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AN ANALYSIS OF THE ADEQUACY OF SOLID WASTE MICRO DISPOSAL SITES IN CALABAR MUNICIPALITY, CROSS RIVER STATE-NIGERIA (2019-2021).

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Abstract

The inability of constituted authorities to evacuate solid waste efficiently from our environment is worrisome. The study investigated the location of municipal solid waste micro disposal sites in Calabar Municipality of Cross River State for two years (2019 to 2021). Research data were gathered from primary and secondary sources. Data were gathered through Ground-Truthing Observation (GTOs) in the field, identification of location of micro disposal sites, coordinates of the micro disposal sites were obtained with Garmin 76CSX hand held GPS. Four hundred (400) questionnaires were randomly distributed to residents in the ten (10) wards to elicit information on the availability of micro disposal sites. Findings reveal that 38.75% of the respondents lack where to dispose their waste with 29.25% having access to collection points, while the remaining 32% complained of inadequacy of area designated as disposal sites. A total of 208 micro solid waste disposal site locations are in Calabar Municipality. Data collected were analyzed using Pearson correlation. The result (-0.097) indicated a negative relationship between population and locations of micro disposal sites. Population played no role in the choice of location or creation of disposal sites Ward 2, with 3,899 (1.3%) of the population has 32 (15.38%) disposal sites, while ward 1 with a population of 89,873 (30.1%) has 13 (6.25%) disposal sites. It is recommended that more micro disposal sites be created, two or more micro dumpsters should be stationed at micro disposal site(s) within a maximum trek able distance of 300m for residents to dispose waste and micro disposal site bay should be created for the purpose of placing dumpster.

Keywords: Solid Waste, Micro, Disposal Sites, Distribution, Dumpsters, Sprawling Waste, Calabar Municipality

1. Introduction

Waste management will always be part of human existence, mainly because the wastes generated are direct product of man's many activities in his bid to satisfy his wants and the needs of the society. Waste collection is the starting point of waste management process and this collection can be carried out in various forms: house to house, communal (dumpsters to waste truck) for onward transportation to final disposal site. Residents, are as a duty require to first transfer the wastes generated at their abode to a micro disposal site, from where it has to be evacuated to the final dump site. Government commitment to waste management starts at this point of

collection/evacuation of the waste from the micro disposal sites to the dump site. Solid waste micro disposal sites are location/space designated by government for waste to be deposited temporally by residents, for onward lifting to the final dumpsite. They are small space where dumpsters are placed to enable residents deposit waste generated from activities carried out by them.

Waste generated from activities such as residential, commercial, institutional, recreational land use etc. are required to be evacuated regularly and timely from the dumpsters placed at the micro disposal site. The pattern of distribution of the micro disposal site in space, the availability, the appropriateness in terms of space allocated for it, their proximity to residents in respect to the distance to be covered to reach the micro disposal site are criteria that needs to be considered for efficient waste management to be achieved.

Micro disposal site can best support the idea of preserving the serenity of our environment in the face of increase in waste generated by our ever increasing urban population, if there is proportionate distribution of micro disposal sites and placement of dumpsters appropriately in the space designated. Population density, expand of land and intensity of commercial, recreational and public activities increases the rate at which waste are deposited on micro disposal sites.

Waste is an inevitable useless by-product of man's actions. It is further categorized into solid, liquid and gaseous waste. Solid wastes are generated from domestic, industrial and other human actions on planet earth (Emri, Nwafor and Ernest, 2019). Man's refusal to take responsibility for the management of the waste constitutes threat to human race and the environment he lives in. According to UNEP (2005), the factor that adversely affected waste collection and transportation systems were the inadequate supply of waste collection containers.

Growth of the world's population, increasing urbanization, rising standards of living, and rapid development in technology have all contributed to an increase in both the amount and variety of solid waste generated by industrial, domestic and other activities. Cities in Nigeria being among the fast growing cities in the world (Onibokun and Komuyi, (1996) are faced with the problem of solid waste management.

According to Ajadike, (2001), Senthil, Vadivel, and Murugesan, (2012) urbanization and changing consumption patterns are resulting in the generation of increasing amounts of solid waste and visible environmental problem in many urban areas, Ajadike, (2001) also said urban waste crisis arises because of three fundamental factors, namely; rapid increase in urban population, heavy consumption pattern of urban dwellers and inefficiency of the authorities whose statutory responsibilities includes efficient waste management in cities.

According to Aina, (1994), "of all the environmental problems facing the nation, the most obvious and embarrassing, and the one which has consistently being employed as a blackmail on us the environmentalist, is the municipal waste disposal problems"

Virtually all aspects of man's productive activities involve the generation of waste (Oyinloye, 2012). Similarly, Ubachukwu, Phi-Eze and Emeribe (2014) sees municipal waste as an important percentage of waste produced by different activities carried out by humans. The way these wastes are handled, stored, collected and disposed can pose risk to the environment and to public health.

Samson-Akpan,(2009), stated that the public should be well educated on the implications of unsanitary solid waste disposal. Afangideh, Joseph, and Atu,(2012), revealed that the attitude

of urban dwellers to waste generation and disposal has caused great damage to the human ecosystem and that the poor attitude of urban dwellers to waste generation and disposal has impacted negatively on the human health and sanity. They concluded by saying that the residents of Calabar Municipality were complacent to the implication of poor waste management.

