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Spatial Assessment of Air Quality and Meteorological Parameters of the Surrounding Area of Active Dumpsite in Port Harcourt Metropolis, Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study analysed the distribution patterns of active dumpsites in Port Harcourt Metropolis, Rivers state, Nigeria. The study made use of locational data obtained through the use of Global Positioning System (GPS) and the data were subjected to analysis in ArcGIS environment. Nearest neighbour analysis was used to determine the significant distribution pattern. Findings showed that twenty-three active dumpsites were found in the entire Port Harcourt Metropolis and the distribution pattern of these dumpsites were significantly dispersed (Z=4225.54; p=0.0000). It is concluded that active dumpsites in Port Harcourt Metropolis are scattered all over and it is recommended that

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proper guidelines must be followed before an area can be sited to become a dumpsite. Also, there should be consideration of the environmental attributes so that the proportion of the effect can be minimized, while periodic monitoring of established dumpsites is essential to reduce the illegal siting of dumpsites.

Keywords: Active dumpsites; distribution; pattern; ArcGIS; nearest neighbor.

1. INTRODUCTION

Waste management and disposal has created great concerns of discourse in various sectors of human endeavor. This is largely because in the course of almost all human activities, all sorts of waste materials are generated in magnitudes that raise issues of where they can be effectively disposed. Hence, the urgent need for waste disposal sites or dumpsites to be provided. Man, continuously comes up with new ways of getting rid of waste locally, either by burning them or by disposing them in active dumpsites provided by the government [1]. According to Johannessen and Boyer, [2] dumpsites are widespread land disposal area, either exposed directly to the atmosphere or covered improperly with soil layer and without proper bottom liner support. The nature of most dumpsites significantly contributes to the contamination and pollution of the entire environment where they are sighted. Dumpsites have the potentials of impacting on the entire location negatively. Because dumpsites are mostly uncovered, most times it provides home for flies, insects, reptiles and other creatures that have the ability to cause diseases to the people who live near the areas where the dumpsites are located more so on the scavengers who make a living from the dumpsites.

A dumpsite is where waste and unwanted materials of waste are dumped directly to the environment or covered improperly. Due to the nature of its management or mode of disposal in most active dumpsites, it is always an eyesore. The rate of pollution of air in the area is likely to contaminate the area where the dumpsites are sited. Dumpsites can negatively affect the general situation of the atmosphere, exosphere, and hydrosphere. It is important to note that most active dumpsites are usually open, hence, they attract insects, flies, animals, reptiles that might give rise to incidences of harm to individuals who are living in the area [3]. It is unfortunate that in Nigeria, all sorts of wastes are littered or disposed indiscriminately with no proper form of management. This can be attributed to either ignorance on the part of individuals using the dumpsites irresponsibly, the government and the state authority in charge. It can also be linked to financial constraints but more significantly, the deficiency of political will on the side of the government to improve, protect and to see to it that the environment is not degraded to the extent that individuals cannot function optimally due to the open dumpsites in their environment.

According to UN-Habitat on a report on African continent, they observed that Africa is speedily developing, with cities like Lagos, Kinshasa, Cairo, Nairobi, including others moving quickly would enable them grow thrice their present level come 2050 [4]. This growth has consequences for municipal waste management and other social services required in the urbanized communities. Data from most cities in the country including Port-Harcourt, shows insufficiency in city social-services especially management of municipal solid wastes which invariably leaves the cities littered with heaps of dirt's in dumpsite and most often open dumpsites (mostly unapproved) a breeding place for flies, insects, reptiles etc. which are breeders of various life-threatening diseases. According to Mu [5], in most countries of the world, particularly in emerging countries, the use of GIS and remote sensing techniques on land suitability assessment for dumpsite is very recent. GIS is applicable on land use planning and evaluation since the 1980's.in time past before the coming and use of GIS and Remote Sensing, decisions relating not just to land suitability for citing of dumpsites, and other urban related activities were handled using the local techniques. However, today, it is unthinkable to assess a suitability of any land outside the help of GIS and remote Sensing system.

