AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766 Volume 53, October- 2026

ASSESSMENT OF THE EFFECT OF WASTE DUMP SITES ON AMBIENT AIR QUALITY IN OBIO-AKPOR LOCAL GOVERNMENT AREA, RIVERS STATE, NIGERIA

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ABSTRACT

Rapid urbanization and rising waste generation have intensified environmental challenges associated with inadequate municipal solid waste management in Nigerian cities. This study analyses the influence of selected waste dumpsites on ambient air quality in Obio-Akpor Local Government Area, Rivers State, Nigeria. A cross-sectional environment field assessment was conducted to evaluate ambient air quality around selected waste dumpsites in Obio Akpor comprising of a control location, Eneka and Obirikwere dumpsites. Some of the ambient air-quality parameters, including PM2.5, PM10, CO, CO2, SO2, NO2, CH4, NOx, NH3, H2S and O¬3 were measured using a battery-operated monitoring instrument. Also, 394 questionnaires were sent out, 353 completed responses were analysed. Descriptive statistics were used to summarise the data, while comparative analysis was conducted to assess variations in air-quality parameters among the sampling locations. The result shows higher concentration of several pollutants at the dumpsite locations compared to the locations. PM10 at Eneka had (0.150±0.040 ppm), followed by Obirikwere (0.090±0.010 ppm), while the control location (0.067 ±0.015 ppm). PM2.5 concentration at Eneka (0.077 ± 0.015), Obirikwere (0.070 ± 0.010) and control location (0.0300 ± 0.010). Carbon monoxide concentrations increased at the dumpsite locations compared with the control point. The control site indicates a mean CO concentration of 2.833±0.737 ppm, while Eneke (5.167±0.115 ppm) and Obirikwere (6.800±1.058 ppm). Similarly, CO2 at control point had 151.00±11.00 ppm compared to Eneka with 194.67±18.58 ppm and Obirikwere with 201.67±43.15. Nitrogen dioxide at the control location recording 0.079±0.002 ppm compared with Eneke and Obirikwere recording 0.143±0.345 and 0.091±0.009 respectively. SO2 at Eneke (0.010±0.010) and Obirikwere had (0.053±0.006). Methane was found only at the waste dump locations, with Eneka (0.093 ± 0.100) and Obirikwere (0.103 ± 0.005). The findings showed the difference in ambient air quality with

KEYWORDS

Pollutants, Ambient Air Quality, Waste Dumpsites; Particulate matter, Municipal Solid Waste; Obio-Akpor, Nigeria.

several pollutants showing higher concentration around the dumpsites. The study recommends better methods of collecting waste and controlled disposal practices.

Introduction

Rapid urbanisation has a significant effect on ecosystem health and sustainability. While it promotes economic growth and social development, it also poses significant risks to the natural environment and social institutions (Voukkali et al., 2023). Hoornweg and Bhada-Tata (2012) stated that rapid urbanization causes a massive surge in municipal solid waste (MSW) generation globally, with the amounts growing even faster than the rate of urban population growth. The United Nations anticipates a 73% rise in yearly solid waste production by 2050, attributed to population expansion and urban development, leading to an estimated global output of 3.88 billion tonnes. 47% of this collection will be disposed of in landfills, 31% recycled, and 22% burnt incinerated (Voukkali et al., 2023). Africa is no different. Sub-Saharan Africa's annual waste volume rose from 81 million tonnes in 2012 to 174 million tonnes in 2016, with a projected increase to 269 million tonnes by 2030, corresponding with the region's strong population expansion since the 1980s (Delacroix & Owoo, 2023; Adedara et al., 2023). Africa collects only 55% of its yearly municipal solid waste, whereas sub-Saharan Africa has an even diminished rate of 44%. Over 90% of waste is disposed to open dumps and unregulated landfills, with 19 of the worldwide 50 largest dumping grounds situated in the region (Kang et al., 2023).

Nigeria faces similar challenges due to rapid urban expansion leading to increase in population density and limited waste management capacity. Rapid urbanization and population growth in Nigeria have led to a substantial increase in solid waste generation, creating significant pressure on local governments responsible for waste management (Oribhabor, 2026). Major urban cities, particularly Lagos, report higher generation rates of 0.72-1.02 kg/capita/day. Regions with significant waste production include high-density areas experiencing rapid commercial growth, such as Lagos, Kano, the Federal Capital Territory (Abuja), Rivers, and Oyo placing significant pressure on local waste management authorities (Maiha & Yusuf, 2025). This became an issue because in many Nigerian cities, inadequate collection systems, insufficient disposal infrastructure, and poor waste handling practices have resulted in the widespread usage of open dumpsites as the dominant method of waste disposal (Chuzeke, 2026). These sites often operate without effective emission control mechanisms, engineered containment systems and waste segregation practices.

