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Assessing the Impact of Solid Organic Waste in Mezam River in the Bamenda Municipality

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ABSTRACT

A survey was carried out involving 100 households randomly selected from the banks of the Mezam River. A waste characterization study and direct observations were also carried out to determine the different waste fractions and the disposal routes for the municipal solid waste (MSW). Laboratory analyses for physiochemical and biological parameters were conducted to determine the water quality of the Mezam River. Results indicated that 24% of households dumped their wastes into rivers, streams and drains with the biodegradable food debris being the most dominant waste fraction. The Mezam River was slightly contaminated at the inlet into the Bamenda city, but highly contaminated at the outlet. There was also an increase of total coliform from 47cfu/100ml to >100cfu/100ml at the inlet and 54cfu/100ml to >100cfu/100ml at the outlet. The values for the BOD increased from 0.2mg/l to 18.6mg/l and from 0.2mg/l 17.9mg/l at the inlet and outlet respectively. With regards to physiochemical parameters, we observed a decrease in the pH from 8.2 to 5.2 and 8.4 to 5.37 for both the inlet and outlet of the Mezam River. The Pb values for both the inlet and outlet increased from 0.00mg/l to 0.6mg/l and 0.00mg/l to 0.54mg/l. These values were greater than WHO recommended standards hence unacceptable for drinking water.

Keywords: Solid waste, Mezam River, Bamenda municipality, Bacteriological parameters, Physico-chemical parameters

1. INTRODUCTION

Waste management is one of the many problems challenging many developing countries and recent events in major urban centres have shown that the problem of waste management has become too complex to handle and has seen declining efforts of municipal authorities, federal Governments, state and professionals alike in addressing the issue [1]. The problem of waste in urban cities of Africa can be better understood in the light of rapid urbanization and for the first time in the history of mankind, we are observing an unparalleled phenomenon in the development of places of habitat making the balance of human settlement patterns shift from more people inhabiting rural areas to more people living in cities [2, 3]. Whilst urbanization is not a new phenomenon in Africa, the current rate of uncontrolled and unplanned urbanization in Africa has given rise to a huge amount of liquid and solid waste being produced. So much is generated that these wastes have long surpassed the capacity of city authorities to collect and dispose of them safely and efficiently [4], with rivers presently used as alternative disposal routes.

Organic waste pollution of rivers by wastewater discharge from human activities (cities, farming and industry) affects humans and ecosystems worldwide through the global sanitation crisis. First, untreated urban sewage contains pathogens that cause a variety of diseases, including diarrhea [5], globally the leading cause of illness and death. As of 2015, up to 2.4 billion people, primarily in sub-Saharan Africa and southern Asia, lack access to proper sanitation [6]. Secondly, accumulation of organic pollutants in rivers stimulates microbial growth, leading to oxygen depletion and disturbance of the entire river ecosystem [7].

The level of organic pollution in a river, commonly expressed by the Biochemical Oxygen Demand (BOD) [8] is the result of two counteracting mechanisms: pollutant loading and natural cleaning. Wastewater discharge from cities and intensive livestock farms constitute the main organic pollutant loads into rivers [9, 10]. With rapid urban population growth expected in the next decades, both sources of organic pollution will increase [11]. Although pollution is introduced at wastewater discharge points along the river, impacts extend to downstream populations and ecosystems, as pollutants are transported through the river network [12].

2. WASTE CHARACTERIZATION STUDY

In order to determine the types and composition of solid waste at the Bamenda 1, 2 and 3 municipalities which is a potential pollutant to the Mezam River, a waste characterization study was carried out. Collection and sorting of solid waste was got from three HYSACAM skips at the Bamenda 1, 2 and 3 municipalities. Sorting was done into nine waste fractions (plastic papers, plastic containers, plastic bags, papers/cartons, metal, textile/leather, bottle/glass, food debris and others and weighed using a mechanical balance. The average percentage composition was got using descriptive statistics.

In order to assess the impacts of solid waste from the Bamenda 1, 2 and 3 municipalities on the Mezam River a waste characterization study was carried out because it provides information on municipal solid waste generation, specific weight and composition [13]. A waste characterization study also allows strengthening up the decision-making and improving the planning and management of waste for its use and final disposal.

