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Investigating the Impact of Solid Waste Disposal along the Drainage Channel: A Case Study of Hotoro North in Nassarawa Local Government

Mujittafa Sariyyu[1], Naziru Ado Musa[2] Umar Faruk Lawan[2], Umar Usman Aliyu[1]
[1]*Department of Civil Engineering,*
Faculty of Engineering,
Aliko Dangote University of Science and Technology,
Wudil, Kano, Nigeria
[2]*Department of Water Resources & Environmental Engineering,*
Faculty of Engineering,
Aliko Dangote University of Science and Technology,
Wudil, Kano, Nigeria

ABSTRACT
The disposal of solid waste leads to retarding the flow rate which may hinder the purpose for which the drainages are built. This study looks into the impact of solid waste management along drainage channels in Hotoro North Nassarawa Local Government, Kano State. The value of the time and distance was used to determine the velocity of the moving water in the drainage channel. The discharge is measured using an approach based on a simplified version of the continuity equation. The drainage pressure was determined at both low and high-concentrated areas of solid waste by dividing the force per unit area of the drainages. The difference in the discharge values depends on the drainage's cross-sectional area considered and the fluid's velocity. The fluid's velocity depends on the drain's slope, the water pressure, and the density of the floater. The deeper the drain, the higher the value of its pressure. The drain depth at Ahmadu Boka Street was 1.2m and had a pressure of 120N/m2, while the drains at Tsamiyar Boka Street and Hotoro Eastern bypass were 0.8m and 1.0m respectively, with water pressures of 49.6N/m2 and 80N/m2. Illnesses linked to solid waste include Malaria, Typhoid, Cholera, Meningitis, and Respiratory diseases.

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INTRODUCTION

Humanity has always produced waste that includes not only the discarded bones of animals slaughtered for food but also the momentous increase in waste that characterized contemporary society dated from industrial resolution. Waste is more easily recognized than defined; some things can become waste when they are no longer useful and fail to fulfill their purpose.

Solid waste according to (Ajibade et al., 2019), is any useless, unwanted, or discarded material that is not liquid or gas. A great mixture of subsistence including fine dust, cinder, metal, glass, paper and cardboard, textiles putrescible and vegetable materials and plastic characterizes solid waste. As narrated from (FAYEMI, 2020), the only certainty is that the accumulation of waste will outstrip its control. Throughout the Western world, there are no longer enough convenient holes in the grounds into which to tip unwanted matter. The third world having refused to become the "dustbin" of the Western world, also lacks appropriate storage facilities, treatment technologies, and good methods of disposal for its waste (Bichi, 2013).

There is no single solution to the challenge of waste management. The waste management process is usually framed in terms of generation, storage, treatment, and disposal with transportation inserted between stages as required. Hence a combination of source reduction recycling, incineration, and burning in landfills or conversion is currently the optimal

Corresponding author: Mujittafa Sariyyu
mujittafasariyyu@gmail.com
Department of Civil Engineering, Faculty of Engineering, Aliko Dangote University of Science and Technology, Wudil, Kano State.

way to manage solid waste (Shwetmala et al., 2011)

It therefore becomes important for this study to examine the problems of solid waste management in Hotoro North. This research is therefore intended to provide insight to citizens, government officials, and business people who might want to help resolve the solid waste management crisis in Hotoro North. Hotoro North lies on the latitude 11^0 98'N and longitude 8^0 58'E, the climate is humid and characterized by both dry and wet seasons.

However, this rainy season lasts between 120-160days (3-4months) while September records the highest rain, mean monthly temperature is highest in March and lowest in August various types of human activities thrive in the study area. Such activities include farming, transportation, and a variety of other professions (Okwesili *et al*., 2016).

In recent times" or "Recently as a result of an increase in population and poor solid waste management, the populace has decided to turn the drainage channels available in the city into dumping grounds whose consequences are obvious and hazardous to both man and the environment as a whole. Studying this environmental-based problem becomes a crucial issue in the hope of alleviating the status of human health and environmental quality.

A lot has been said, written, and demonstrated about the inadequacies in solid waste management and its associated problems. According to a United Nations Conference on Human Settlement report, one-third to one-half of solid waste generated within most cities in low- and middle-income countries, of which Nigeria is no exception, is not collected. They usually end up as illegal dumps on streets, open drainages, and wastelands as narrated by(Cock et al., 2021).

According to (Lindhard & Larsen, 2016), a garbage historian, "Since human beings inhabited the earth, they have generated, produced, manufactured, excreted, secreted, discarded and otherwise disposed of all. Waste generation encompasses activities in which materials are identified as no longer being of value (in their present form) and are either thrown away or gathered together for disposal. Waste generation at present is not very controllable. However, reduction of waste at source is included in system evaluations as a method of limiting the quantity of waste generated.

Solid waste can be classified into different types depending on its source.

