

## EVALUATION OF SPATIAL DISTRIBUTION OF OPEN DUMPSITES OF SOLID WASTE AND ITS PUBLIC HEALTH IMPORTANCE IN ABIA STATE

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### ABSTRACT

The indiscriminate disposal of solid waste in open dumpsites poses public health and environmental risks. This study assessed the spatial distribution of open dumpsites and their associated risks in Umuahia and Ikwuano LGA, Abia State, Nigeria, using global positioning system to capture the geographical coordinates of open dumpsites in the study area. Geographic Information System technology was used for spatial analyses, including overlay operations, nearest neighbourhood and proximity analysis to determine hotspots for disease incursion. Forty dumpsites were identified, of which 70% were illegal which suggest indiscriminate dumping of solid waste in the study area. The nearest neighbourhood ratio of 0.6896, indicates a clustering spatial distribution pattern, with a z-score of -3.755 ( $P=0.000173$ ) indicating that the observed clustering pattern is statistically significant, i.e. the points were more densely packed than expected. Additionally, the 500 to 2000meter buffer rings accentuated the clustering distribution pattern of study area. These nearby structures could be delineated as hotspots areas of high vulnerability, ideal breeding grounds to vectors including mosquitoes, cockroaches, rodents, and houseflies, which act as carriers of diseases such as malaria, typhoid fever, diarrhoea, and Lassa fever. The maps generated in this study provide relevant baseline data for Abia state and are valuable for hazard identification and for the development of intervention strategies. To address the root causes of indiscriminate dumping, legal waste disposal facilities should be expanded, particularly in high-density areas. Priority should be given to establishing these facilities within a 500-meter radius of residential zones to reduce the occurrence of illegal dumping.

**Keywords:** Open dump sites, Geographic information systems, Public health

### INTRODUCTION

Open dumpsites remain the most common method of municipal solid waste (MSW) disposal worldwide, drawing significant environmental concerns over the past decades (UNEP, 2021). This issue is particularly severe in developing countries, where waste is often disposed of indiscriminately. Unlike developed nations, many African countries, including Nigeria, rely heavily on open dumpsites due to the absence of standardized sanitary landfills (Omeiza *et al.*, 2022). Globally, more than two billion tons of municipal solid waste are generated annually (WHO, 2024). Solid waste from residential areas, often referred to as household waste, refuse,

or domestic waste, is frequently discarded in open dumps. These dumpsites, whether located on land or water, serve as disposal points for various waste materials, including solids, liquids, semi-solids, and gases (Abul, 2010). While waste generation in African cities remains relatively low compared to global standards, the lack of reliable and geographically comprehensive data complicates waste management efforts (UNEP, 2018). As a result, planning, evaluating, and monitoring waste management systems at local, national, and regional levels remain major challenges, contributing to improper waste disposal and exacerbating environmental and public health concerns (Godfrey *et al.*, 2020).

In Nigeria, solid waste management challenges are intensified by rapid population growth, urbanization, poverty, and inadequate government support (Zafar *et al.*, 2024). Indiscriminate dumping of solid waste has become a widespread practice in many cities, with waste often accumulating along roadsides, in rivers, drainages, and open spaces, posing significant risks to human health and the environment (Saidu, 2011).

Abia State, characterized by a high population density, generates substantial waste and has experienced multiple food and waterborne disease outbreaks in recent years (Dada, 2021; Ejike *et al.*, 2021). Studies have documented the indiscriminate dumping of solid waste near residential areas and public spaces, further heightening health risks (Ndukwe *et al.*, 2019; Nasir *et al.*, 2024). Therefore, the proper siting, management, and regulation of dumpsites are critical for safeguarding public and environmental health.

This research employs geographical information system (GIS-based) spatial analysis to assess the distribution of open dumpsites in Umuahia and Ikwuano LGAs. By developing a comprehensive database of dumpsite locations within these areas, the study aims to support waste management agencies in identifying their precise locations and improving waste disposal strategies. Key objectives include establishing a readily available spatial epidemiological database of open dumpsites to aid public health emergency responses and identifying the location of open dumpsites and residential areas at risk due to their proximity to these sites. This analysis is essential for understanding and mitigating the health impacts of open dumpsites in nearby communities.

## METHODOLOGY

### STUDY AREA

The study was conducted in Umuahia (5°32'N 7°29'E) and Ikwuano local government area (LGA) (5°25'59.99"N 7°34'0.01'E). Umuahia comprises two local government areas (LGAs): Umuahia North and Umuahia South, with a population of 359,230 and Ikwuano with a population of 137,993. according to the 2006 Nigerian census (NEWMAP, 2017; Cityfacts, 2019). (Figure I). The study areas are rapidly developing LGAs, owing to the presence of several federal parastatals including Micheal Okpara University of Agriculture (MOUAAU), Federal Medical Center, National Root crop Research Institute, etc.