3. BACTERIOLOGICAL MEASUREMENTS

3.1 Total coliform

Pathogens are bacteria and viruses that can be found in water and cause diseases in humans. Typically, pathogens cause disease when they are present in public drinking water supplies. Pathogens found in contaminated runoff may also contain parasitic worms (helminths). Coliform bacteria and faecal matter may also be detected in runoffs. These bacteria are a commonly used indicator of water pollution, but not an actual cause of disease [4]**.** Total coliform gives a clear indication of the general sanitary condition of water since this group includes bacteria of faecal origin. However, many of the bacteria in this group may originate from growth in the aquatic environment. This is used to evaluate the general sanitary quality of drinking and related water use [14].

4. PHYSICO-CHEMICAL MEASUREMENTS

Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is used as an index for determining the amount of decomposing organic materials as well as the rate of biological activities in water. This is because oxygen is required for respiration by micro-organisms involved in the decomposition of organic materials. Thus high concentration of BOD indicates the presence of organic effluent and hence oxygen-requiring micro-organisms [4].

pH of Water

pH is important in water quality assessment as it influences many biological and chemical processes within a water body [15].

5. HEAVY METALS

5.1 Lead (Pb)

Pb in the environment is mainly particulate bound with relatively low mobility and bioavailability. Pb does, in general, not bioaccumulate and there is no increase in concentration of the metal in food chains [16]. The presence of Pb in the water may be due to the discharge of industrial effluents from petroleum production [17]. Pb may also come from lead-acid batteries, plastics and rubber remnants, lead foils such as bottle closures, used motor oils and discarded electronic gadgets including televisions, electronic calculators and stereos [18] where leachates from the waste dumpsites may find their way into the rivers. It is on this basis that this work was carried out to assess the impact of organic solid waste to better understand their impacts on the ecological and human health on the Mezam River.

6. MATERIAL AND METHODS

6.1 Presentation of the study area

Bamenda Municipality is located to the West by Mbatu, Nchomba and Bafut to the North by Tubah, to the South by Bali and to the East by Santa (Fig.1).

The municipality has three council areas which are Bamenda I, II and III with very busy commercial zones associated with many trading activities. The municipalities cut across three major villages namely; “Bamendakwe” where river Mezam takes its rise, “Nkwen” and “Mankon” where Bamenda City Council is located with Bamenda, the headquarter of the North West Region of Cameroon.

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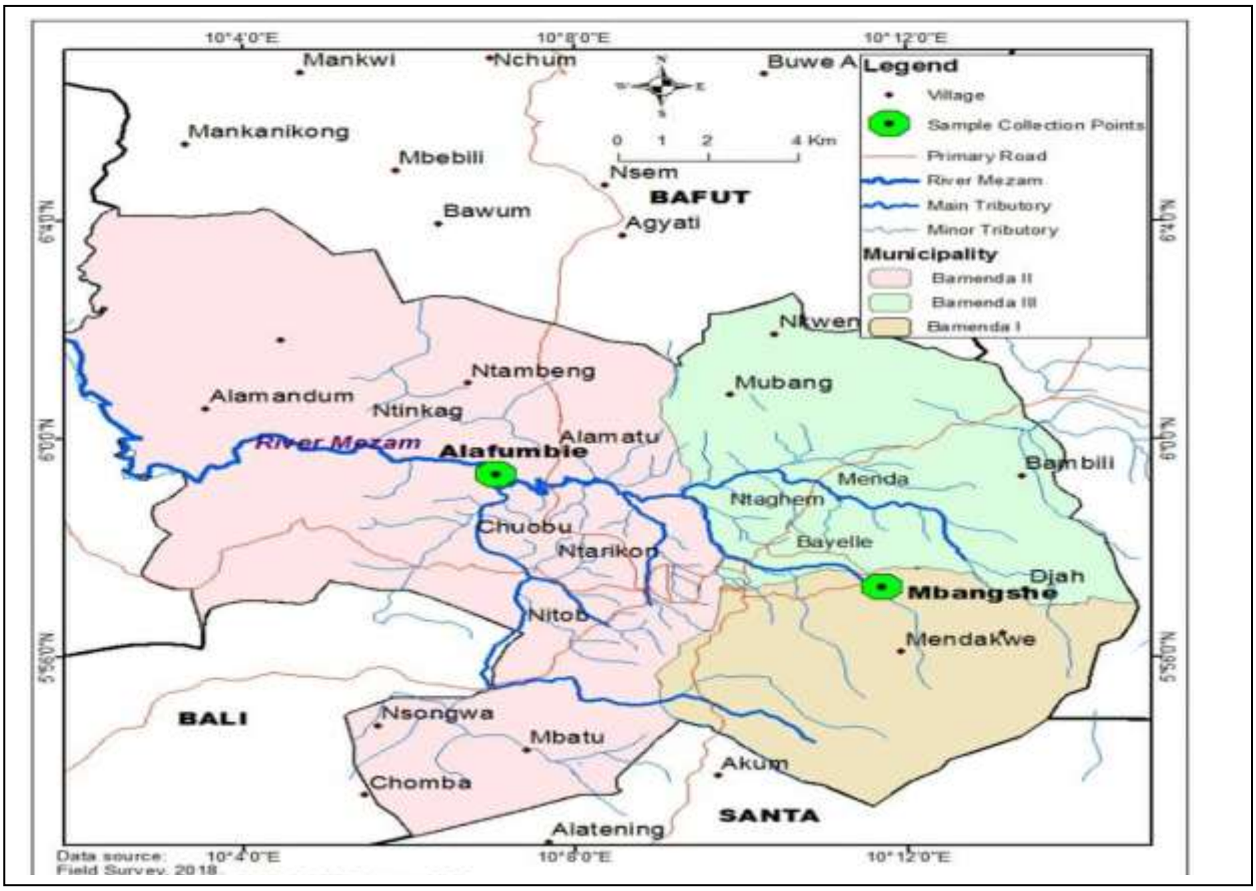

