Available online www.unicrossjournals.com

JOURNAL OF CONTEMPORARY RESEARCH (JOCRES)

RESEARCH ARTICLE VOL. 3 (3) ISSN:2814-2241

Date Published: September 30, 2024

Pages 112- 127

ANALYSIS OF SPATIAL DISTRIBUTION OF SOLID WASTE MICRO DISPOSAL SITES IN UNIVERSITY OF CROSS RIVER STATE CALABAR-NIGERIA

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Abstract

The paper analyzed how solid waste micro disposal sites are spatially distributed in UNICROSS, Calabar Campus by management to promote efficient solid waste collection and evacuation. Coordinates of the authorized solid waste micro disposal sites, the illegal sites and the open dump sites were obtained using Garmin 76CSX Handheld GPS. The solid waste micro disposal sites were identified and mapped. It was observed that there is inadequacy of the designated waste collection points as well as bins placed on the sites which has resulted in appearance of numbers of flash points within the campus. The distribution pattern is adjudged to be clustered using the Nearest Neighbour Analysis index with an Rn of 0.493. The clustered pattern has made most areas to be excluded in the waste collection/evacuation strategy of the Institution, the staff quarters is not accommodated in the waste management plans of the Institution. It is recommended that for the purpose of sustaining a healthy academic environment, there is need to acquire more receptacle, create more micro disposal sites by upgrading the flash points to authorized micro disposal sites and create new solid waste micro disposal sites in the staff quarters.

Key words: Solid waste, Micro Sites, Disposal, Distribution, Authorized, Flash Point, Dumpsite, Effective, Management.

1.0 Introduction

Effective waste management practices are essential for averting pollution of any kind, it is an antidote to environmental mishap in any settlement, ranging from farmstead to mega cities or remote rural areas to urbanized urban centres. Waste Management is a global environmental issue affecting most urban areas in developed and developing countries and our tertiary institutions are not immune against the menace. Solid waste management has become an overwhelming problem facing tertiary institutions in Nigeria. The phenomenon is a consequence of the outrageous growing population in our institutions of higher learning occasioned by increase intake of new/fresh student which has a direct link to rapid increase in population and urbanization and the desire for acquisition of higher certificate. Solid waste disposal is a vital part of waste management system and it requires much

attention to evade environmental pollution and health problems. The problem is particularly severe in developing countries that are characterized with increased urbanization, poor planning and lack of adequate resources (Mato, 1999; Obirih and Post, 2002). Management of solid waste is a major public health and environmental issues that tertiary institution should give the attention it requires. A conducive environment makes learning to be pleasurable, it is an important factor that affects the quality of teaching and learning environment of a University.

Waste collection and evacuation represent indispensable components of urban infrastructure worldwide, crucial for maintaining public health, environmental sustainability, and societal well-being (UNEP, 2018). Generation of waste is unavoidable due to existence of life, the concern should be more on how the waste is managed through the processes of collection, transportation and disposal. The adequacy in handling of the process is what is assessed to determine the efficiency in waste management.

Solid waste management involves scientific processes that include collection, transportation and disposal of waste products in an economically feasible and environmentally viable way (Emri,Nwafor and Ernest, 2019). It is apparent that the process of waste management starts with collection of waste and it can be achieved through the designation of collection points (micro disposal sites) and the placement of dumpsters/receptacles on such designated sites for the public to drop their waste. Waste collection involves the transportation of waste from its point of generation to intermediate storage facilities or directly to final disposal sites, while evacuation encompasses the process of transporting waste away from populated areas to prevent environmental contamination and public health hazards (European Commission, 2014).

Micro disposal sites, according to Emri, Upuji and Ayambem (2022), are location/space designated by government for waste to be deposited temporally. The reason for designation of disposal sites is to promote efficient collection and evacuation of waste to promote a serene physical environment. In this research, the authority concern is the management of University of Cross River State, Calabar that have taken steps to designates locations for members of the community to dispose their waste appropriately. Waste management is one of the major problems facing city planners all over the world (Jegede and Taiwo, 2019). It is obvious that solid waste is the most common of all the wastes (liquid, gas and solid) that are abound in our environment. It does not flow, evaporate, diffuse, dissolve or be absorbed into the surrounding unlike gaseous and liquid wastes that are likely to evaporate into the atmosphere or sip into the aquifer. According to Srinivas, (2002) one of the problems facing major urban areas in developing countries at present is disposal of huge quantities of solid waste. In spite of the fact that human interface with solid waste daily, managing it efficiently has remained a difficult task. Men have explored the universe, gone to space, descended to depths of oceans, harnesses elusive atom, and developed computers but cannot take out