To free the society of filth requires designating sites that are appropriate in terms of space, location and numbers of sites available. The space to accommodate the dumpsters as well as the evacuating vehicle, a location that will interfere less with the traffic flow and the number of sites created or the numbers of dumpsters placed on the site at locations are parameters that require diligent consideration. It is imperative to find out the relationship that exists between population and the provision of designated micro disposal sites in the study area.

The Aim of this study is to analyze the adequacy of spatial distribution of solid waste micro disposal sites in Calabar Municipality.

2. The Objectives are:

1. To assess the adequacy of the disposal sites.
2. To examine the pattern of solid waste micro disposal site distribution
3. To create a data base for municipal solid waste micro disposal sites in Calabar Municipality.
4. To suggest possible ways to address the abnormally (ies) observed in the field.

3. Study Area

Calabar Municipality is the study area. It is located on Latitude 4^0 55'N of the equator and longitude 8^0 16'E of the Greenwich meridian, it is bounded to the north, south, east and west by Odukpani LGA, Calabar South LGA, Calabar River and Akpabuyo LGA respectively (See figure 1). The local government is comprised of two major ethnic groups namely the Ejaghams and Efiks. However, other immigrant ethnic groups such as Igbos, Yoruba, Hausa, Ibibios, Annangs, Orons, and other ethnic groups from the Central and Northern Senatorial Districts of Cross River State. The population of Calabar Municipality in 2006 was 191,515 (NPC), projected to 2021 at 3% growth rate bring the population to 298,380. The climate of the area is humid tropical although rainfall occurs throughout the year. The place experiences double maxima, rainfall regime in July and September. The area has a high relative humidity usually between 80% and 100% and vapour pressure in the air averaged 29 millibars throughout the year. High salinity ($3.8 \pm 0.4\%$) is limited to the dry season while lower salinity ($0.5 \pm 0.6\%$) occurs in the rainy season (Ukpong1995). Politically, the local government has a total of ten (10) wards (1, 2, 3, 4, 5, 6, 7, 8, 9 and 10). The administrative headquarters is along Ndidem Usang Iso Road. It has rich mangrove swamp and rainforest vegetation with variety of hard wood and raffia palm. The vegetation is enhanced by the aquatic deposit due to its strategic location between the rivers. Both the State Government House and the Governor's Office are located within the local government as well as other important state of the art facilities, being a gate way to Calabar Metropolis, it is expected that disposal sites within Calabar Municipality should be located to enable residents dispose their waste generated appropriately.

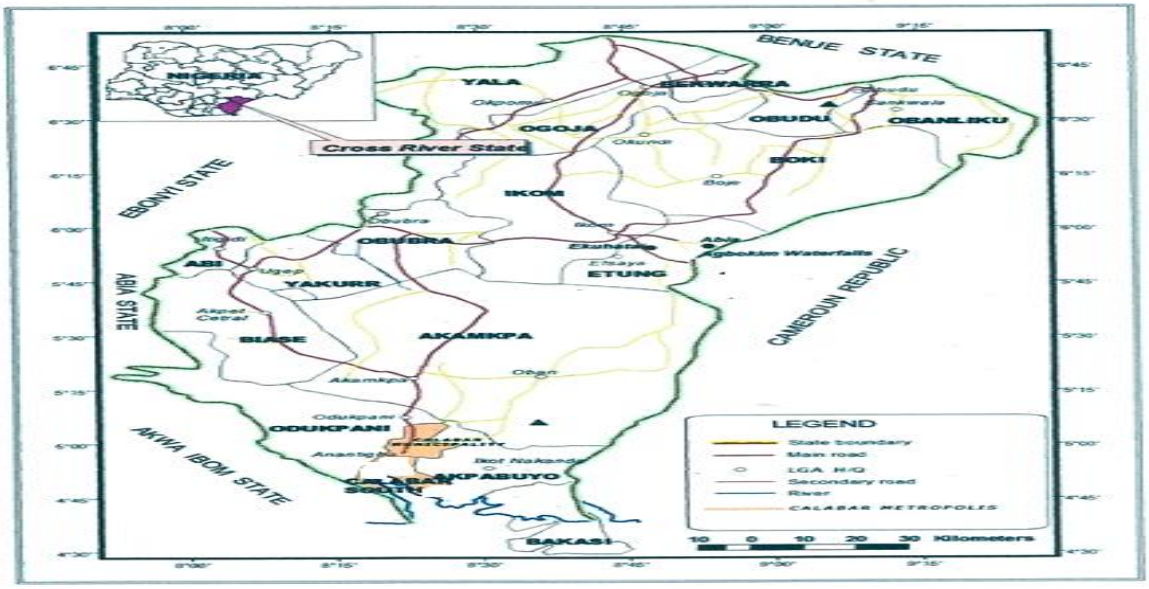

Figure 1: Map of Cross River State showing Calabar Municipality

Source: Cross River Geographic Information Agency (CRGIA

4. Conceptual framework/Literature review

The conceptual underpinning for this study is the Concepts of Equity and Inequity

The term equity can be defined in various ways. According to the Webster's New Collegiate Dictionary, equity is the justice according to natural law or right; specifically: freedom from bias or favoritism. The American Heritage dictionary also defines equity as the state, ideal, or quality of being just, impartial, and fair. Inequity on the other hand is the linguistic opposite of equity. It is the state, ideal, or quality of being unjust, partial, or unfair. Although equality and equity are often conflated, the words have two different meanings and are conceptually very different. Equality is sameness, and equity is fairness.