Figure 1: Map of study area showing sample points

6.2 Collection of water samples

Water samples were collected from the Mezam River up-stream and down-stream (sample points) in the months of April and May 2018. This is in line with earlier studies conducted by [19] in the Mezam River system that revealed higher faecal counts during periods of low and rising water levels (February to May), corresponding to the dry season and the onset of the rainy season, respectively. Collected samples were stored in a cooler containing ice cubes, and later transported to the laboratory for analysis in line with [20].

7. RESULTS AND DISCUSSION

Results from the household survey indicated that a majority of households used garbage bin (85%), while 11% do not use garbage bins (Fig.2)

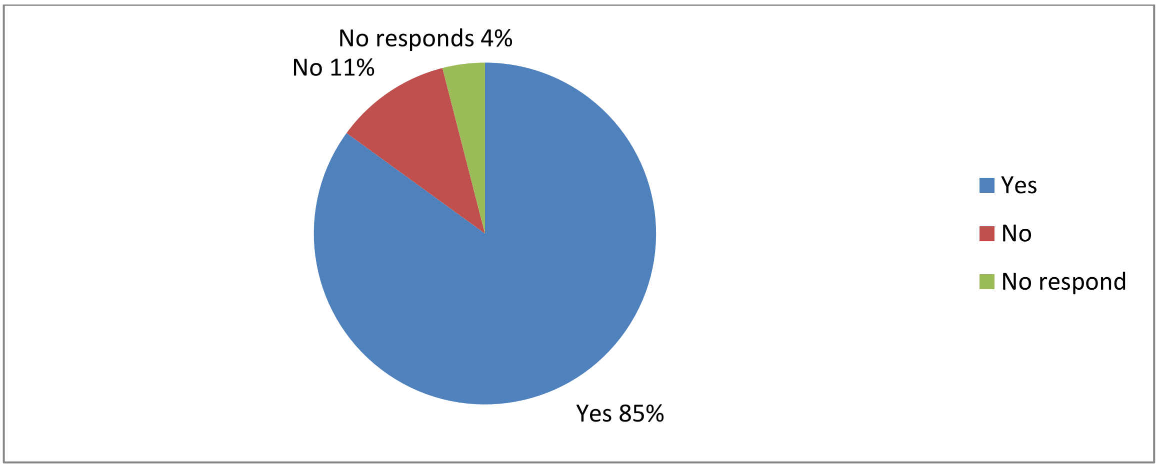

Figure 2: Frequency of households on the use of garbage bins

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With regards to the frequency of waste collection (Fig.3), 37% of households indicated that collection was done after 3 days, 32% after one week, 6% after one month, 14% indicated that there was no collection at all (Fig. 3).