their own household garbage and dispose of it properly; thereby freeing their generation from the fear of being buried alive in it. The issue of removing solid waste from their immediate environment has, and is still elusive. According to Emri, Iheukwumere and Ifeanyi, (2023) the distribution of the micro disposal site in space, the availability, the appropriateness in terms of space allocated for it, their proximity to users are vital. These are key issues that are not to be overlooked if effective and efficient management of solid waste is the focus.

2.0 Statement of the research problem

The Management of the University of Cross River State, Calabar in her efforts to free the academic environment of filth, designated some disposal sites within the institution in the Calabar campus for members of the community (staff, students, business men and visitors) to dispose their waste into the dumpsters, from where the evacuation of the solid waste so deposited will take place. However, it is difficult to say if the purpose of freeing the campus of solid waste has been fully achieved through the designation of collection points. According to Antigha, Ogarekpe, and Ekesi, (2023) The University of Cross River State, Calabar municipal waste generation per capita per day is roughly 2.67kg, implying that not less than 19,491,000kg of waste is generated annually. The interest of the research is to assess waste collection and evacuation strategies adopted by the Management of the University, in ensuring that waste generated is not a threat to a conducive environment for learning, teaching and living in the Calabar campus. This will be achieved through a careful examination of the strategies employed by the Institution in the collection and disposal of solid waste, identify the designated solid waste micro disposal sites, assess the adequacy of dumpsters placed for the temporal deposition of waste, examine the challenges inherent in the strategies adopted for the management of solid waste as well as offer useful suggestion that will promote efficiency and effectiveness in the management of solid waste in Calabar campus of UNICROSS

3.0 Conceptual framework and literature review

Concept of Integrated Sustainable Waste Management (ISWM} is adopted for this research because, Integrated Sustainable Waste Management is a holistic approach to managing waste within an institution that emphasizes environmental sustainability, social responsibility, and economic viability (UNEP, 2015). It involves integrating various waste management practices to optimize resource utilization, minimize environmental impact, and promote sustainable development. One of the key principles of ISWM in an institution is the adoption of a waste hierarchy approach (EPA, 2020). The approach prioritizes waste prevention, reduction, reuse, recycling, and recovery over disposal options such as land filling or incineration. By focusing on waste minimization and resource recovery, institutions can reduce the amount of waste sent to landfill as well as conserve valuable resources.

ISWM involves the implementation of designated collection points for different types of waste, such as recyclables, organic

waste, hazardous materials, and general waste. By providing convenient access to waste collection services, communities, neighborhoods and institutions can encourage proper waste disposal and segregation at the source. ISWM promotes waste reduction and recycling programmes within the institution (DEFRA, 2018). This requires providing educational materials and outreach programmes to raise awareness about the importance of waste reduction and recycling among staff, students, and visitors. By advocating behavioural change and encouraging participation in recycling initiatives, UNICROSS can divert waste from landfill and promote a culture of sustainability.

The concept (ISWM) is concern with the adoption of innovative technologies and best practices to improve waste management efficiency. This may include investing in technologies such as smart waste management systems, advanced recycling technologies, and waste-to-energy processes. By leveraging on technology and innovation, institutions can optimize waste collection, segregation, and disposal processes to minimize environmental impact and maximize resource recovery. Engaging stakeholders (staff and students) in the waste management process will helps ensure that diverse perspectives are considered and that the resulting strategies are socially acceptable and culturally appropriates.

Integrated Sustainable Waste Management (ISWM), Health Impact Assessment (HIA), and Integrated Waste Collection and Evacuation System (IWCES) collectively form a comprehensive framework for managing waste and promoting public health within institutional settings. ISWM ensures sustainable waste practices, HIA evaluates health impacts of institutional decisions, and IWCES facilitates efficient waste collection and disposal. By integrating these concepts, institutions can effectively address environmental, social, and health considerations, leading to more sustainable and resilient operations.