The Abia State Environmental Sanitation and Protection Agency (ASEPA), is a government parastatal responsible to overseeing the appropriate disposal and management of waste, including solid waste and hazardous waste. The study area comprising Ikwuano, Umuahia North and South LGAs is geographically classified under Umuahia Zone by ASEPA. For this zone, ASEPA has allocated a total of 40 dumpsters: 10 for Ikwuano, 18 for Umuahia North, and 12

for Umuahia South) (<https://abiastate.gov.ng/tag/asepa-umuahia/>, Worldbank report, 2017).

### DATA ACQUISITION

Two types of data were used for this study: spatial and attribute data.

#### SPATIAL DATA

Primary data involved a handheld global positioning system (GPS) device (Trimble Juno T41/5B SurvCE Version 5.02 Software), through field survey. Table Ia, b and c shows coordinates of legal and illegal open dumpsites. For this study, illegal dumpsites are defined as locations that do not have a government assigned dumpster.

#### SECONDARY DATA

The Nigeria Administrative shapefile and the Abia state shapefile were sourced from GEO-Referenced Infrastructure and Demographic Data for Development (GRID3 Nigeria - (<https://grid3.gov.ng/state/abia>)). The Nigeria political map, Abia state political map, Abia state local government areas map, Umuahia (North and South) boundary map, Umuahia (North and South) ward map, Umuahia (North and South) legal dumpsite data, Umuahia (North and South) settlement data, Umuahia (North and South) health facilities data.

**ATTRIBUTE DATA:** The attribute data are textual data like names of road/streets, area, etc., which were obtained in the field during the survey.

### SPATIAL AND STATISTICAL ANALYSIS

Geospatial data were imported into ESRI's ArcGIS 10.7.1 (2019 edition) GIS software and was performed at the GIS laboratory, Lagos State Ministry of Science and Technology. The proximity analysis was used to evaluate the spatial relationship between dumpsites and locations (settlements, farmlands) using buffer zones. The study covers Umuahia North and South and Ikwuano LGAs, with buffers at 500m, 1000m, 1500m, and 2000m to assess risk zones. Additionally, the average nearest neighbourhood analysis (ANN) was carried out using the spatial statistical tool to determine the spatial distribution pattern of the open dumpsites. The ANN (Average Nearest Neighbour) analysis calculates the distance between each feature's centroid and the centroid of its nearest neighbour. It then determines the average of these nearest neighbour distances. If the observed average distance is smaller than that of a hypothetical random distribution, the features are considered clustered. Conversely, if the observed average distance is greater, the features are classified as dispersed. The ANN ratio is derived by dividing the observed average distance by the expected average distance, based on a hypothetical random distribution. Descriptive statistics was performed using Stata 14 (Stata Corp, College Station, TX, U.S.A.).