In any particular situation, equal may not be equitable, or equal may be precisely be equitable, but an ethical justification must be presented for why a certain distribution constitute inequity (PAHO, 1999). The term equity can also be delineated into horizontal equity and vertical equity. Horizontal equity describes the allocation of equal or equivalent resources for equal need while vertical equity is the allocation of different resources for different levels of need. These two conceptions of equity have dramatically different policy implications, and cannot be applied randomly to problems but must appeal to some principle or special feature of the problem that justifies the choice of one over the other. For example, the need for a clean plan might appeal to horizontal equity on the basis that everyone needs healthy environment to live in.

The term inequity has a moral and ethical dimension. It refers to differences which are unnecessary and avoidable but, in addition, are also considered unfair and unjust. So, in order to describe a certain situation as inequitable, the cause has to be examined and judged to be unfair in the context of what is going on in the rest of society (Whitehead, 2000).

It is believed that application of the concept of equity in the distribution/designation of micro disposal sites will help maintain the healthy environment in the study area, especially when population/density form the basis for the distribution of micro disposal sites among wards in Calabar Municipality.

5. Literature review

There is plethora of literature on location of disposal/dumpsite across the globe. Urban solid waste management is one of the challenges prevalent in developed and developing countries. This is because the agglomeration of human settlement has the potential to produce large amount of solid waste. According to Enete, (2010), increasing population, prosperity and urbanization, in developing countries remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of solid waste. The problem is

aggravated by the open dump nature of disposing waste especially in the slum areas of most Africa cities (UNFPA, 2007). The most obvious and most embarrassing environmental problems faced by cities in Nigeria are the problem of municipal waste disposal.

Waste disposal/management involves generation of waste at home, movement of the waste from home to a temporal dumpsite (micro disposal site) where the process of evacuation, disposal/management of the waste by public authority begins. There is the need to carefully select such sites. ZUMO, and VOKNA, (2014), selected a sanitary landfill site for waste disposal in Yola, five themes were created; they are buildings, roads, river, soil type and elevation model. The five themes were reclassified and overlaid using the analyst tool in the ArcGIS environment. Babalola, Ishaku, Busu and Majid (2010), Adeofun, Achi, Ufoegbune, Gbadebo and Oyedepo (2011) and Gbanie, Tengbe, Momoh, Medo and Kabba, (2013) applied the techniques of GPS, GIS and RS to disposal sites and transport route selection in Damaturu, Abeokuta, and Bo, Southern Sierra Leone respectively. Ojiako, Emengini and Iwuchukwu, (2014) examine Solid Waste Management in Onitsha Urban Anambra State, Nigeria using Geographic Information System (GIS) Approach, they dwell on route planning for waste collection vehicles within the urban area. They proposed installation of vehicular tracking systems like Geographical Position System (GPS) on the vehicles to calculate waste collection timings.

Ebistu, and Minale, (2013) evaluated Solid waste dumping site suitability analysis using Geographic Information System (GIS) and Remote Sensing (RS) for Bahir Dar Town, North Western Ethiopia. It was arrived at that the farther lands from lake and river banks got more preferences for solid waste dumping site suitability. While Udoh, and Inyang (2016) evaluated Purview of Public Solid Waste Collection, Disposal and Management Practices in Akwa Ibom State, they observed that some areas were in complete neglect of waste bins and this in a way impacted negatively on the environment. One of such negative effect is the degrading of the environment aesthetically. Earlier on, Adeoti, and Peter, (2015) focused on the waste conditions and disposal as well as the influence on the environment in term of cleanliness at Ado Ekiti capital of Ekiti State. The field observation takes account of the strategic locations of waste bins and indiscriminate waste dump spots across the city. They concluded that the town witnessed rapid population growth, physical development and expansion over the years this view agrees with views of Butu, et al (2013) and Butu, et al (2014) which stated that, with increase in population and corresponding increase in the amount of waste generated on one hand and low participation of all stakeholders on the other hand, the challenge of waste management is huge.

The literature cited in this study from both developed and developing countries of the world, emphasis is on pattern of collection of waste, refuse evacuation, identification of site suitable for development of sanitary landfill for waste disposal, optimization, and the challenges of inadequacy of dumpsters/bins (Babalola, Ishaku, Busu and Majid, 2010, Ojiako, Emengini and Iwuchukwu, 2014, ZUMO, and VOKNA, 2014, and Adeoti, and Peter, 2015). Rarely was the focus on the space (micro disposal site) where the dumpsters are placed to provide the service for residents to deposit their waste after removing it from their abode be it residential, commercial, institutional, recreational land uses, rather the emphasis is on selecting the final dumpsite and transport route planning for purpose of evacuation of waste from micro dumpsite to the final disposal site. Although researcher's work cited showed the potentials of GIS technology in the location of landfill, attention was not paid to the very facility (solid waste micro disposal site) where waste products are temporally deposited before it is finally evacuated by the authorities. The emphasis was more on the container (dumpsters/bins) placed on the site and not on the space(s) designated as micro disposal sites.