Solid waste is globally described as non-liquid waste materials arising from domestics, commercial, agricultural, industrial activities, public services, (Aibor, and Olorunda, 2006). Solid wastes are generated from domestic, industrial and other human actions on planet earth and it is an inevitable useless by-product of man's actions. As man engage in the production of goods and services, consumption of goods and recreational activities, waste is generated, (Emri,Nwafor and Ernest, 2019). According to Basel convention, waste are substances or objects which are disposed or are intended to be disposed or required to be disposed of by provision of natural laws. Wastes is also seen as materials that are of prime product for which the generator has no further use in term of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose of. It is any unwanted material that is due for discarding.

Technically, waste is considered as a resource in the wrong place (Abdullahi 2011). Waste can also be defined as any substances which require being disposed of, it is any material arising from human activity which has no economic value and meant for disposal. In the process of socialization,

human being requires a healthy environment to increase their performance. A clean, quiet and comfortable environment is important components of the learning environment and should not be toyed with.

Wastes can be classified into three major groups based on their sources and composition namely; solid, liquid and Gaseous. The classes of solid waste based on the source are: municipal (domestic, institutional and commercial), agricultural, mining and mineral, radioactive and industrial wastes. Material composition of the waste stream is also used to classify wastes into such types as organic waste, paper and cardboard, plastic, glass, ceramics, textiles, metal and inert waste, it can also be categorized as paper/card, plastic film, dense plastic, textiles, miscellaneous combustibles, glass, ferrous metal, garden waste and food waste. It is pertinent to understand that the solid waste generated on the Calabar Campus of the University is the focus and it includes paper/cardboard, glass, ferrous metals, polytene, remnants of food/snacks, bottles, cans, shells, tracing papers, raps, containers etc.

According to Jegede and Taiwo, (2019) solid waste occupies a geographical space It does not decompose easily, and also does not evaporate like the gaseous waste. This means solid waste cannot just disappear from the space it occupies, even if it is to disappear through the process of decomposition, it will be only organic waste that are biodegradable that will decomposed and this will not be without effects (poignant odor, leachate, eye sour etc.). The nonbiodegradable waste will remain in the space and will to a large extent render the space unavailable for any other use. This make the issue of strategizing to collect and dispose of waste in an efficient and effective manner in University of Cross River State, Calabar Campus an inevitable and interesting investigation to carry out, as research on it has not been carried out by previous researchers on environmental issues with regards to the Institution.

4.0 Study area

The study area is the Calabar campus of the University of Cross River State. The university is a multi-campus institution, it has four campuses (Calabar, Obubra, Ogoja and Okuku). The Calabar campus is the main campus. The institution metamorphosed from College of Technology that was established in 1973 to The Polytechnic Calabar in 1987 and was later transformed to Cross River University of Technology in 2002. Presently, it is now a conventional university, after it was converted from a “technological” one, following the passage of the bill for the Change of Name and other Related Maters sponsored by Honourable Peter Odey. The governor, Benedict Ayade assented to the bill on February 15, 2021. The decision was rooted in the aspiration to evolve Cross River University of Technology into a conventional university model, thereby expanding the academic scope to encompass a broader spectrum of professional courses, rather than restricting it to technical-centric disciplines.

The Calabar campus is located approximately on Longitudes 8^{o} 19’ 33’’ E and 8^{o} 20’ 18’’ E of the Greenwich meridian and Latitudes 4^{o} 54’ 56’’ N and 4^{o} 55’ 58’’ N of the Equator. The relief is in between 3M to 20M above the Sea Level, it has a land area of 193.934 hectares (78.396 portion encroached upon)

that accommodates the Administration and seven faculties of Architecture, Biological Sciences, Communication Technology, Education, Engineering, Environmental Sciences, and Physical Sciences. The population of Calabar campus from the available records obtained from the office of the Registrar is 20,212 as at 2024, this population is made up of staff and students.

5.0 Methodology

The University of Cross River State Calabar Campus imagery was digitized directly from Calabar Mosaic. Points of interest were roads and the various disposal sites (authorized or unauthorized) within the study area. Disposal site were identified and their coordinates taken using a hand held GPS (Garmin 76CSX), recorded in Microsoft Excel and was later imported into Arc GIS 10.3 as points data, the roads were digitized as lines data. The digitized file was saved in JPEG format.