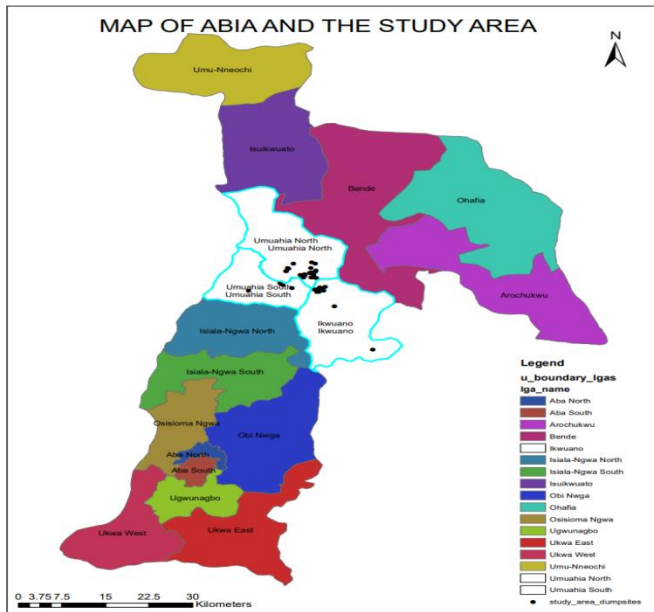


Figure 1: Map of Abia State highlighting the study area

TABLE Ia: COORDINATES OF LEGAL AND ILLEGAL DUMPSITES IN UMUAHIA NORTH LOCAL GOVERNMENT AREA (LGAS) IN ABIA STATE

Dumpsites Location	LGA	Latitude	Longitude	Altitude (feet)
Ahiaeke	UN	5°30'12.37"N	7°30'53.74"E	460
Orieugba	UN	5°32'00.50"N	7°32'09.82"E	572
Orieugba	UN	5°32'00.27"N	7°30'08.60"E	568
IBB by DW	UN	5°30'36.54"N	7°31'09.57"E	421
Dozie Way	UN	5°30'25.77"N	7°31'07.54"E	512
Dozie Way	UN	5°30'25.30"N	7°31'11.69"E	444
Lodu (Ibeku)	UN	5°30'10.09"N	7°31'03.53"E	442
Olokororo	US	5°30'08.74"N	7°29'36.64"E	518
Olokororo	US	5°28'44.85"N	7°29'59.32"E	514
Isi Court	US	5°29'12.51"N	7°29'09.63"E	577
Ubakala	US	5°28'27.88"N	7°25'58.88"E	551
Afara	UN	5°29'21.08"N	7°28'56.21"E	500
Afara	UN	5°29'29.75"N	7°28'53.54"E	463
Afara	UN	5°31'01.78"N	7°29'26.69"E	507
Afara	UN	5°31'02.25"N	7°29'27.12"E	506
Umudike Junc.	UN	5°31'24.08"N	7°29'39.91"E	501

UN: Umuahia North, US: Umuahia South \*IBB by Dozie Way

TABLE Ib: COORDINATES OF LEGAL AND ILLEGAL DUMPSITES IN UMUAHIA SOUTH LOCAL GOVERNMENT AREA (LGAS) IN ABIA STATE

Dumpsites Location	LGA	Latitude	Longitude	Altitude (feet)
Ahiaeke	UN	5°30'12.37"N	7°30'53.74"E	460
Orieugba	UN	5°32'00.50"N	7°32'09.82"E	572
Orieugba	UN	5°32'00.27"N	7°30'08.60"E	568
IBB by DW	UN	5°30'36.54"N	7°31'09.57"E	421
Dozie Way	UN	5°30'25.77"N	7°31'07.54"E	512
Dozie Way	UN	5°30'25.30"N	7°31'11.69"E	444
Lodu (Ibeku)	UN	5°30'10.09"N	7°31'03.53"E	442
Olokororo	US	5°30'08.74"N	7°29'36.64"E	518
Olokororo	US	5°28'44.85"N	7°29'59.32"E	514
Isi Court	US	5°29'12.51"N	7°29'09.63"E	577
Ubakala	US	5°28'27.88"N	7°25'58.88"E	551
Afara	UN	5°29'21.08"N	7°28'56.21"E	500
Afara	UN	5°29'29.75"N	7°28'53.54"E	463
Afara	UN	5°31'01.78"N	7°29'26.69"E	507
Afara	UN	5°31'02.25"N	7°29'27.12"E	506
Umudike Jun.	UN	5°31'24.08"N	7°29'39.91"E	501

UN: Umuahia North, US: Umuahia South \*IBB by Dozie Way

## RESULTS

### LEGAL AND ILLEGAL OPEN DUMPSITES AT UMUAHIA AND IKWUANO LGA

Illegal dumpsites are defined as locations that do not have a government assigned dumpster.

Geographical coordinates of forty legal and illegal dumpsites were obtained from this study: legal dumpsites were 30% (12/40) and illegal was 70% (28/40).

Umuahia North had the highest number (50%) of legal and illegal dumpsites followed by Ikwuano (37.5%) and Umuahia South (12.5%). See Table II.

**TABLE Ic: COORDINATES OF LEGAL AND ILLEGAL DUMPSITES IN IKWUANO LOCAL GOVERNMENT AREA (LGAS) IN ABIA STATE**

Dumpsites Location	LGA	Latitude	Longitude	Altitude (feet)
Ariam Mkt	IK	5°20'38.96"N	7°37'28.62"E	373
Ndioro Mkt	IK	5°26'22.26"N	7°33'56.36"E	475
Amaba	IK	5°28'15.48"N	7°32'30.24"E	431
Amaba	IK	5°28'16.37"N	7°32'17.34"E	454
Amaba	IK	5°28'27.37"N	7°32'55.73"E	512
Umariaga	IK	5°28'57.28"N	7°33'04.23"E	454
Umudike	IK	5°28'45.20"N	7°32'47.00"E	446
MOUUAU	IK	5°28'52.54"N	7°32'35.71"E	403
MOUUAU	IK	5°28'36.28"N	7°32'29.01"E	406
MOUUAU	IK	5°28'36.30"N	7°32'20.44"E	407
MOUUAU	IK	5°28'36.22"N	7°32'17.77"E	399
MOUUAU	IK	5°28'39.14"N	7°31'59.31"E	377

**IK: Ikwuano, MOUUAU (Inside MOUUAU)**

**TABLE II: LEGAL AND ILLEGAL DUMPSITES AT UMUAHIA AND IKWUANO LGA**

Study areas	Legal dumpsites (%)	Illegal dumpsites (%)	Total (%)
Umuhahia North	6 (30)	14 (70)	20 (50)
Umuhahia South	4 (80)	1 (20)	5 (12.5)
Ikwuano	2 (13.3)	13 (86.7)	15 (37.5)
<b>Total</b>	<b>12 (30)</b>	<b>28 (70)</b>	<b>40 (100)</b>

**NEAREST NEIGHBOUR ANALYSIS**

Distances: Near distance values ranged from 23.3m (Dozie Way) to 2172.98m (timber market), indicating variability in dumpsite density. Short distances (e.g., 23.3–110m) suggest clustering, common in urban areas like MOUUAU or Government College. Long distances (e.g., >500m) imply dispersion, typical in rural/peri-urban zones (e.g., Oriuegba, Timber Market) (Table IIIa, b and V).