6. Materials and method

6.1 Sampling Design, Instruments, and Analysis of Data

The study sample size was statistically determined using "Taro Yamane" (1967) formula:

$$n = \frac{N}{1+N(e)^{*2}}$$

Where:

n is the sample size;

N is the finite population,

e is the level of significance (limit of tolerable error), that is 0.05(5%) and

1 is unity (a constant)

Using the sampling frame formula with a population of 298,380, approximately 400 respondents were sampled randomly and administered with questionnaire.

Research data were gathered from primary and secondary sources. Data from primary sources were obtained through observation, identification and location of micro disposal sites, within Calabar Municipality using Garmin 76CSX hand held GPS, to obtain the coordinates of the micro disposal sites, Quick Bird Imagery of Calabar Auto Photo Map and Arc GIS 9.3 software to handles multiple tables and relate them.

Secondary sources of data were obtained from existing literature on primary waste management from textbooks, internet, journals and magazines. Information was also sourced from the Ministry of Lands and Surveys Calabar, Ministry of Environment Calabar, Cross River Waste Management Agency, Calabar office of the National Population Commission (NPC) and the office of the State Statistician General where demographic data were collected.

7. Data analysis

Table 1: Availability of disposal site

Ward	Adequate	Inadequate	Lacking	Total
1	10	9	21	40
2	16	16	8	40
3	11	13	16	40
4	16	14	10	40
5	13	12	15	40
6	17	14	9	40

7	12	17	11	40
8	6	8	26	40
9	10	13	17	40
10	7	13	21	40
Total	**117**	**128**	**155**	**400**
Percentage	**29.25**	**32**	**38.75**	**100**

Source: Field survey, 2021

Residents responds as regards to the availability of disposal sites(s) as contain in table 1, shows that 117 (29.25%) respondents are of the opinion that the numbers of micro disposal sites in their area are adequate, 128 (32%) respondents are of the opinion that the available disposal sites are inadequate, while 155 (38.75%) respondents expressed dissatisfaction as they complained that micro disposal sites are lacking in their neighbourhood.

Table2: Population distribution per ward.

Ward	**Population**	**Percentage**
1	89,813	30.1
2	3,879	1.3
3	50,426	16.9
4	4.177	1.4
5	19,693	6.6
6	50,426	16.9
7	8,056	2.7
8	29,540	9.9
9	10,742	3.6
10	31,628	10.6
Total	**298,380**	**100**

Source: Field survey, 2021

Table 2: shows that a total of two hundred and ninety-eight thousand three hundred and eighty persons lived in Calabar Municipality as at 2021. Ward 1 has the highest population (89,813) which account for 30.1%, while Ward

2 has the least population (3,879) which account for 1.3%.

Table 3: Distribution of Micro disposal sites per ward

Ward	**Micro disposal sites**	**Percentage**
1	13	6.25
2	32	15.38
3	21	10.1
4	21	10.1
5	10	4.81
6	28	13.46
7	10	4.81
8	42	20.19
9	19	9.13
10	12	5.77
Total	**208**	**100**

Source: Field survey, 2021

Table 3: shows that a total of two hundred and eight (208) solid waste disposal sites are located in Calabar Municipality. Ward 1 has 13 sites, ward 2 has 32 sites, wards 3and 4 have 21 sites each, wards 5 and 7, have 10 each, ward 6, 28 sites, while ward 8, 9, and 10 have 42, 19 and 12 disposal sites each.