6.0 Results and discussion

Table 1. Micro Sites, Flash Points and Open Dumpsites

ID	LOCATION	EASTING	NORTHERN	TYPE_OF_SITE	QTY_OF_BIN	BIN _NUMBER
1	By Gate By Security Post	425688	545108	Micro Site	1	
2	By UNICROSS MFB	425750	545124	Micro Site	1	
3	Opp. CES	425692	545013	Micro Site	1	
4	Engr. Workshop 1	425639	544877	Micro Site	1	
5	Wood Product Engr.	425698	544897	Micro Site	1	
6	By Faculty Of Sciences	425717	544927	Micro Site	2	10 & 43
7	Behind Stores	425734	544821	Micro Site	1	
8	Soil Mech.	425524	544626	Micro Site	2	8 & 31
9	Estate & Works	425499	544543	Micro Site	1	
10	ETF	425533	544558	Flash Point	0	
11	between Prefab & ETF	425578	544544	Flash Point	0	
12	Behind Estate & Works	425484	544466	Open Dump	0	
13	Behind Estate & Works	425470	544446	Open Dump	0	

14	Behind Estate & Works	425463	544441	Open Dump	0	
15	Behind Estate & Works	425472	+544471	Open Dump	0	
16	Chemistry & Biology	425507	544451	Micro Site	1	
17	Chemistry & Biology	425546	544442	Micro Site	1	
18	Chemistry & Biology	425656	544399	Micro Site	1	
19	Faculty Of Comm. Tech	425627	544319	Micro Site	1	
20	PG Edu Hall 1	425741	544563	Micro Site	2	5 & 38
21	Open Field Prefab	425615	544663	Micro Site	1	
22	Behind Block A	425667	544649	Flash Point	0	
23	Behind Computer Sc.	425715	544688	Flash Point	0	
24	Behind Statistics	425691	544724	Flash Point	0	
25	Ent Int'l Rel. & Dev Cent	425942	544453	Micro Site	2	14 & Nil
26	Medical Centre	425956	544512	Micro Site	2	Nil
27	By Male Hostel	425928	544729	Micro Site	1	
28	Behind URP	425909	544731	Micro Site	1	
29	Old Café SUG	425842	544764	Micro Site	1	
30	Equip Dev & Maintenance	425704	544779	Micro Site	1	
31	By Statistics	425699	544768	Micro Site	1	
32	Soft Ware Engr.	425741	544760	Flash Point	0	
33	Computer Software Lab	425757	544705	Micro Site	1	
34	Behind Visual Art	426027	544631	Flash Point	0	
35	Medical Centre Road	425910	544603	Flash Point	0	
36	By Old Edu Block	425914	544662	Micro Site	1	
37	By New Café	425927	544781	Micro Site	2	7 & 3
38	By New Café	425936	544850	Micro Site	1	

	By Rhema				
39	Computer	425951	544883	Micro Site	1
	Between Female				
40	HL 1 & 2	426024	544858	Flash Point	0
41	Lib And Info Sc.	425910	544983	Micro Site	1
	Faculty Of				
42	Biological Sc.	425869	545060	Micro Site	1
43	Library	425793	544926	Flash Point	0
44	Shell Building	425866	544882	Micro Site	1
	Pavilion				
45	Northwards	426543	545276	Flash Point	0
	Pavilion				
46	Eastwards	426516	545156	Flash Point	0
	Behind Female				
47	Hostel	426025	544836	Flash Point	0
48	**Total**				**36**

Source: Author's Field research 2024

The coordinates of micro disposal (authorized) sites, flash points (illegal sites) and open dumpsites were determined using Garmin 76CSX handheld GPS receiver. The number of dumpsters placed on the micro site as well as the description of the location of each micro disposal site are contained in table 1.

Table 2: Waste Disposal site on Campus

TYPE	**Number**	**Percentage**
Authorized	30	63.83
Illegal	13	27.66
Open Dumpsite	4	8.51
Total	**47**	**100**

Source: Author's Field research 2024

Further analysis in table 2, shows that 47 sites were captured and out of this number, authorized sites are 30(63.83%), unauthorized (illegal) sites are 13(27.66%) and the open dump sites are 4(8.51%). Authorized sites are locations designated for members of the community to deposit their waste temporary for it to be evacuated later. While the illegal sites are locations where people dump waste at their convenience. The open dump are locations were waste collected within the campus are dumped in an open dumpsite.

