites I and III which had a combined mean value of 22.75 x $10^7$ per ml. The variation in the figures obtained in these sites was as a result of the location of the sites to the sources of the effluents received from all the sites investigated. The TVC of bacteria recorded showed a significantly higher difference ($p< 0.05$) with respect to sites and period.

### Total coliform count (TCC).

The bacteria total coliform count (TCC) results are summarised in Fig 2. It was found to vary with sampling time. The coliform count was also found to vary with sampling sites coliform count had 5.00 ± 3.22, 14.36 ± 3.32, 13.45 ± 2.38 and 15.73 ± 3.85 respectively. The highest mean value of the coliform total count 15.73 x $10^{-3}$ per ml. was recorded at Site IV and the lowest value of 3 .72 x $10^{-3}$ per ml. was obtained at site 1 (control). In addition, the combined values of 3 .72 x $10^{-3}$ per ml. was discovered to be

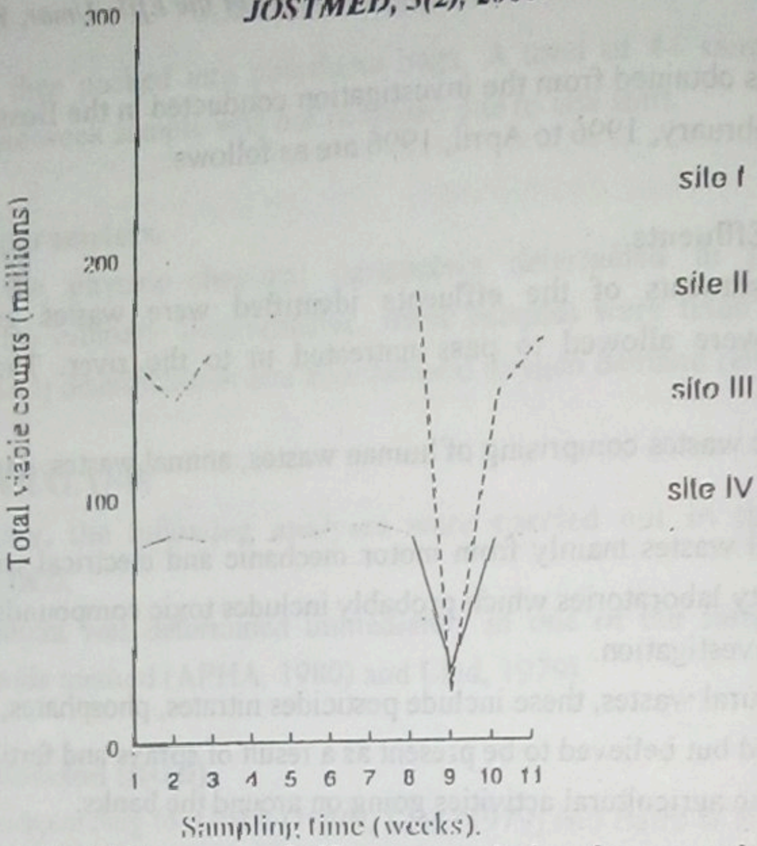


**Figure 2: Bacterial (TVC) per ml. of effluent sample for eleven weeks from four sites.**

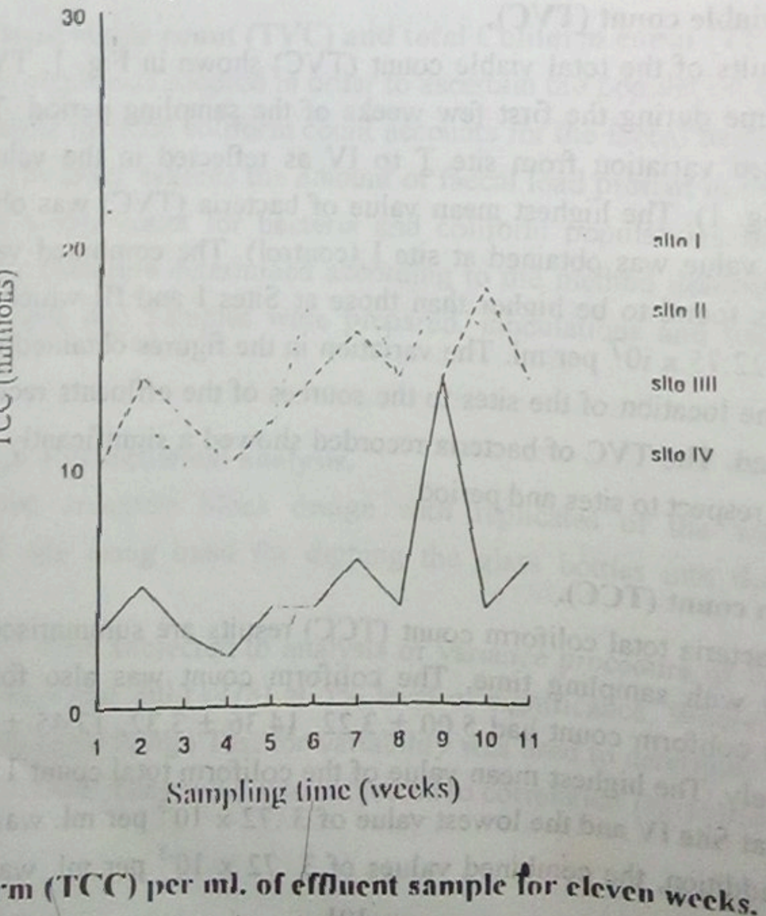


**Figure 3: Coliform (TCC) per ml. of effluent sample for eleven weeks.**

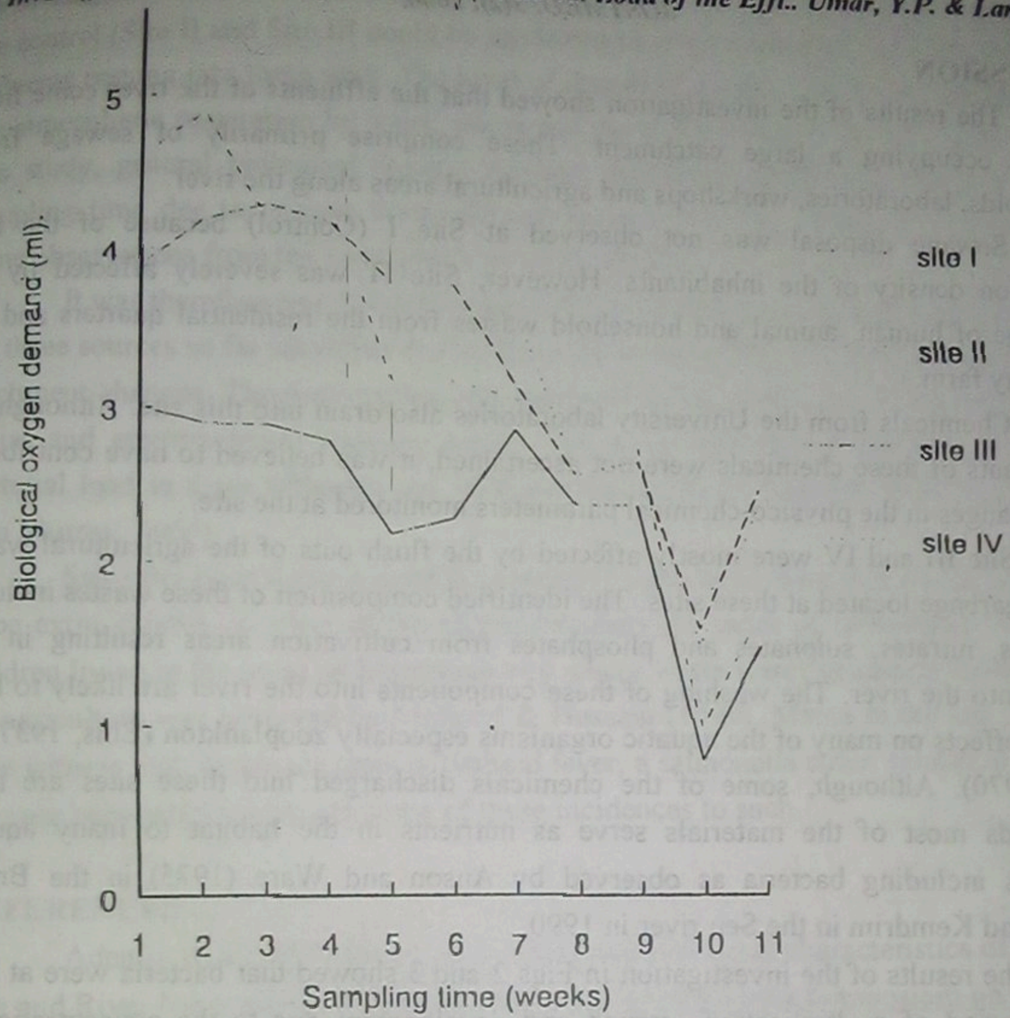


**Figure 4: Weekly BOD from sampling stations for eleven weeks.**

higher than those of sites I and III which had combined mean value $17.07 \times 10^{-3}$ per ml. Fig.2 and Fig.3). The coliform count ascertained showed significantly higher difference with respect to sites ($p < 0.05$), particularly site I (control). The reasons for this variation may also be as a results of effluents composition as well as distance from out falls.