**TABLE IIIa: NEABY STRUCTURE AND NEAREST NEIGHBOUR DUMPSITE AT UMUAHIA AND IKWUANO LGAS BELOW 300M**

Location of Dumpsites	Nearby Structure	Legality	*Near Distance
Dozie Way	DIS	Illegal	23.30729094*
Govt. College	Fuel Station	Legal	47.66443405*
Afara	Residential Home	Illegal	59.40609618*
Umudike	Chaise World	Legal	73.46780241*
MOUUAU	Goodluck Hostel	Illegal	83.274003*
MOUUAU	NDDC Hostel	Illegal	90.47582134*
Govt. College	Residential Home	Illegal	105.4565723*
Dozie Way	DIS	Illegal	110.140397*
Govt. College	Chalice Hotel	Illegal	137.8801543*
Ahiaeke	Fuel Station	Illegal	150.3443991*
MOUUAU	CNREM College	Illegal	160.5556455*
Ahiaeke	Glajosh Hotel	Illegal	177.4821424*
Timber Mkt	Shops	Legal	196.9271648*
MOUUAU	Staff Canteen	Illegal	207.2535714
IBB by Dw	Residential Home	Legal	216.6389521
MOUUAU	ICAN Hall	Illegal	239.6009053

**\*Structures less than 200m near dumpsites; MOUUAU: inside MOUUAU; DIS: Dozen Internation School; \*IBB by Dozie Way**

**HOTSPOTS FOR ILLEGAL DUMPSITES**

Inside MOUUAU (8 illegal sites), Ahiaeke (6 illegal sites), Amaba (3 illegal sites).

Additionally, the majority of dumpsites are located less than 200 meters from buildings—for example, just 73.5m from Chaise World Hotel—posing significant health and environmental risks (Table IIIa and b).

Figures IV and V provide visual representations of both legal and illegal dumpsites within the study area, offering a clearer understanding of their conditions and locations.

**TABLE IIIb: NEABY STRUCTURE AND NEAREST NEIGHBOUR DUMPSITE AT UMUAHIA AND IKWUANO LGAS ABOVE 300M**

Location of Dumpsites	Nearby Structure	Legality	*Near Distance
Afara	Residential Home	Legal	331.4866913
Afara	Residential Home	Illegal	333.5095545
Afara	GGB	Illegal	348.0402878
Ahiaeke	Residential Home	Illegal	364.3932941
Olokoru	Ahiku Market	Legal	393.9913275
Isi Court	Shops	Illegal	398.777006
Amaba	Residential Home	Illegal	406.6324552
Lodu (Ibeku)	Residential Home	Illegal	483.5087934
Ahiaeke	Residential Home	Illegal	506.251311
Oriuba	Residential Home	Legal	528.8426417
Ahiaeke	Residential Home	Illegal	559.5048568
Umariaga	Winner's Lodge	Illegal	592.387692
Timber Mkt	Residential Home	Illegal	646.1624264
Amaba	Lodge	Illegal	660.7752207
Amaba	Lodge	Illegal	676.8571573
Ahiaeke	Farmland	Illegal	715.5520655
Ahiaeke	Farmland	Legal	849.0863242
Umudike Junc.	ASD	Legal	1111.479647
Olokoru	School of the Blind	Legal	1170.711501
Orieugba	Shops	Legal	1989.530463
Timber Mkt	Residential Home	Illegal	2172.983399