Table 3: Bins placed at Micro Site

Bins	Number	Percentage
Single Bin	24	80
Double Bin	6	20
Total	30	100

Source: Author's Field research 2024

As contained in table 3, out of the 30 authorized waste disposal sites on campus, 24 (80%) of the sites have a single bin placed on it, while only 6 (20%) of them have double bin placed on it. These has resulted in overflow of waste in all the micro sites, because the capacity of the container is inadequate to accommodate waste generated within the service radius. Hence, there are overflows of waste at locations where single and double bins are placed at micro site. See plate 1 and 2.

Plate 1: Single Bin location by PG and Edu Hall

Plate 2: Double Bin location by Faculty of Sciences

It was discovered that very interesting places like the school library do not have a bin placed for users of the library to disposed waste generated at this location. It is more disturbing because of the prime location of the library which is accessed by both members and non-members of the community with ease, the illegal dump by the school library is an embarrassment to the Institution . See plate 3.

Plate 3: Illegal Dumpsite by E-Library

The team of seven (7) men that are saddled with the responsibility of cleaning the environment within the campus expressed their frustration with the frequency at which their duty vehicle (tractor) breakdown and

that there are cases where the vehicle will be down for an upward of two weeks.

See plate 4

Plate 4: Waste Operation vehicle

Whenever this happens, it is common to see waste overflow at designated micro disposal sites and littering within the campus, especially when the school is in session. The scope of their duty does not include the staff quarters, even though wastes are generated by residents of the staff quarters, this is incorrect and has resulted in illegal dumps at various locations (behind Visual Art Department, pavilion and behind Hostel 2. See Plate 5 & 6.

Plate 5: Waste sprawl behind visual Art Department

Plate 6: Waste Sprawl by Pavilion (Exit gate to Bakassi)

Some of the challenges militating against keeping the environment clean is that the numbers of bins placed in each of the designated points are far less than required. Placement of single bin is an issue especially, when the bin is evacuated without provision of an alternative place for people to drop their waste, it has often result in people dumping the waste on the ground.

Some locations are overgrown with bushes rendering the receptacle invisible.

See plate 7.

Plate 7: Waste bin covered with bushes by Old Cafe

There are situations where students resorted to unhealthy waste disposal practice (burning of waste). Whenever wastes are burnt the atmosphere is polluted rendering the environment unfit for academic activities . See Plate 8.

Plate 8: Burning of waste by Academic Block A

The distribution of the micro disposal site was discovered to be clustered as investigated with Nearest Neighbour Analysis is shown here:

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

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.

∑Min Distance =1880

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

$d=1880/30=62.67$

$Rn=2\times62.67\sqrt{30}/1939340$

$125.34\sqrt{0.0000154918}$

125.34×0.00393

0.493

An index 0.493 of Rn, portray a clustered distribution pattern. In the situation under study, the clustering pattern is in favour of some section of the campus, other locations such as Faculty of Communication Technology, Faculty of Architecture, Faculty of Environmental Sciences and staff quarters are left unattended. See figure 1