1. Household waste is generally classified as municipal waste.
2. Industrial waste is classified as hazardous waste.
3. Biomedical waste
4. or tropical waste is classified as infectious waste
5. Special waste

Table 1: Categories of Solid Waste

Types of litter	Approximate time it takes to degenerate
Paper	10 – 30 days
Cotton cloth	15– months
Wood	10–15 years
Woolen items	1 year
Tin, aluminum, and metals such as cars	100 – 500 years
Plastic bag	1 million years
Glass bottles	Undetermined

The most common kinds of drainage are:

Downspout Drainage

Another kind of drainage system is the downspout drain which connects to the gutter system of a building and carries water away from the roof towards the ground. Downspout pipes can be rectangular or round and are mostly made of aluminum, copper, or steel.

Slope Drainage

The main job of a slope drain is to direct water away from a building and its

Corresponding author: Mujittafa Sariyyu
mujittafasariyyu@gmail.com
Department of Civil Engineering, Faculty of Engineering, Aliko Dangote University of Science and Technology, Wudil, Kano State.

landscaping. The primary method is to allow the water to follow a natural route down a slope. Typically, a pipe is installed and anchored to the small incline on which it sits.

Highway Drainage

The highway drainage is used to clear surface water from the highway. It is not designed to cater to run-off from adjacent properties.

The hydraulic capacity of a drainage channel is dependent on the size, shape, slope, and roughness of the channel section. For a given channel, the hydraulic capacity becomes greater as the gradient of the depth of flow increases. The channel capacity decreases as the channel surface becomes rougher. A rough channel can sometimes be an advantage on steep slopes where it is desirable to keep floe velocities from becoming excessively high. Open channel designs, which lower the water surface elevation, can result in excessive flow velocities and cause erosion problems.

The planned rise in water surface elevation can cause the following:

i. Objectionable flooding of the roadbed and adjacent properties.
ii. An environmental and maintenance problem with sedimentation **is** due to reduced flow velocities.

The objectives of the study are to determine the Velocity, Flow rate, and acceleration of the solid waste deposited along the drainage channels of the case study, and determine the pressure at both concentrated and non-concentrated zones of a drainage channel partially filled with solid waste.
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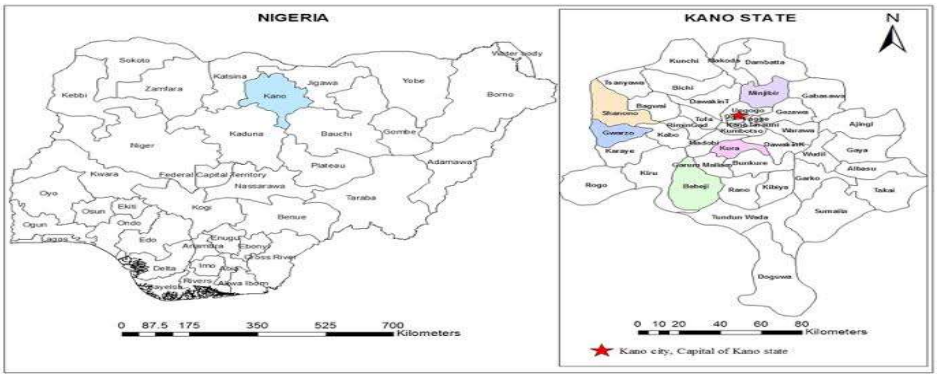

Figure 1 Map of Kano State, Nigeria
Source: field survey data, 2022

Figure 2: Drainage with low and high solid waste at Tsamiyar Boka, Hotoro
Source: field work, 2022

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mujittafasariyyu@gmail.com
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Figure 3: Catchment area with solid waste at Hotoro
Source: field survey data, 2022

MATERIALS AND METHODS

1. 30–meter measuring tape: This is used to measure the distance from the point of high concentration and low concentration area of solid waste.
2. Stopwatch: This is used to measure the time taken for the floating material to flow from one point to another.
3. Floaters: are materials that can be carried easily by liquids i.e. water.

The drainage area was calculated as the product of its length and width. The value of the time and distance was used to determine the velocity of the moving water in the drainage channel. The velocity of the flow on the drainage channel was determined by the use of a floater, stopwatch, and measuring tape.

The methodology used for measuring the discharge is based on a simplified form of the continuity equation. The equation implied that for any incompressible fluid such as water, the discharge (Q) is equal to the product of the drainage's cross-sectional area (A) and the mean velocity (V). The drainage pressure was determined at both low and high-concentrated areas of solid waste by dividing the force per unit area of the drainage.

The flowrate (Q) is given mathematically as:

$$Q\left(m^3/_s\right) = AV \quad (1)$$

Where,

V = mean velocity (m/s) and A = cross-sectional area perpendicular to the flow direction (m^2)

The pressure at each part was calculated by using the following equations

The Mass (Kg) = $Density \times Volume$, Velocity (m/s) = $\frac{Distance}{Time}$, Acceleration = $\frac{Velocity}{Time}$ (m/s^2),

$Force\ (\mathrm{N}) = mass\ x\ acceleration$ and

$Pressure\ (\mathrm{N/m2}) = \frac{Force}{Area}$ (2)

RESULTS AND DISCUSSIONS

The discharge obtained in the various drainages with high concentrations of solid waste differs; the difference in the discharge values depends on the cross-sectional area of the drainage considered and the velocity of the fluid. The velocity of the fluid depends on the slope of the drain, the volume of water in the drain (water pressure), and the density of the float. In this research, the float's density was not considered a factor since it was the same floater that was used throughout the experiment in all the drains. Table 2 shown the results of water pressure at all channels of highly concentrated areas of solid waste

Corresponding author: Mujittafa Sariyyu
mujittafasariyyu@gmail.com
Department of Civil Engineering, Faculty of Engineering, Aliko Dangote University of Science and Technology, Wudil, Kano State.