\*GGB: Golden Guinea Breweries; ASD: Akudo Sewage Disposal

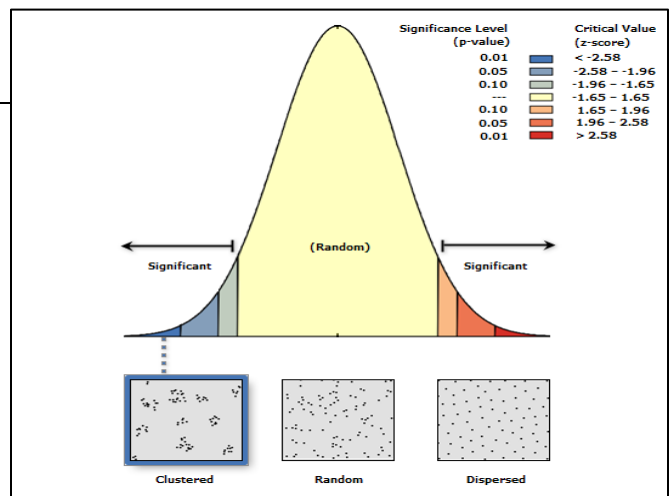
**CLUSTERED SPATIAL DISTRIBUTION PATTERN OF OPEN DUMPSITES IN STUDY AREA**

The average nearest neighbour ratio was 0.6896; a ratio less than 1 suggests a clustered spatial pattern. Specifically, the observed nearest neighbor distances between dumpsites are shorter than would be expected in a random distribution. This indicates that the average distance between nearest neighbors is approximately 69% of the expected distance, further supporting the presence of clustering (Table IV).

**TABLE IV: AVERAGE NEAREST NEIGHBOUR SUMMARY OF DUMPSITES AT UMUAHIA AND IKWUANO LGAS**

Variable	Description
Observed Mean Distance	949.1190m
Expected Mean Distance	1376.3445m
Nearest Neighbour Ratio	0.689594
z-score	-3.755699
p-value	0.000173
Input Feature Class	Dumpsites
Distance Method	Euclidean
Study Area	303091855.4
Level of significance	0.05

The observed mean distance between nearest neighbour dumpsites was 949.12 meters, compared to an expected mean distance of 1376 meters under a random distribution. The observed distance is 427m shorter, this considerable difference reinforces the conclusion that dumpsites in the study area are not randomly distributed but tend to group together in specific areas. The z-score measures the standard deviation difference between observed and expected distances. A negative z-score indicates clustering, and the magnitude -3.76 suggest that pattern is statistically significant. as values further from zero signify a lower likelihood that the observed pattern is due to random chance. The p-value of 0.000173, which is well below the 0.01 threshold, indicates that the clustering pattern is statistically significant, with less than a 0.02% probability that this result occurred by chance. See Figures II, III, and Table IIIa, b, IV and V for visual and tabular representation of the results.



**Figure II: Average nearest Neighbour Summary showing a clustered spatial distribution pattern of open dumpsites in Umuahia and Ikwuano LGAs.**

**TABLE V: LEGAL AND ILLEGAL DUMPSITES CLOSE TO STRUCTURES AT UMUAHIA AND IKWUANO LGA**

Nearby structures close to dumpsites	No. of dumpsite close to the structures
Ahia Ukwu Market	1
Chalice Hotel	2
CNREM College	3
International School	3
Fuel Station	2
Glajosh Hotel	1
Golden Guinea Breweries	3
Goodluck Hostel	1
Market Square supermarket	2
NDDC Hostel	2
Residential Home	10
School of the Blind	1
Shops	4
Staff Canteen	1
Lodge	1
<b>Total</b>	<b>37</b>

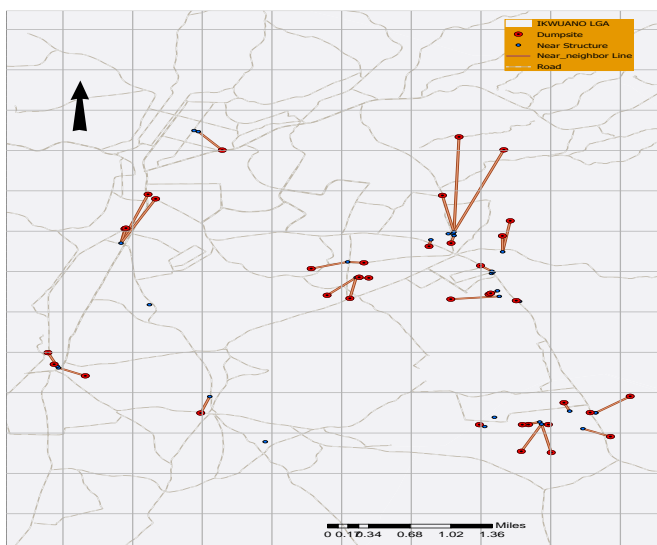
**PROXIMITY ANALYSIS**

Urban clustering at 500m buffer (high risk zones), shows high density of illegal dumpsites. Clusters near settlements: inside MOUAU - six illegal sites within 500m of hostels/lecture halls, at Government College – three illegal sites near fuel stations.

At Timber market, one legal dumpsite was observed at 500m but illegal ones at 200m. Other cluster zones include, fuel stations, Ariam and Ndioro markets. Overall, 76% (28/37) of illegal dumpsites fall within 500m of residential areas, violating the guidelines for waste proximity (EC, 2020) (Figure VI).

At 1000m buffer (Moderate Risk Zone), shows expanded impact of illegal dumpsites i.e. 92% (34/37) encroach on farmlands and residences. Schools at Dozie way and fuel stations at around Government College remain at risk.