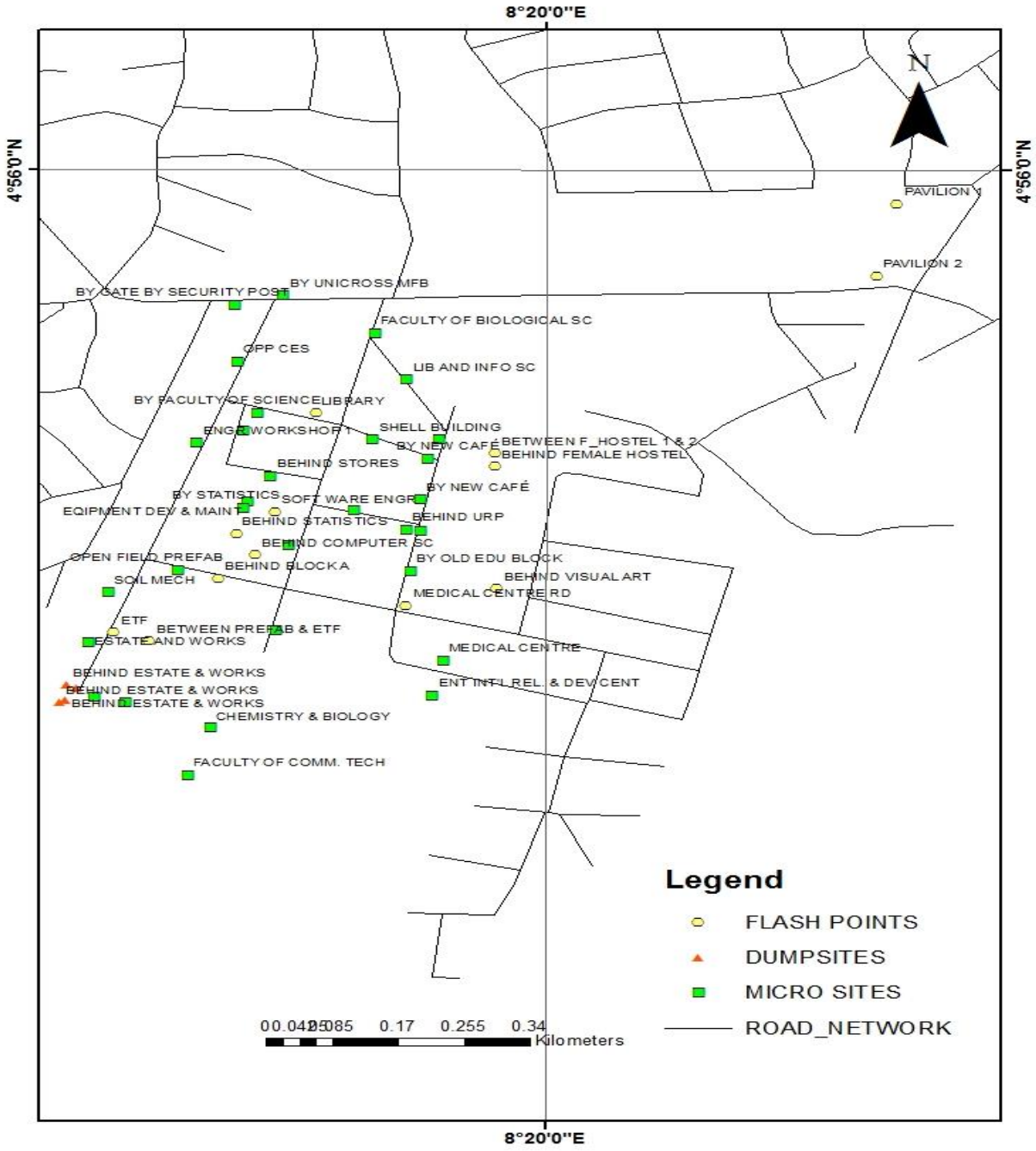

Figure 1. Location of the various waste sites

6.0 Conclusion and recommendation

Spatial distribution of solid waste micro disposal site in UNICROSS Calabar campus is shown by the Nearest Neighbour Analysis Indexes to be clustered. This is not healthy for effective waste management and probably explained the existence of flash points within the campus. There is no equity in the distribution of solid waste micro disposal sites, some areas are under serve or completely without one, areas such as faculty of Environmental Sciences, faculty of Education "New Block", Library etc. Residents of the staff quarters are not accommodated in the plan of evacuating waste from the campus. Being a community made up of staff and students, a holistic approach considering all members of the community will be the best approach towards efficient management of waste. The obvious inadequacy of bins is appalling, this reflects in over spill of waste from the bin and littered sites. In some situation the bins are even buried by the waste.

Based on the findings, it is necessary for the management of the UNICROSS to take these steps: to strategize towards a fair distribution of solid waste micro disposal sites, first by recognizing and converting the illegal/flash points to authorized solid waste micro disposal sites and the staff quarters should be included in the waste management plan. Purchase more waste receptacles and ensure a minimum of three (3) receptacles are placed on each micro disposal site. Enlightenment of the members of the community on proper way to dispose refuse into the receptacles not just to throw refuse at receptacle which most time do not get into the container and instead littered the sites. It is imperative to add that after creation of solid waste collection points, provision of waste receptacles, the actual evacuation of waste from the disposal sites timely is what is needed to free the environment of pollutants/pollution. Further research may be conducted to explore the disposal methods adopted by residents of the staff quarters in the absence of designated waste collection points.

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