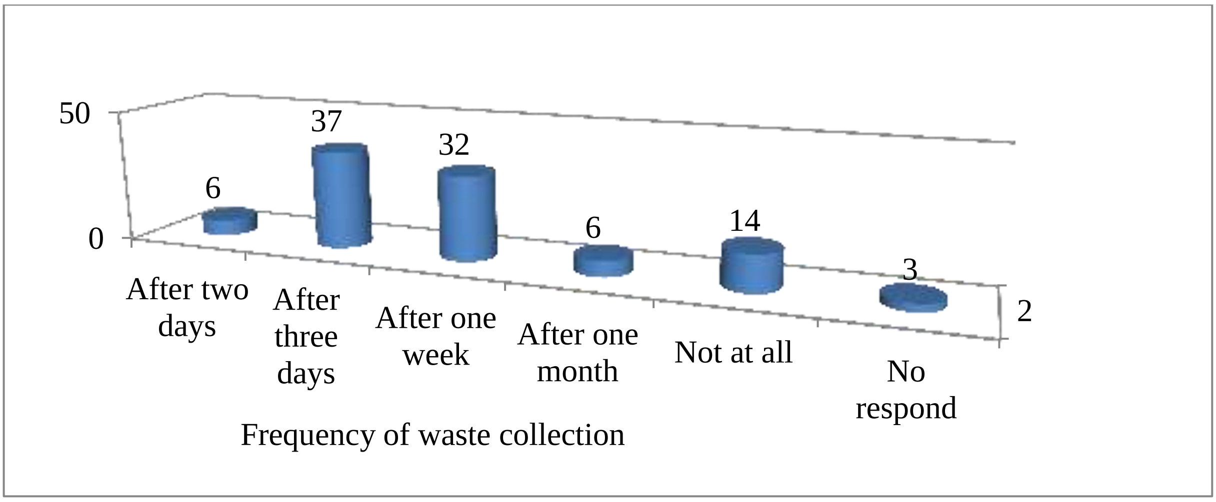

Figure 3: Frequency of waste collection

Results from the household survey indicated that 35% of the waste was dumped in the HYSACAM skips, followed by 24% in the streams/drains with 2% recycled (Fig.4).

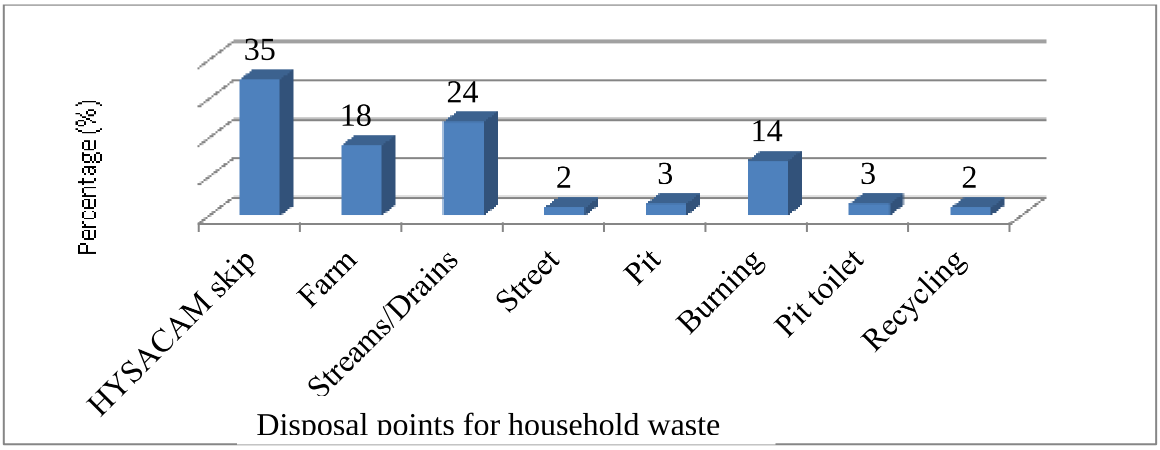

Figure 4: Disposal points for household waste

Results from the waste characterization study for Bamenda I, II and III municipalities (Fig. 5) showed food debris as the most dominant waste fraction (27.5kg) in the Bamenda II municipality. The Bamenda I and III municipalities also recorded a significant quantity of food debris. Paper/carton (25.0kg) was the dominant waste fraction is the Bamenda I municipality and textile/leather in the Bamenda III municipality. Metals constituted the least waste fraction in the three municipalities with an average composition range of 0.25 -5.5 kg. The high food waste in the three municipalities can be explained by the fact that a large proportion of the populations were agrarian. The presence of many educational establishments and tailoring workshops in the Bamenda I, II and III municipalities is responsible for the large quantity of paper/carton and textile/leather waste.