At Ahiaeke, five illegal dumpsites within 1000m of farmland (Figure VII). At 1500m buffer (Low Risk Zone), rural dispersion observed showing legal dumpsites around Olokoro School of the Blind, but illegal dumpsites persist near farmlands. (Figure VIII). At 1500m buffer (Low Risk Zone), shows minimal overlap, suggesting better planning at larger scales. (Figure IX).



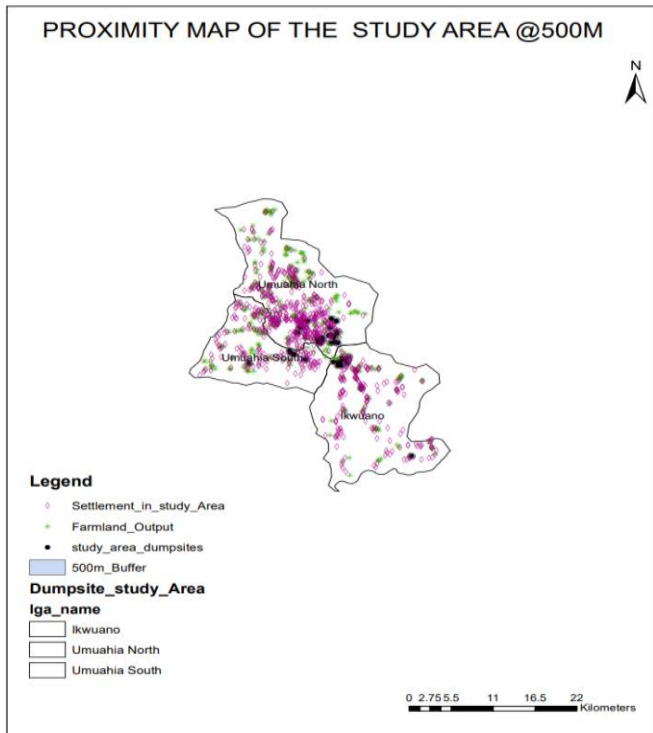
**Figure III: Nearest Neighbourhood analysis of open dumpsites in Ikwuano LGA. The lines are connecting each dumpsite to its nearest neighbour.**



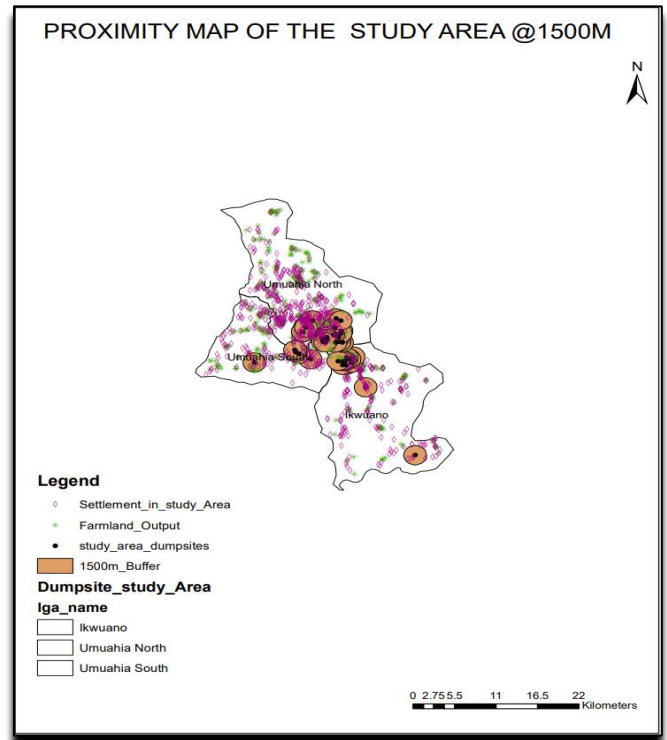
**Figure IV: A legal open dumpsite at Umuahia town**



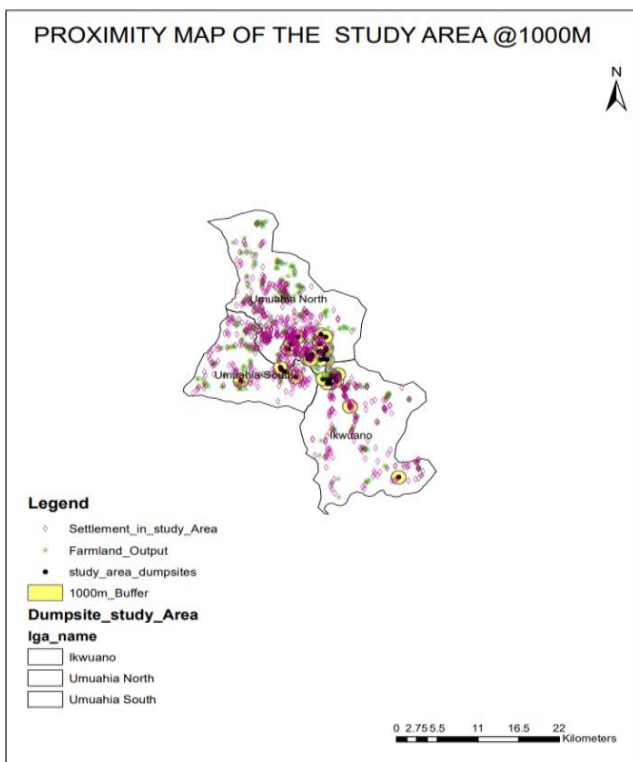
**Figure V: an illegal open dumpsite at Ikwuano LGA**