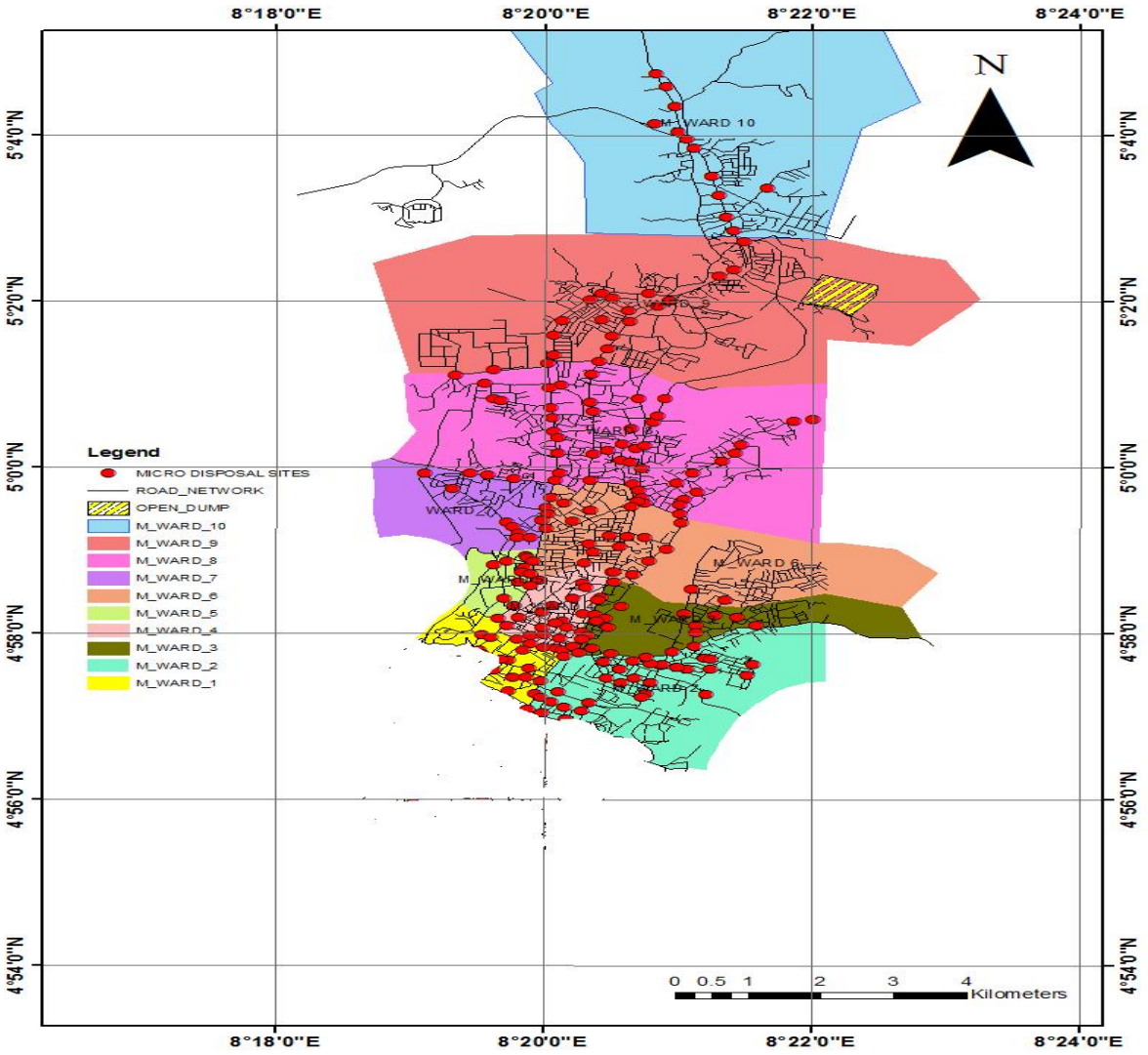

Figure 2: Map of Calabar Municipality showing location of micro disposal sites.

Figure 2 shows the various locations of the designated micro solid waste disposal sites. The locations of the micro disposal site coordinates were obtained with hand held GPS and processed with Arc GIS 9.3. The distribution of the micro disposal sites as contained is table 2, is further displayed in figure 2.

Table 4: Landmass (SQM) of each ward

Ward	Area (M^2)	Percentage
1	1,685,759,583.361	1.9
2	7,325,732,054.406	8.0
3	4,055,952,517.623	4.6
4	1,778,419,573.102	2.0
5	1,176,340,526.422	1.3
6	8,500,501,125.526	9.3
7	3,853,292,390.602	4.2
8	15,646,987,290.775	17.2
9	21,836,223,963.368	24.0
10	25,049,176,636.965	27.5
Total	91,108,385,612.150	100

Source: ArcGIS Analysis, 2021

Table 4 shows that the study covers a total land area of 91,108,385,612.150 Square meters. Ward 10 has the largest landmass 27.5%, followed by Ward 9(24%) and ward 8 (17%). While, the least in terms of landmass is ward 5 which account for 1.3% of the total study are

Table 5: Type/number of bins placed in each ward.

Ward	Types of Bin at Disposal Site		Total Bin per ward
	Dumpsters (L)	Compactor (S)	
1	13	Nil	13
2	15	26	41
3	14	12	26
4	13	12	25
5	10	Nil	10
6	27	3	30
7	6	4	10
8	38	9	47
9	9	12	21
10	12	Nil	12
TOTAL	**157**	**78**	**235**

Source: Field survey, 2021. *L=Large, *S=Small

Table 5, shows the number of bins placed in each ward of Calabar Municipality. A total of 235 bins (comprising of 157 large bins and 78 small bins), are placed at 208 designated micro disposal sites.

Table 6: Number of dumpsters place at each micro disposal site.

Ward	Site with Single Bin	Site with Double Bin
1	13	Nil
2	23	9
3	16	5
4	17	4
5	10	Nil
6	26	2
7	10	Nil
8	37	5

9	17	2
10	12	Nil
Total	**181**	**27**
Percentage	**87**	**13**

Source: Field survey, 2021

Table 6, shows the number of micro disposal sites with single bins placed on it as well as micro disposal sites with double bins placed on it. From the analysis 87 percent of the micro disposal site has a single bin place on it. While, 13 percent of the sites have double bins placed on it.

8. Findings

The number of municipal solid waste micro disposal sites and land area (M^2) per ward in Calabar Municipality as contain in Table 4, form the base where matrix tables were created and calculated using the Nearest Neighbour Analysis formular:

$Rn = 2d \sqrt{n}/A$

Where Rn= the Nearest Neighbour Index

A= the size of the area concerned

d= the mean distance between settlements or facilities (taken as an average of the distance between nearest neighbor) ∑Minimum Distance.

9. Decision

Any calculated value of R_N will fall between Zero (O) and 2.1491 (Cark & Evans, 1954). Therefore the facilities or settlements will tend to be clustered when the Rn is less than 1, Random when the figure is above 1 and more regularly spaced than in a random situation when the value of R_n is higher (2.15).