Waste composition analysis indicate that organic matter constitutes 50% to 60% od the waste stream, predominantly from food and putrescible waste. Plastics and packaging account for 10% to 15% with an increasing trend linked to consumer habits. Other materials include paper (5-10%), metals (5%), and glass (2-5%) (Adekunle et al., 2025). The rise of uncontrolled dumpsites, driven by consumer patterns, urban development, and industrial growth extend beyond aesthetic degradation (Maiha & Yusuf, 2025). Open dumpsites are recognised sources of atmospheric pollutants because of uncontrolled combustion and waste decomposition releasing a variety of harmful substances into the surrounding environment (Chuzeke, 2026). Anaerobic decomposition of organic waste produces landfill gases, including methane (CH_4) and carbon dioxide (CO_2), while open burning of municipal waste emits carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2), volatile organic

compounds, particulate matter ($PM_{2.5}$ and PM_{10}) and other hazardous pollutants (Ayodele et al., 2025). Studies carried out by Okafor et al. (2022) conducted around Nigeria dumpsites have indicated the presence of gaseous pollutants and particular matter related with waste disposal activities, emphasizing the contribution of dumpsites to declining ambient air quality.

The effect of particulate matter released from dumpsites is of particular concern because fine particles such as $PM_{2.5}$ can affect the respiratory system by penetrating deeply, while PM_{10} can add to respiratory irritation and reduced air quality (Ayodele et al., 2025). Additionally, pollutants generated from waste combustion may contain dangerous toxic compounds such as persistent organic pollutants and other hazardous substances capable of affecting ecological systems and human health. The substances contribute significantly to global climate change as waste adds to the gases that thicken the ozone layer and pollutes ambient air (Abubakar et al., 2022). This, in turn, affects the weather and melts the ice caps, raising the sea level and negatively damaging natural habitats demonstrating than uncontrolled waste disposal affects communities.

Open dumping occurs on vacant lots and drainage paths, with less than 30% of the 32 million tonnes of solid waste generated annually being collected in River State and the Niger Delta (Favour Onamrewho & Okiemute, 2026). This poor waste disposal practices contribute to broader environmental and public health issues. Waste accumulation produces unpleasant odours, contaminates surrounding water and land resources, encourages the proliferation of disease vectors and educe the overall environmental quality of affected communities. However, while several studies have examined the challenges of waste management in Nigeria, fewer focused specifically on the influence of waste dumpsites on ambient air quality, particularly within rapidly developing urban areas of Rivers State. This necessitates the need for location-specific assessment of air pollutants within waste disposal sites comparing it with areas that experience minimal direct dumpsite influence. The conceptual pathway of dumpsite influence on air quality is shown in Figure 1

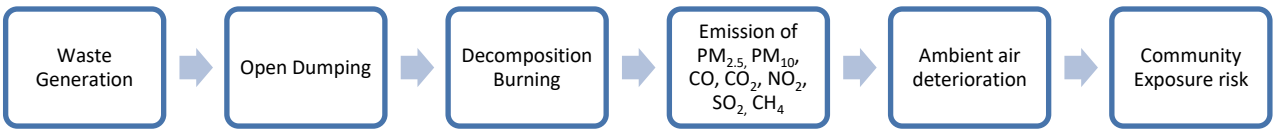


Figure 1: Conceptual Pathway of dumpsite Influence on air quality

Obio-Akpor Local Government Area of Rivers State is a rapidly growing urban area with increasing population density, commercial activities and waste generation leading to the establishment and continued operation of waste disposal sites. A 2020 study showed lead levels near these sites can be 12 times above safe limits, threatening agriculture and safety, particularly for the 35% of the population relying on farming (Chuzeke, 2026). The presence of these uncontrolled dumpsites within residential and urban environments raises concerns due to their contribution to local air pollution levels and potential implications to community health. Hence, assessing ambient air quality around selected dumpsites is pivotal for comprehending pollution patterns and informing appropriate waste-management and pollution-control strategies. Therefore, this study analyses the influence of selected

waste dumpsites on ambient air quality in Obio-Akpor Local Government Area, Rivers State, Nigeria. Specifically, the study evaluated selected physicochemical air-quality parameters at dumpsite and control locations and compared the concentrations of measured pollutants across the sampling locations.

2. Materials and Methods

2.1 Study Design

A cross-sectional environment field assessment was conducted to evaluate ambient air quality around selected waste dumpsites in Obio Akpor. The study involved direct measurement of selected air-quality parameters at two active waste disposal locations and a control location with minimal direct dumpsite influence. The study involved direct measurement of selected air-quality parameters at two active disposal locations and a control location with minimal direct dumpsite influence. Also, a structured questionnaire was administered to residents living within the study area to obtain information on their perceptions of health concerns and environmental conditions concerns associated with proximity to waste disposal sites. Air quality was tested using a rechargeable battery-operated monitoring instrument. The study assessed selected particles and gaseous pollutants, including $PM_{2.5}$, PM_{10}, CO, CO_2, SO_2, NO_2, CH_4, NOx, NH_3, H_2S and O_3. The measurement of air quality parameters around selected dumpsites with community-based data collection to assess variations in ambient air quality associated with the sampled waste disposal environments.