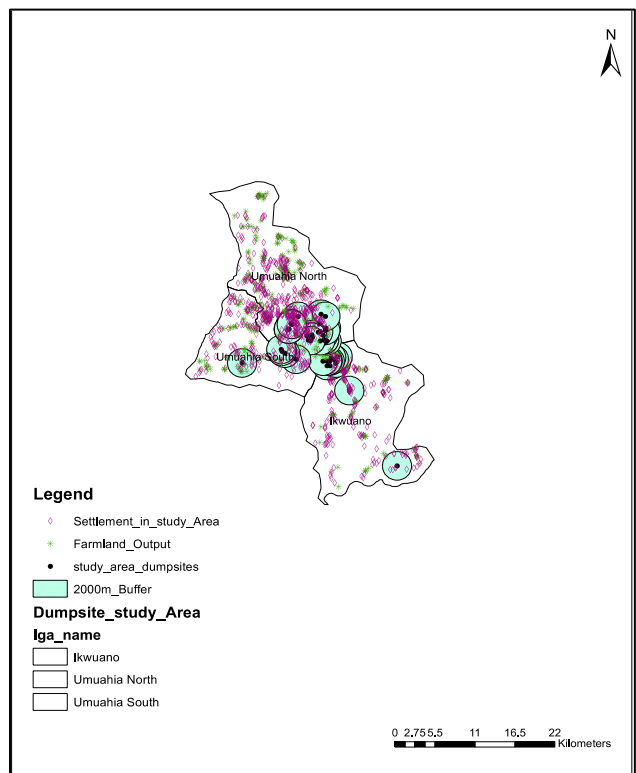
**Figure VI: 500m Buffer (Highest Risk Zone) to determine the spatial relationship between open dumpsites and farmlands and settlements in Umuahia and Ikwuano LGAs**



**Figure VIII: 1500m Buffer (Low-Moderate Risk) to determine the spatial relationship between open dumpsites and farmlands and settlements in Umuahia and Ikwuano LGAs**



**Figure VII: 1000m Buffer (Moderate Risk Zone) to determine the spatial relationship between open dumpsites and farmlands and settlements in Umuahia and Ikwuano LGAs**



**Figure IX: 2000m Buffer (Lowest Risk) to determine the spatial relationship between open dumpsites and farmlands and settlements in Umuahia and Ikwuano LGAs**

## DISCUSSION

Part of the objective of this study includes identifying the locations of open dumpsites and nearby residential areas at risk due to their proximity. This is because indiscriminate open dumpsites pose significant health, environmental, and economic challenges (WHO, 2024). In developing countries, the management of solid waste is worsened by unsustainable practices that increase the environmental contamination and the spread of diseases. In particular, the open dumping in uncontrolled sites, is prevalent in Nigeria (Ichipi, and Senekane 2023). Similarly, this study shows that illegal open dumpsite 70% (28/40) was prevalent, which suggest that indiscriminate dumping of solid waste could be common practice in the study area. Benedineet *al.*, (2011) stated that open and illegal dumpsites are indiscriminately sited, irrespective of the presence of infrastructural facilities available in those locations. This makes open dumping of waste the most prevailing form of waste disposal in developing countries, especially Nigeria (Saidu, 2011). This possibly stemming from attitudinal problem from the public (Saidu, 2011), particularly in developing countries, where people prefer disposal sites within the shortest distance, as well as institutional constraints in the Nigerian government, which lacks a structured framework to address this issue (Saidu, 2011).

Additionally, as these illegal open waste dumpsites are not regularly removed and lack proper management infrastructure, the smaller dumpsites are likely to expand, while larger ones will continue to grow. As their size increases, managing them becomes more difficult, significantly raising the risk of disease exposure for nearby residents, because these sites become ideal breeding grounds to vector borne diseases such as Lassa fever. Interestingly, this is reflected in the nearest neighbour analysis that indicated a high density of eight illegal dumpsites inside MOUAU (Ikwuano LGA), six illegal sites at Ahiaeke (Umuahia North LGA) and three at Amaba (Ikwuano LGA). This suggests an urban area with high clustering of illegal dumpsites near infrastructure (e.g., schools, hostels), reflecting poor waste management enforcement. Rural areas like Umuahia South are characterized with dispersed legal dumpsites, possibly due to lower population density and better planning.