According to Siddiqui et al. [6] and Bedasa et al. [7], Geographical Information system is a digital database management system designed to handle and store large amount of data from various sources because of its efficiency in storing, management, analysis, retrieval and display geographical information based on the user-defined specifications. They added that it is a very reliable instrument in site selection studies and project works. Laurini [8] quoted by Laurini [9] and Arunkumar et al [10] were also on the side that GIS provides a common framework for

integrating and analyzing multiple datasets based on geographic location while Mu. [5], stated that the main goal of GIS is to collect raw data and transform it, through an overlay and other analytical operations, into new knowledge, that support decision-making processes.

According to Mehdi et al [11], the use of GIS in disposal sites for hazardous wastes which is now known globally as a complex and complicated problem. It added that in the pursuit to develop technologically, industries leave behind materials hazardous not just to the life of humans but also the environment. Certain raw materials used by refineries, power factories, chemical and petrochemical industries create hazardous wastes. Vesilind et al. [12]; Agamuthu, [13] and Begum et al. [14] opined that waste management practices differ from emerging countries to advanced nations, and for villages and city area, and for large volume or producers in manufacturing industries. They added that Management of residential and organized waste in metropolitan areas is usually the duty of local authorities, while management for non-hazardous commercial and waste materials from industries is the duty of the generator subject to local, national or international supervision.

The gathering, and eventual disposal of domestic and commercial waste is the key local government services, essential to maintaining a neat, healthy and disease-free environment and society. The challenge is most severe in the compactly occupied regions especially in Nigeria. The growth in resource consumption pattern has had a negative effect on the urban environment-production of waste far beyond the abilities of urban government. These problems forced the many residents of communities or locations where dumpsites are located to engage in daily or weekly sanitation or involving private sector into private coalition for the gathering of huge refuse dumps. In relation to the above statement, there are many techniques that will be put in place to overcome disposal of waste and the latest technology to engage as a tool is called Geographic Information System (GIS). Golit [15] and Salami et al. [16] believed that the handling of solid waste in our cities has posed serious challenges because to the deficiency of the right and organized waste handling values and technologies. This is coming largely from financial and technological constraints.

Hardoy et al. [17]; Myers [18]; and UN-Habitat, [19], added that the judicious handling of solid waste is now a national embarrassment mainly because of fast increase in population growth accompanied with high rate of resource consumption, and the incapability of many municipal authorities to give proper waste-disposal services within their jurisdictions. The spatial distribution analysis of environmental phenomenon has been done by different scholars both at the national and international levels. Uelmen [20] analyzed the siting wind turbine based on the parameters water depth, wind speed, distance to the coastline, shipping routes, and urban areas; and Abramovich (2012) performed an analysis to determine the location using GIS methods based on maximal distance, travel time, and network analysis, using tools and extensions such as ArcGIS Spatial Analyst and network analyst to determine the location of the fire station. Also in Nigeria, GIS has been equally been applied in locating educational facilities [21]; health issues [22]; ecotourism [23] while Omogunloye and Ayeni [24], and Kika and Ikezam [25] analysed the hotels in Lagos State and Port Harcourt respectively.

Explaining the distribution pattern of active dumpsite using geospatial tool is not in exemption because of the relevance of the mapping analysis in the recent times. Considering the previous studies, it is realized that very few of them discussed the issue of the spread and distribution pattern of active dumpsite which is the main focus of the present study. The presence of dumpsites in Port Harcourt City is a fact however, their spatial distribution pattern is not yet established in a coordinated manner to determine the risks they could pose to health and the environment where they are found. Therefore, the present study focuses at assessing the spatial analysis of active dumpsites in Port Harcourt Metropolis, Rivers State, Nigeria with a view to deploying nearest neighbour analysis to quantify the distribution pattern.