Table 2: Point of high concentration of solid waste

S/N	Location	Length (M)	Width (M)	Depth (M)	Area (M^2)	Time (sec)	Velocity (M/s)	Discharge (M^3/sec)	Pressure (N/M^2)
1	Ahmadu Boka Street	14.50	0.90	1.20	13.05	12.00	1.21	15.79	120.0
2	Tsamiyar Boka Street.	10.50	0.70	0.80	7.35	13.00	0.81	5.95	49.6
3	Hotoro North Eastern bypass	13.00	0.80	1.00	10.40	12.80	1.02	10.61	80.0
4	Hotoro Saye Quarters	10.00	0.80	1.20	8.00	10.50	0.95	7.6	109.2

The results show that in the concentrated area, there is a high level of solid waste and vice versa. The water pressure at all channels of the low-concentration area is shown in Table 3. The water pressure in an open drainage is of great importance considering the safety of the inhabitants. The discharge evaluated at the point of low concentrated area of solid waste are presented in table 3. High concentrations of solid waste varies with the depth of the drain. The deeper the drain, the higher the value of its pressure. Consider the drain at Ahmadu Boka Street; its depth is 1.2m and it has a pressure of 120N/m^2 while the drain at Tsamiyar Boka Street and Hotoro Eastern bypass with 0.8m and 1.0m have a water pressure of 49.6N/m^2 and 80N/m^2 respectively. Therefore, water pressure also depends on the topographic condition of the drainage location.

Table 3: Point of low concentration of solid waste

S/N	Location	Length (M)	Width (M)	Depth (M)	Area (M^2)	Time (Sec.)	Velocity (M/S)	Discharge (M^3/Sec.)	Pressure (N/M^2)
1	Ahmadu boka Street	14.50	0.90	1.20	13.05	9.00	1.61	21.01	214.8
2	Tsamiyar boka Street.	10.50	0.70	0.80	7.35	10.50	1.00	7.35	76.0
3	Hotoro north Eastern bypass	13.00	0.80	1.00	10.40	10.00	1.30	13.52	130.0
4	Hotoro Saye Quarters	10.00	0.80	1.20	8.00	8.30	1.21	9.68	175.2

The accumulated solid waste in the drain reduces the water carrying capacity of the drains thereby leading to diversion of the runoff water from the drainage channel and reducing the water pressure in the channel and this leads to flooding of its environs. The discharge is low where the level of solid waste is high while the discharge was high where the level of solid waste is low. From the results obtained, it was deduced that Hotoro eastern bypass drainage had higher velocity compared to other drainages within Hotoro. Consequently, the discharge is higher at both points of high and low concentrations of solid waste. Solid wastes

Corresponding author: Mujittafa Sariyyu
mujittafasariyyu@gmail.com
Department of Civil Engineering, Faculty of Engineering, Aliko Dangote University of Science and Technology, Wudil, Kano State.

produced in Hotoro are either dumped in open areas, which negatively impact environmental friendliness, on roadsides, in illegal disposal sites, or in waterways (drainage systems). The results support those of (Bichi, 2013), who contended that the enormous piles of trash dumps that are frequently seen on public property and on main streets are washed into drainage channels by rainstorms, which obstructs the easy flow of water and eventually causes flooding of the highways and occasionally residential areas.

CONCLUSION AND RECOMMENDATIONS

The velocity, flow rate, and acceleration of the solid waste disposed along the drainage channels was determined at both high level and low levels of concentrated solid waste at Ahmad Boka Street, Tsamiyar Boka Street, Hotoro North Eastern bypass, and Hotoro Saye Quarters.Illnesses associated with solid waste i nclude meningitis, cholera, malaria, typhoid, an d respiratory disorders.

The pressure at both concentrated and non-concentrated zones of a drainage channel partially filled with solid waste was determined. The water pressure in an open drainage is of great importance considering the safety of the inhabitants.

1. A policy should be made that will change the culture, lifestyle, and habits of the public in terms of proper disposal of solid waste, this cannot be achieved overnight but requires long-term planning
2. The government should sponsor television programs to educate the general public in the form of drama or discussion about the improper disposal of solid waste along drainage channels.
3. Kano state government should adopt a conduit drainage system in the construction of its drainage in the Hotoro metropolis and insert screening material in all the drains to sieve out debris in the drainage channels.

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Corresponding author: Mujittafa Sariyyu
mujittafasariyyu@gmail.com
Department of Civil Engineering, Faculty of Engineering, Aliko Dangote University of Science and Technology, Wudil, Kano State.