Hence ward 5 and 6 experience random distribution pattern. Ward 1, 2, 3, 7, 8, 9 and 10 have clustered distribution pattern, while, ward 1 has regular distribution pattern. This information is contained in table 7 (Decision).

Table 7: Decision (Calculated value of Rn)

Location (Ward)	Rn Index	Decision
1	0.93	Clustered
2	0.45	Clustered
3	0.90	Clustered
4	1.2	Regular
5	1.00	Random
6	1.00	Random
7	0.40	Clustered
8	0.44	Clustered
9	0.58	Clustered
10	0.53	Clustered

Rn < 1 Indicate pattern is clustered

Rn = 1 Indicate pattern is random

Rn > 1 Indicate pattern is regular

Clustered	=	7
Random	=	2
Regular	=	1
TOTAL	=	10

From analysis and calculation of the pattern of distribution of the micro disposal sites using Nearest Neighbour Analysis, revealed that 7 wards experienced clustered distribution pattern, 2 wards have random distribution pattern with only 1ward having regular distribution pattern.

A total of 208 micro solid waste disposal site locations are in Calabar Municipality as at the period of the study (2019-2021). Population played no role in the choice of location or for the creation of disposal site. A typical example is contained in table 2. Ward 2, with 3,899 (1.3%) of the population has 32 disposal sites representing (15.38%), while ward 1 with a population of 89,873 (30.1%) has 13 (6.25%) disposal sites located in it. The relationship between ward population and the number of disposal sites is negative. The figures in table 2 (population distribution per ward) where correlated with figures in table 3 (distribution of micro disposal site), using minitab 17 to process the data, the result is -0.097. The correlation coefficient of -0.097 indicated that there is a negative relationship between population and locations designated as solid waste micro disposal sites. The implication is that population is not a consideration for the designation of locations as solid waste micro disposal sites, this ought not to be.

Micro disposal site with two bins place on it account for (13%) of a total of 208 designated micro disposal sites in Calabar Municipality, while 87% of the designated micro disposal sites have one bin placed on it. This has led to issues of sprawling waste especially, when the bin is moved for the purpose of evacuation. With no alternative, residents who get to deposit their waste simply pour it on the ground. It is possible to see a two-lane street half-blocked and reduced to a lane by sprawling waste. The challenge of sprawling waste is there even when two bins are placed in a micro disposal site, largely due to delay in evacuation of waste or replacement of bin. The situation of sprawling waste is uglier at disposal site with single bin.

The area (M^2) of the ward is not a consideration for the designation of micro disposal point as it is evidence in designation of 12 disposal sites in ward 10 with a total land area of 25,049,176, 636.965M^2. While ward 2 and 8 with 32 and 42 designated disposal sites have 7,325,732,054.406M^2 and 15,646,987,290.602M^2 respectively. It is apparent that neither population nor land area is a criterion for the designation or creation of micro disposal site.

Micro disposal sites are located within the carriage way of access road. This has reduced the carriage way on a single lane road to a half especially on roads such as Old Odukpani Road, Ikot Efa Road, Bishop Ukpo Avenue, Ediba Road. Where long queue of vehicles is experienced at any time waste is evacuated from the micro disposal site. See Plate 1.

Plate 1: Queue during evacuation along old Odukpani Road Ikot Ansa (morning hour)

The situation is slightly different on Murtalla Mohammed Highway (MMHW) because it is a dual carriage way. However, overtaking at some of the locations (MMHW by Native Kitchen, by WAEC, and by 8Miles Market etc) is extremely dangerous because the dumpsters occupied half of the service lane. During evacuation, motorists do spend between 60 to 90minutes waiting.

It was discovered that micro disposal site are located along tarred roads only. Hence, residents in neighbourhoods without designated site, dumped their waste in any available unused space, such as dry valleys/ravines, undeveloped plots, uncompleted buildings and some dispose their refuse into storm water during rains.

10. Conclusion

The study examined the pattern of solid waste micro disposal sites distribution in Calabar Municipality It was discovered that population and land size have no bearing on the number of micro disposal site located in the study area. The absence of micro disposal sites locations to enable residents dispose their waste with minimum energy has contributed to the filthy nature of some areas in the study area. The spate of incessant waste sprawl at micro disposal site is an indication of inadequacies in terms of number of dumpsters placed at micro disposal site and lopsided distribution pattern thereby affecting the aesthetics of the environment negatively.

11. Recommendation

It is a known fact that there is a direct relationship between population and amount of waste generated by human beings. The management of Cross River State Waste Management Agency should consider population distribution per ward as yardstick for creation of micro disposal sites. In addition to this, areas with high population density as well as the Business Districts (BD) should be prioritized.

It is recommended that the evacuation team should get to micro disposal sites where single dumpster is placed with an empty dumpster as a replacement for the one to be evacuated. Such act will not only prevent residents pouring their waste on the ground, but will also help prevent the immediate environment of the location of the micro disposal site to become an eyesore. It is expected that each micro disposal site should have between 2-3 dumpsters placed on them for purpose of effective waste deposition/evacuation.

The size of an area is a necessary criterion and must be taken into consideration in the location of micro disposal site. This is inevitable because distance to be trekked by residents to a large extent, influence/discourage usage of the dumpsters for purpose of disposing waste. In

most cases humans are willing to trek a maximum of 300metres to dump their wastes in the dumpsters. Also, the expansion of town due to urbanization makes it proper to accommodate sub urban residents as it concerns designation of locations as solid waste micro disposal sites.