2. MATERIALS AND METHODS

The study was carried out in Port Harcourt Metropolis. Port Harcourt, the Rivers State capital is located in the Southern Nigeria and lies along the Bonny River; an eastern distributaries of the River Niger, 66km upstream from the Gulf of Guinea. Port Harcourt is located geographically between latitudes 4° 7’ 5’’ N and 4° 8’ 15’’ N and longitudes between 7° 05’ 0’’ E and 7° 45’ 0’’ E (Fig. 1). According to Igoni et al. [26], Port Harcourt, the Rivers State capital is located in the Niger delta region in the southern region of Nigeria. Its population is estimated at

about 5,198,716, while the Port Harcourt metropolis is estimated to have 1,356,000 people. Its name was crafted by Lewis Harcourt the then secretary of the English territories. The city has two seasons; the wet season and dry season as also found in other parts of the country. The rainy or wet season is associated with heavy down pour of rain and periodic surge in sea sides and city centers. The wet season starts around the month of April and stops around November whereas the dry season starts toward the end of November and ends around March. Port Harcourt is said to experience larger period of rainfall annually as likened to other states in the nation. The temperature of the region ranges from 24 degrees to 30 degrees centigrade and is majorly warm for most parts of the year. The city of Port Harcourt is hub to many conglomerates and local companies providing an array of services to the public and the country at large. Port Harcourt has the many popular markets in the nation and attracts people from the neighboring towns and all works of live to patronize them. It is located by off Aba road in Rumuokurushi community.

Binafeigha and Enwin, [27] opined that Port Harcourt was originally designed to be home to its locals has however experienced a high inflow of individuals after the sighting of hydrocarbon in the city. This incessant growth has lingered and has affected villages like Rumuola, Rumuokwuta, Rumuokwurushi, Rumueme, Woji, etc. There are sections under advancement now called the greater Port Harcourt city. From historical perspective, Ikwerres and Okrikas occupied the land of Port Harcourt city before 1913. However, the Ikwerre occupies the main land area of Obio/Akpor LGA, with three different kingdoms, namely, the Akpor, Obio and Evo Kingdoms. They majorly engage in fishing and subsistence farming. The current day urban center has witnessed developments in socio-economic activities, which thus, promotes transportation (land, air, water), exploration and oil production, crafts and tourism. Port Harcourt is now well known for commerce, industry, farming etc.

The Global Positioning System (GPS) was used to track the geographic coordinates of the active dumpsites in Port Harcourt Metropolis. The GPS points obtained for the spatial distribution of active dumpsites was used to decide the distribution of active dumpsites in ArcGIS 10.5 environment. Spatial distribution pattern (clustered or dispersed) was analyzed in ArcGIS 10.5 using average nearest neighbor from Spatial Statistics tools. This is a tool used to define the pattern of distribution of both moth and privet in each period considered for this study. The Z score and Nearest Neighbor Index (NNI) were calculated to determine the pattern of distribution. The NNI is conveyed as the ratio of the observed distance divided by the expected distance. The expected distance is the average distance between neighbors in a hypothetical random distribution. If the index is less than 1, the pattern exhibits clustering; if the index is greater than 1, the trend is toward dispersion or competition. When Z-score is less than 0, the pattern of distribution is clustered but when it is greater than 0, it is dispersed. If it is 0, the pattern is neither clustered nor dispersed; else it is random, (culled from StatTrek.com). Descriptive statistics were deployed for the study.

3. RESULTS AND DISCUSSION

The distribution of active dumpsites in Port Harcourt is displayed in Fig. 2 and the analysis of the distribution pattern is displayed in Fig. 3. It is observed that twenty three active dumpsites were found in the entire Port Harcourt Metropolis. The distribution pattern reveals that the active dumpsites was significantly dispersed ($Z=4225.54$; $p=0.0000$). This shows that they exhibited a kind of particular distance from each other; and there is less than 1% likelihood that this dispersed pattern could be the result of random chance. This may be attributed to the fact that these active dumpsites served different areas in the study area and they may maintain certain distance from each other to ascertain that they are not conglomerated at a particular place. The pattern of dumpsite distribution might have been responsible for the irregular dumpsite found everywhere. Okpara et al [28] confirmed that irregular dumpsites serve as a receptor of heterogonous materials which are known as the major threat to groundwater and other environmental resources such as air quality. This may also lead to inefficient management of municipal waste produced which might have linked to different problems to public health concerns. The spatial distributions have established the type of disease spreading across the residential areas from the dumpsites [28].