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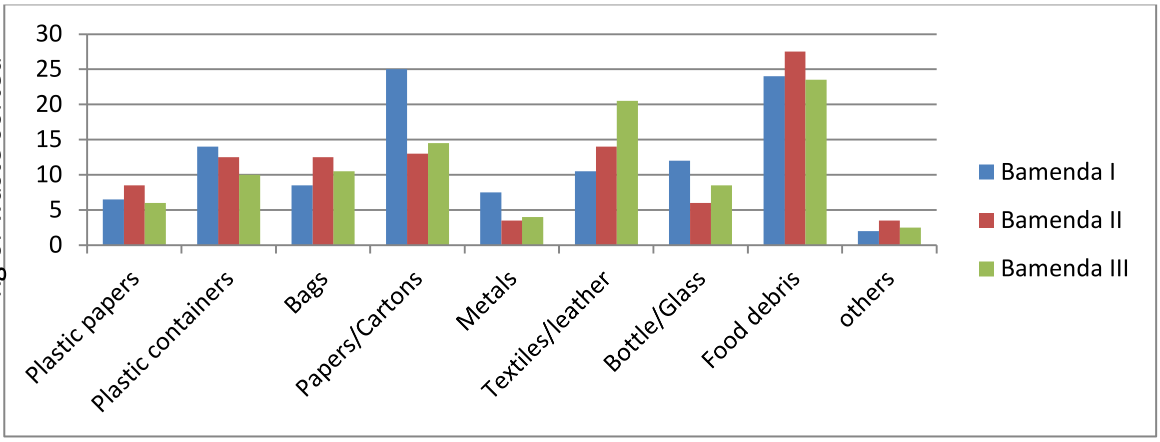

Figure 5: Average composition (kg) of household waste in the Bamenda I, II, III

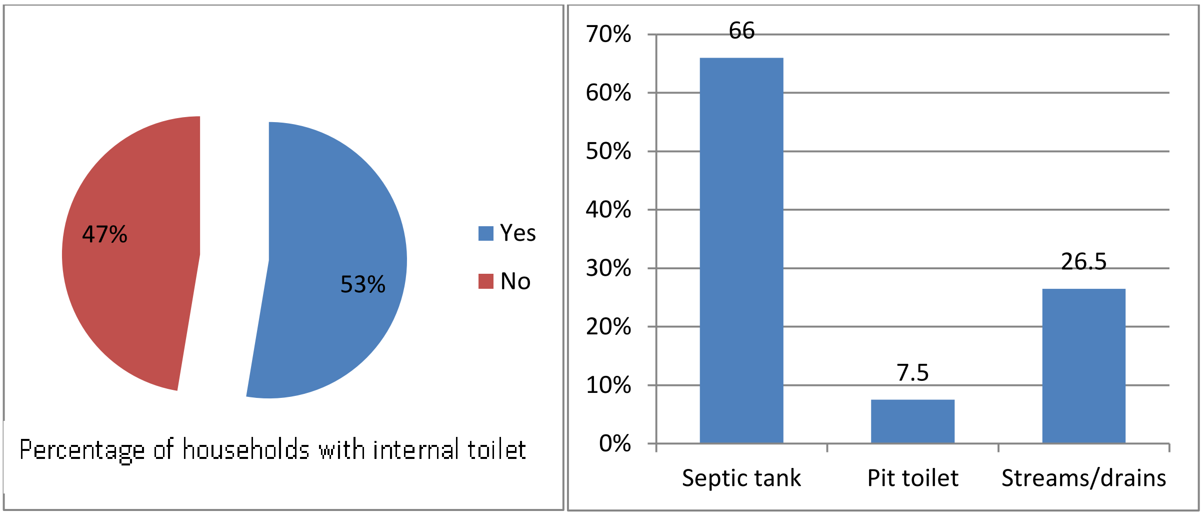

Figure 6: Disposal points of human waste

Microbiological analysis of water from the Mezam River (inlet and outlet) in April and May showed pollution from total coliform (Fig.6). The high concentration of total coliform 47cfu/100ml and 54cfu/100ml (inlet) and >100 cfu/100ml (outlet) of Mezam River could be due to in- discriminate defecation, sewage, land and urban run-off and domestic waste waters [15].