Micro disposal site bay or platform should be created for the purpose of placing dumpsters. Such platform should be located within the Right-Of-Way (ROW) and not within the carriage way as it is at present at some sites. Creation of a bay will erase the challenges experienced on access roads by road users on micro disposal sites locations.

The increase in population has made expansion/urban sprawl inevitable, thus it require that residents of such areas need to be provided for, in terms of where to dispose wastes generated from their activities. A proposal for 54 additional disposal sites is recommended to facilitate disposing of waste with minimal energy. See figure 3.

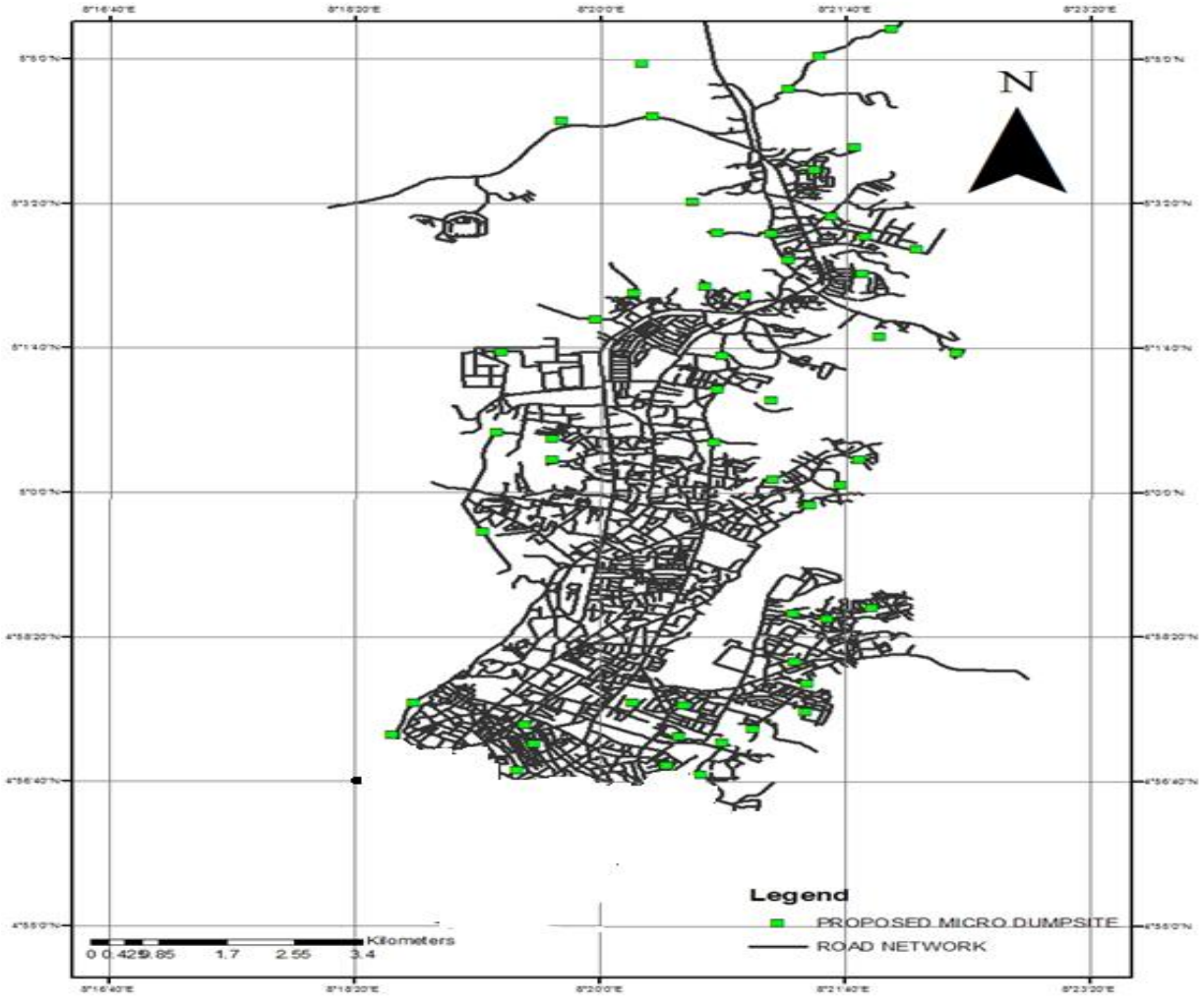

Figure 3: Proposed micro disposal sites.

References

Adeofun C. O., Achi H. A., Ufoegbune G. C., Gbadebo A. M. and Oyedepo J. A.(2011): Application of Remote Sensing and Geographic Information System for selecting Dumpsites and Transport Routes in Abeokuta, Nigeria Proceedings of the Environmental Management Conference, Federal

University of Agriculture, Abeokuta, Nigeria.