The results analyzed showed weekly variations in the biological oxygen demand. The biological oxygen demand showed mean values of $2.38 \pm 0.65$, $3.25 \pm 1.2$, $3.25 \pm 0.71$ and $3.35 \pm 0.84$ mg for sites I, II, III and IV respectively. The biological oxygen demand (BOD) range was 0.80-4.30 mg with the highest value recorded at Site IV and the lowest at the control Site 1. Significantly high difference in biological oxygen demand (BOD) with respect to sites were recorded ($p<0.05$), due to variation in the composition of effluents received at different sites. However, there was no signifi ant difference with respect to sampling time ($p> 0.05$).

## DISCUSSION

The results of the investigation showed that the effluents of the river come from sources occupying a large catchment. These comprise primarily of sewage from households, laboratories, workshops and agricultural areas along the river.

Sewage disposal was not observed at Site I (Control) because of the low population density of the inhabitants. However, Site IT was severely affected by the discharge of human, animal and household wastes from the residential quarters and the university farm.

Chemicals from the University laboratories also drain into this site. Although the constituents of these chemicals were not ascertained, it was believed to have contributed to the changes in the physico-chemical parameters monitored at the site.

Site III and IV were mostly affected by the flush outs of the agricultural wastes and the garbage located at these sites. The identified composition of these wastes included pesticides, nitrates, sulphates and phosphates from cultivation areas resulting in soil erosion into the river. The washing of these components into the river are likely to have harmful effects on many of the aquatic organisms especially zooplankton (Ellis, 1937 and Boyd, 1970). Although, some of the chemicals discharged into these sites are toxic compounds most of the materials serve as nutrients in the habitat to many aquatic organisms including bacteria as observed by Anson and Ware (1975) in the Bristol channel and Kemdrim in the Sen river in 1990.

The results of the investigation in Figs 2 and 3 showed that bacteria were at their optimal period of multiplication, growth and development due to the concentration of nutrients at the river bed and favourable temperatures (Baker & Farr, 1977). The variations in the accumulation of organic matter resulted in the difference in the number of bacteria along the designated sites.

The results obtained showed higher numbers of bacteria in sites II and IV which are located near the effluents or outfalls than Site I (Control) and III in the low effluents receiving area. This high number is possibly due to the influx of both cattle and human wastes, household effluents and university farms into area around Site II and artificial fertilizers and garbages into areas around Site IV. The same observations were made along River Niger below the Kainji dam (Adeniji, 1976).

Average biological oxygen demand of the river ranged from 0.80-4.20 mg/1. The higher value of this oxygen demand obtained in Sites II and IV may not be unconnected to the oxidative metabolic rates of bacteria (Atlas, 1981). Here the TVC and TCC in these two sites are high. This is because the high oxygen levels favour biodegradation of high molecular weight compounds (HMWCS). The low level of biological oxygen demand in the control (Site I) and Site III could be attributed to none availability of wastes from the effluents coming into these sites. The level of dissolved oxygen (DO) rises chiefly due to the atmospheric re-aeration by wind, waves and the shallow nature of the stream flow. In this study, general biological oxygen demand decreased significantly ($p < 0.5$) with sampling time due to reasons illustrated above. In his studies, Ndana (1995) made the same observations from the river which he investigated.

It was therefore concluded that this river will continue to receive its effluents from the three sources so far identified that is households, industrial and agricultural except the catchment changes. The composition may also continue to reflect the sources unless some social and environmental changes occur. The study has clearly revealed the size of bacterial load in these effluents and their potential risks to both fish (Zebbe, 1991) and man Murray, 1965).

Since the river water is used for vegetable cultivation there is the need for farmers to be extra careful, in view of the aforementioned. As cases of salmonella infection in children living in the areas of Marrakesh city where waste water spreading fields are used for agriculture was observed by Mellowl & Hussain (1999). Minna in the last 5-10 years have witness high incidence rates of typhoid fever, a salmonella strain causative disease. It may not be wrong to associate some of these incidences to such.

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