Studies have demonstrated the inextricable link between the environment and the health impacts of solid waste disposal on people living in proximity of wastes dumpsites (Ndukwe *et al.*, 2019; Njoku *et al.*, 2019; Kwun *et al.*, 2021; Siddiqua *et al.*, 2022; Shammi *et al.*, 2023). Accordingly, the illegal sites near residential zones including hostels and hotels (e.g., 406m to a home in Amaba - Table IIIb) increase contamination risks (groundwater, air quality), posing health/environmental risks such as direct exposure to toxins. Furthermore, the observed average nearest neighbour ratio of 0.6896, which indicates a

clustering spatial distribution pattern of nearby structures, coupled with the strength of the clustering pattern ( $z$  score = -3.755;  $P$ -value = 0.000173), demonstrates that the clustering is either deliberate or influenced by external factors (e.g., lack of enforcement, population density). This underscores the potential for disease incursion into homes and congregational places such schools and hostels in close proximity to open dumpsites. These nearby structures as shown in Tables III and V, could be delineated as hotspots areas of high vulnerability i.e., optimal environments for the proliferations of vector borne diseases. In these nearby structures, vectors including mosquitoes, cockroaches, rodents, and houseflies, could act as hosts or carriers of diseases such as malaria, typhoid fever, diarrhoea, and Lassa fever (Rushton, 2003; Ferronato *et al.*, 2017; Nasir *et al.*, 2024).

With a minimum 3 km protection zone required for disease prevention and control (EC, 2020), buffer zones of 500m, 1000m, 1500m, and 2000m were created around open dumpsites. The results revealed a spatial clustering of structures within these buffer zones, including residences, markets, schools, hotels, and lodges. This underscores the public health risks associated with the indiscriminate siting of open dumpsites and reinforces the previously established clustering pattern of spatial distribution. Notably, the illegal dumping at Ahiaeke farmland (five sites within 1000m) poses a serious threat to food safety. This contamination can lead to heavy metal poisoning and the spread of pathogens in agricultural produce.

The public health implications of the high clustering of illegal dumpsites near infrastructures are enormous. Studies have demonstrated that vectors such as cockroaches can travel 50 to 100 meters between waste sites and homes (Vazirianzadeh *et al.*, 2014). Muscoid flies (*Musca domestica*) are documented mechanical vectors of gastrointestinal pathogens, capable of a flight range of 5 -7 Km from their breeding sources (Nazni *et al.*, 2005). Their movement between human and animal food, organic waste, manure, and refuse makes them effective carriers of contamination, linking clean and polluted environments (Sparagano *et al.*, 2018). Additionally, houseflies have been identified as potential mechanical vectors for the AI H5N1 virus, contributing to the spread of Avian Influenza, a zoonotic priority disease (Waranatana *et al.*, 2011). Similarly, rats (*Rattus rattus*) can travel 150–500 meters in search of food within dumpsites and nearby settlements, transmitting diseases such as Lassa fever through urine (FAO, 1994).

In conclusion, the Nearest Neighbour Analysis reveals significant clustering of illegal dumpsites in urbanized zones, highlighting urgent need for improved waste management policies. Legal dumpsites demonstrate better spatial planning but require expansion to underserved areas. GIS tools like ArcGIS 10.7.1 (2019 edition) effectively identify priority

zones for intervention. The clustering of structures around dumpsites and the proximity analysis, which reveals violations of the 3 km protection zone, heighten the risks of zoonotic, environmental, and foodborne disease transmission, posing significant public health challenges. Unfortunately, similar spatial clustering patterns are likely present in other LGAs within Abia State. The maps produced in this study serve as valuable baseline data for guiding epidemiological investigations, hazard identification, risk assessment, and the development of intervention strategies. These findings provide a framework for addressing waste management challenges and promoting environmental sustainability in both urban and rural contexts.

## RECOMENDATIONS

The government should prioritize the cleanup of clustered illegal dumpsites—such as those near MOUAU and Ahiaeke—and implement stricter enforcement measures, including penalties for violations. Zoning regulations should be re-evaluated to prohibit the establishment of dumpsites near sensitive structures, including schools, fuel stations, and hostels.

To address the root causes of indiscriminate dumping, legal waste disposal facilities should be expanded, particularly in high-density areas. Priority should be given to establishing these facilities within a 500-meter radius of residential zones to reduce the occurrence of ad-hoc dumping.

Furthermore, long-term waste management strategies should incorporate buffer-based zoning policies aligned with spatial planning principles. This includes enforcing a minimum buffer zone of 1,000 meters between dumpsites and settlements or farmlands to minimize public health risks and environmental contamination.

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