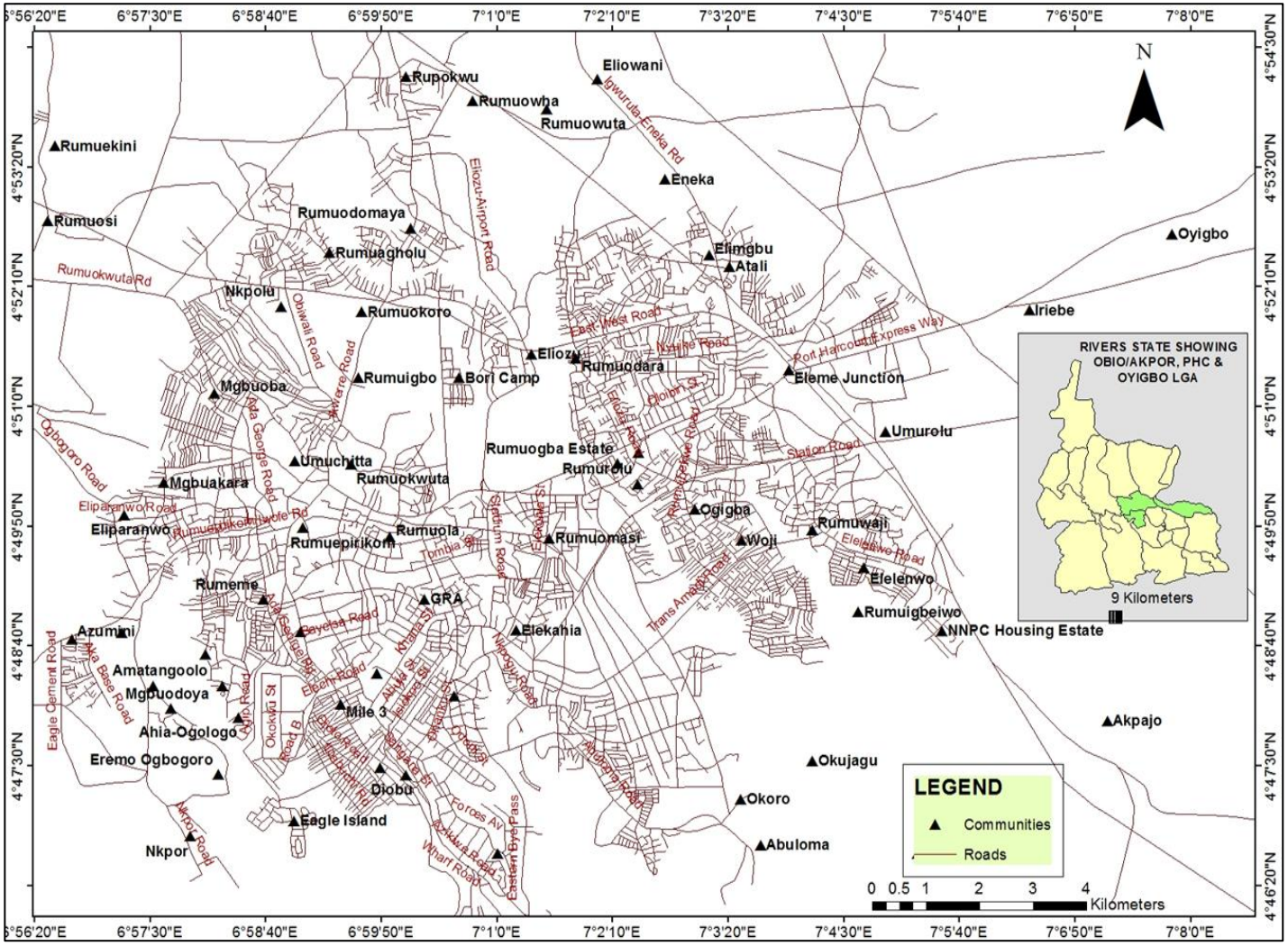

Fig. 1. Port Harcourt Metropolis

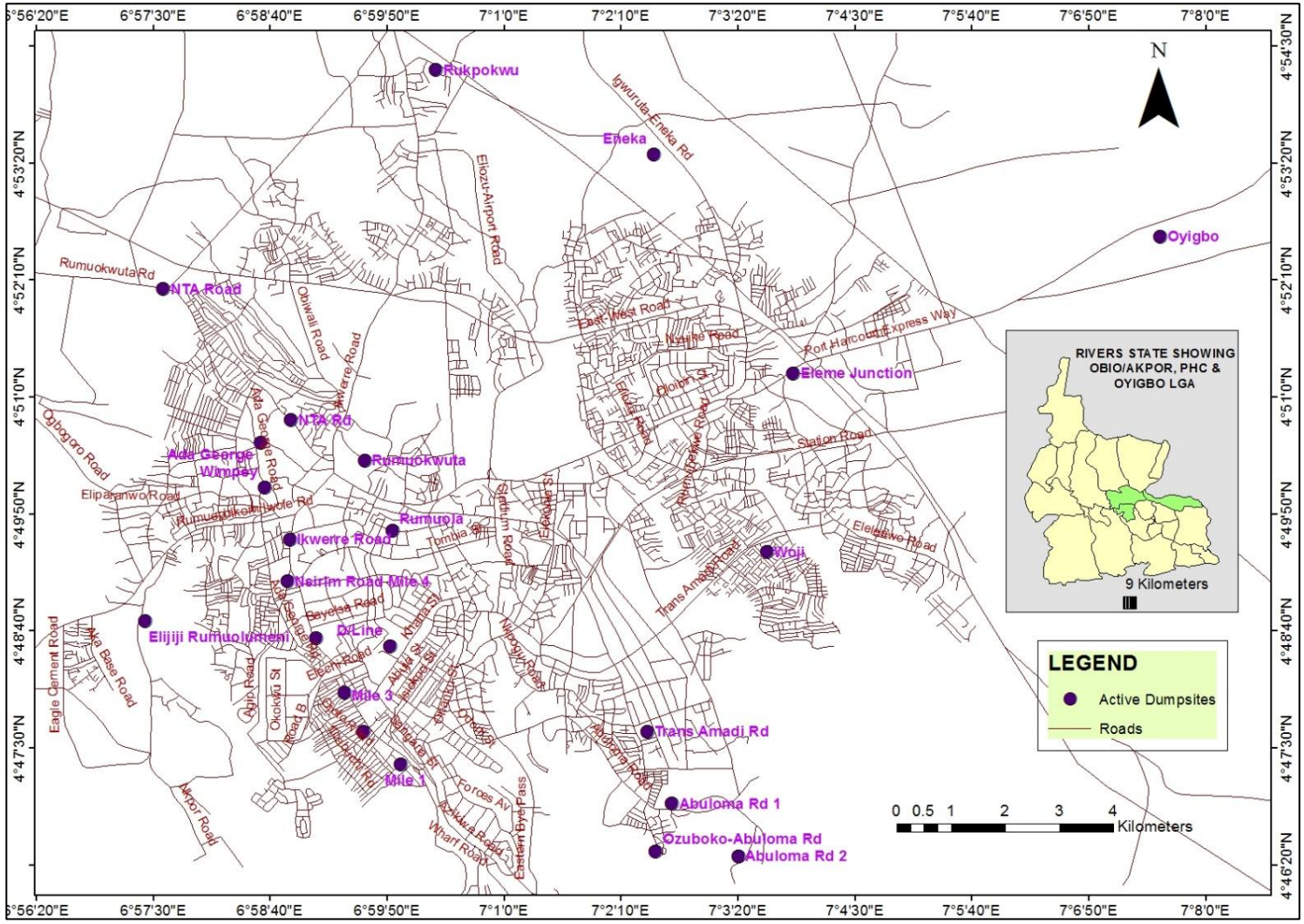

Fig. 2. Dumpsite in Port Harcourt Metropolis

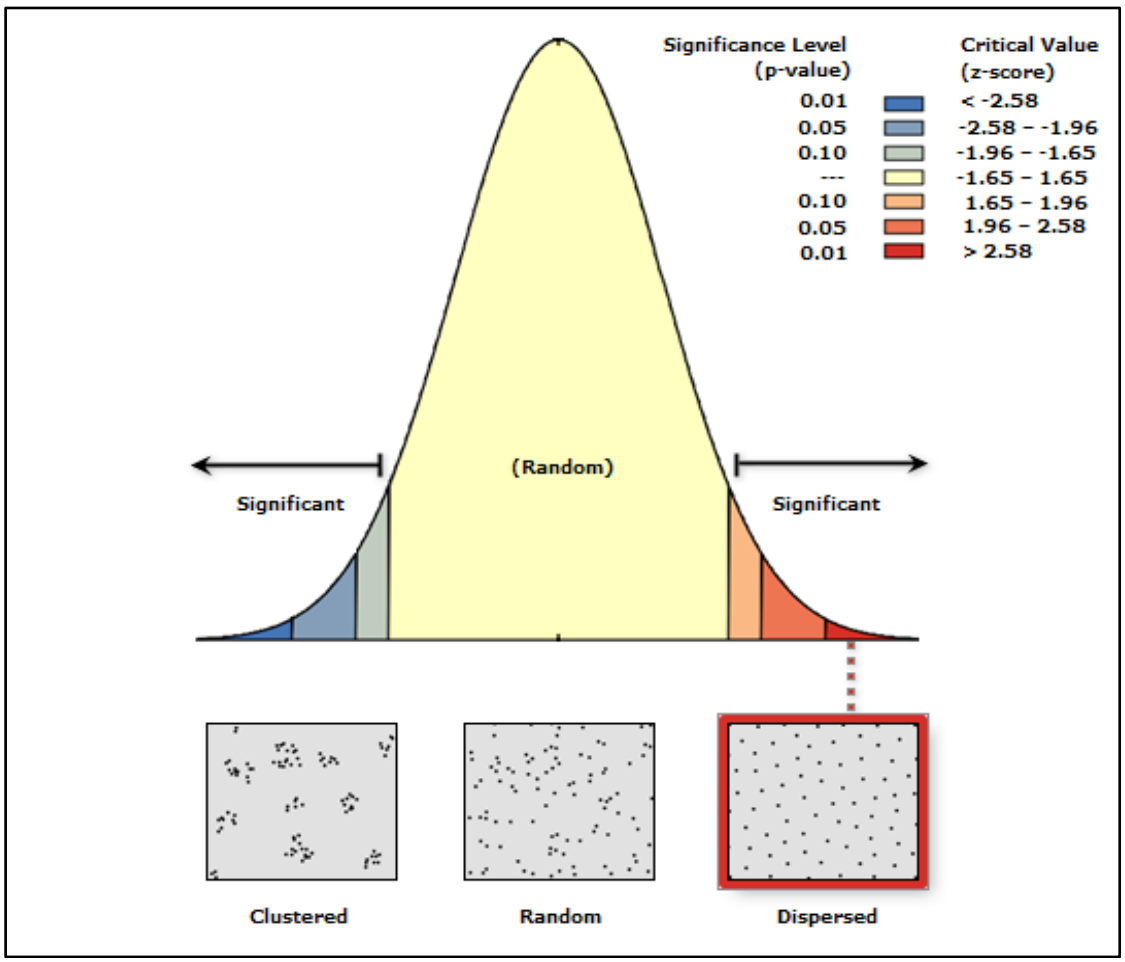

Fig. 3. Average nearest neighbor summary

Table 1. Average nearest neighbor summary

Observed Mean Distance:	1580.1449 Meters
Expected Mean Distance:	2.7659 Meters
Nearest Neighbour Ratio:	571.302585
z-score:	4225.536448
p-value:	0.000000

4. CONCLUSION AND RECOMMENDATIONS

It can be concluded that the study has revealed that active dumpsites are scattered all over in Port Harcourt Metropolis, suggesting that most of the environmental attributes like soil, water, and air may be in great danger if care is not taken. It is therefore recommended that proper guidelines must be followed before an area can be sorted to becoming a dumpsite and also there should be consideration of the environmental attributes so that the proportion of the effect can be minimized. Periodic monitoring of establishment of dumpsite is essential to reduce the illegal siting of dumpsites.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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