The high total coliform counts in both the inlet and outlet of the Mezam River (Table 1) made the River unsuitable for both primary contact, such as swimming and secondary contact such as boating and fishing. This is in line with the World Health Organization (WHO) limit [20].

Table 1: Sampled River water (inlet and outlet) for Total coliform

Month	Inlet of Mezam River	Outlet of Mezam River	WHO limit for drinking water	Remarks
April	47cfu/100ml	>100 cfu/100ml	0.00cfu/100ml	Unacceptable
May	54cfu/100ml	>100 cfu/100ml	0.00cfu/100ml	Unacceptable

There was a significant variation in the BOD between inlet (0.2mg/l) and outlet (18.6mg/l and 17.9mg/l) in April and May respectively (Table 2). The high BOD values at the river outlet may be attributed to the discharge of solid organic waste into water bodies leading in the uptake of dissolved oxygen in the oxidative breakdown of these wastes [21].

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Table 2: Sampled River water (inlet and outlet) for BOD

Month	Inlet of Mezam River	Outlet of Mezam River	WHO limit for drinking water	Remarks
April	0.2mg/l	18.6mg/l	<0.5mg/l	Unacceptable
May	0.2mg/l	17.9mg/l	<0.5mg/l	Unacceptable

The pH values were alkaline 8.2 and 8.4 respectively and acidic, 5.2 and 5.37 for the River inlet and outlet respectively in April and May (Table 3). According to [4], variations in pH affect chemical and biological processes in water and low pH increases the availability of metals and other toxins for intake by aquatic life while a slightly high alkaline pH value decreases the availability of metals and other toxins for in-take by aquatic life as well as plants

Table 3: Sampled River water (inlet and outlet) for pH

Month	Inlet of Mezam River	Outlet of Mezam River	WHO limit for drinking water	Remarks
April	8.2	5.2	6.5 – 8.5	Unacceptable
èMay	8.4	5.37	6.5 – 8.5	Unacceptable

The values for Pb (Table 4), showed a significant variation at the inlet and outlet of Mezam River. The values for the inlet (0.00mg/l) for April and May were in line with WHO standards for drinking water. However, the River outlet recorded higher values (0.6mg/l and 0.54mg/l) in April and May respectively, higher than WHO acceptable standards for drinking water. These may be due to tires, motor batteries, iron and metals dumped into the river by some city dwellers as the River flows across the city as well as pesticide from agricultural activities along the banks of the Mezam river. This is in line with [22,23] who carried out an assessment of some heavy metals in the ground water and canal water of Nagpur village of Yavatmal distict,

Table 4: Sampled River water (inlet and outlet) for Heavy metals (Pb)

Month	Inlet of Mezam River	Outlet of Mezam River	WHO limit for drinking water	Remarks
April	0.00mg/l	0.6mg/l	0.00mg/l	Unacceptable
May	0.00mg/l	0.54mg/l	0.00mg/l	Unacceptable

8. CONCLUSION

A research work to assess the impact of solid waste in the Mezam River was carried out using direct observations, a waste characterization study, physico-chemical and bacteriological and heavy metal analysis of water samples collected from the Mezam River (inlet and outlet) for the months of April and May. The results indicate that pollution of the Mezam River was only marginally polluted at the point of entry but heavily polluted at the point of exit from the City of Bamenda from the indiscriminate dumping of organic solid waste and human feaces as well pesticides from agricultural runoff. This pollution level was above WHO standard recommendations for drinking water.

With the increase in urbanization in the Bamenda I, II and III municipalities from rural urban migration, reuse, recycling and composting of the organic solid waste is considered a sustainable option that will mitigate its disposal into the Mezam River.

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