Adeoti, S and Peter, A. (2015) Integrated Solid Waste Management as Panacea for a sustainable Clean City in Nigeria: A Case Study of Ado Ekiti IOSR Journal of Mobile Computing & Application Volume 2, Issue 2. PP 08-14 www.iosrjournals.org

Babalola, A., Ishaku, H. T., Busu, I., and Majid, M. R. (2010)The Practice and Challenges of Solid Waste Management in Damaturu, Yobe State, Nigeria *Journal of Environmental Protection*Volume 1, Issue 4

Butu, A.W., Ageda B.R. and A.A. Bichi (2013) Environmental Impacts Of Roadside Disposal Of Municipal Solid Wastes In Karu, Nasarawa State, Nigeria International Journal of Environment and Pollution Research. Vol. 1, No 1, pp.1 -19, September 2013 Published By European Centre for Research Training and Development UK

Butu,A. W. and Mshelia,S.S. (2014):Municipal Solid Waste Disposal And Environmental Issues In Kano Metropolis, Nigeria British Journal of Environmental Sciences Vol.2, No.1, pp.1-16, June 2014 Published by European Centre For Research Training and Development UK (www.ea-journals.org)

Afangideh, A.I., Joseph, Kinuabeye. U., and Atu, J.E. (2012): Attitude Of Urban Dwellers To Waste Disposal And Management In Calabar, Nigeria. European Journal Of Sustainable Development Volume 1, No. 1, 2012

Aina E. (1994) Interview of the former Director General of Federal Enviromental Protection Agency (FEPA). Daily Guardian Monday, July 18

Ajadike, J. C. (2001) Urban solid waste management in Nigeria in G.E.K. Ofomata and P. O. Phil-EZE (eds). Geographic perspective on environmental problems in Nigeria. Nsukka Department of Geography, University of Nigeria Nsukka

Clark, P. J and Evans F. C (1954) "Distance to Nearest Neighbour as a Measure of Spatial relationship in Population Ecology 35, pp. 445-453

Ebistu, T. A. and Minale, A. S. (2013) Solid waste dumping site suitability analysis using geographic information system (GIS) and remote sensing for Bahir Dar Town, North Western Ethiopia. African Journal of Environmental Science and Technology. Vol. 7 (11), pp 979-989

Emri, Nwafor and Ernest (2019) Analysis of Solid Waste Collection nad Management in Calabar South Cross River State-Nigeria. International Journal of Agriculture, Environment and Bioresearch. Vol 4. No 06 pp 461-472

Enete, I. C. (2010). Potential Impacts of Climate Change on Solid Waste Management In Nigeria https://earthzine.org

Gbanie, P. S., Tengbe, B. P., Momoh, S. J., Medo, J., and Kabba, S. T. V. (2013) Modelling landfill location using Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA): Case study Bo, Southern Sierra Leone Applied Geography 36 3-12 journal homepage: www.elsevier.com/locate/apgeog

NPC (2006) National Population commission

Ojiako, J. C., Emengini, E. J.,and Iwuchukwu, J. N. (2014) Geographic Information System (GIS) Approach to Solid Waste Management in Onitsha Urban Anambra State, Nigeria International Journal of Scientific & Engineering Research, Volume 5, Issue 12,

Onibokun, A. G and Kumuyi, A. J (1996) Urban Poverty in Nigeria: towards sustainable strategies for its alleviation. Centre for African Settlement Studies and Development, Ibadan, Nigeria. CASSAD Monograph Series 10.pp.1-2.

Oyinloye, M. A. (2012): Using GIS and Remote Sensing in Urban Waste Disposal and Management: A Focus on Owo L.G.A, Ondo State, Nigeria. European International Journal of Science and Technology. 2304-9693 www.eijst.org.uk

PAHO (1999) Principles of Basic Concepts of Equity and Health, Division of Health and Human Development, PAHOWHO

Samson –Akpan,P. E. (2009): Solid Waste Management in Calabar, Cross River State hittps://www.ResearchGate.net

Senthil, Vadivel and Murugesan (2012) Optimum Location of Dust Bins Using Geo-Spatial Technology: A Case Study Of Kumbakonam Town, Tamil Nadu, India. Pelagia Research Library Advances in Applied Science Research, 3 (5):2997-3003

Ubachukwu, N. N., Phil-Eze, P. O. and Emeribe, C. N. (2014). Analysis of Household Harzardous Waste Awareness Level in Enugu Metropolis. Academic Journal of Interdisciplinary Studies Vol 3. No1. Pp369 ISSN 2281-3393

Udoh, I.B.1 and Inyang, S.A. (2016) Purview of Public Solid Waste Collection, Disposal and Management Practices in Akwa Ibom State Nigeria International Research JournalVol. 5(7), 55-63

Ukpong, I. E. (1995). Mangrove Soils of the Creek Town, Calabar River Swamp, South Easterm Nigeria, Journal of International Society for Tropical Ecology 36 (1): 103-115.

UNFPA (2007): The State of World Population 2001, Phoenix – Trykkeriet AS, Denmark, UNFPA

UNEP (2005) United Nations Environmental Protection Solid Waste Management Vol.1

Whitehead, M (2001) The Concepts and Principles of Equity and Health, WHO, EURO Report.

Zumo, I. M. and Vokna, S. A. (2014): Identification of Suitable Site for Solid Waste Disposal in Yola, Nigeria. Using GIS Method FIG Congress 2014 Engaging the Challenges – Enhancing the Relevance Kuala Lumpur, Malaysia 16-21 June 2014

Yamane, Taro (1967). Statiaticsc: An Introductory Analysis, 2nd Edition, New York: Harper and Row