2.2 Description of the Study Area

The study was conducted in Obio-Akpor Local Government Area of Rivers State, Nigeria. Obio/Akpor Local Government Area, part of the Metropolitan region of Port Harcourt, Nigeria, has its headquarters in Rumuodumaya Town. It is located in the Niger Delta of Rivers State and is bordered by Port Harcourt City, Oyigbo, Eleme, Etche, Ikwerre, and Emohua. Covering 260 km² with a population of 464,789 according to the 2006 Census, it is primarily lowland with an elevation average below 30 meters with a postal code of 500102. It has experienced considerable urban development and population growth, accompanied by increased residential, commercial and industrial activities and corresponding increases in waste generation.

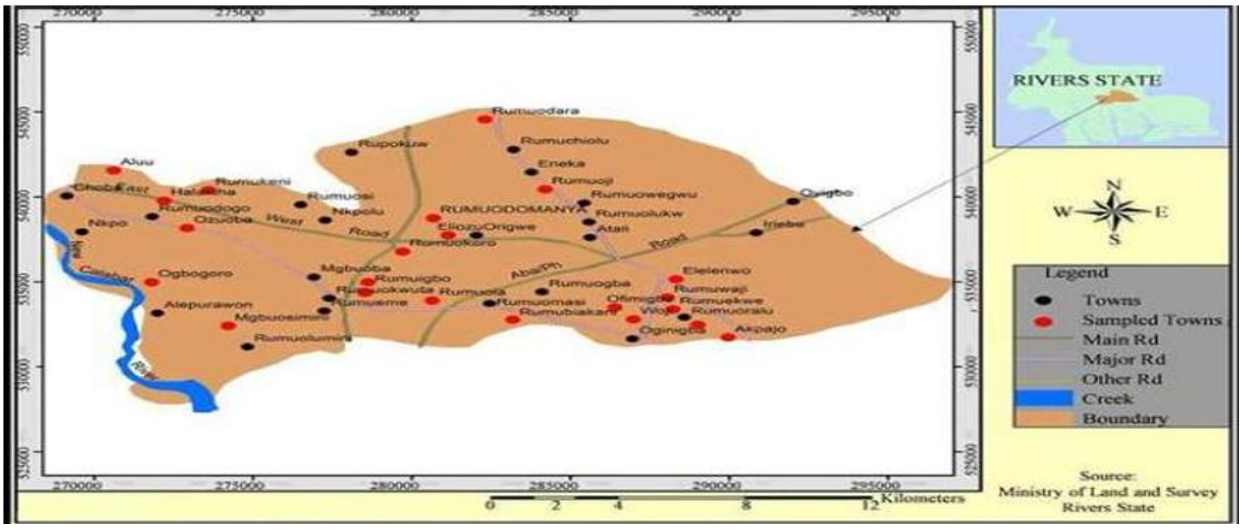


Figure 2: Map of Obio/Akpor Local Government Area

2.3 Sampling Location and Sampling Procedure

This study focuses on three sampling waste dumpsite establishments in Obio Akpor Local Government Area. These comprises of one control location with minimal direct influence from waste disposal activities and two active municipal disposal locations at Eneka and Obirikwere. Table 1 below gives the sampling location and characteristics.

Table 1: Sampling Locations and Characteristics

Location	Description	Category
Control Point	Area with minimal direct dumpsite influence	Control
Eneka	Active municipal waste disposal location	Dumpsite
Obirikwere	Active municipal waste disposal location	Dumpsite

In Table 1, control location was selected to facilitate a basis for comparison with areas directly influenced by waste disposal activities. Eneka and Obirikwere were selected because of the presence of active waste disposal activities and their proximity to surrounding residential areas.

Table 2: Coordinates of the Sampled Location

Stations	Longitude	Latitude
Location 1: Control Point	E6 57’ 49.38	N4 54’ 4.03
Location 2: Eneka Link Road	E6 57’ 48.44	N4 53’ 1.97
Location 3: Obirikwere	E7 0’ 48.03	N4 54’ 22.84

Table 2 indicates that coordinates for three sampled locations are provided: Control Point (Longitude: E6 57’ 49.38, Latitude: N4 54’ 4.03), Eneka Link Road (Longitude: E6 57’ 48.44, Latitude: N4 53’ 1.97), and Obirikwere (Longitude: E7 0’ 48.03, Latitude: N4 54’ 22.84). The selected locations were assessed based on proximity to waste accumulation areas and their potential exposure of surrounding communities to emissions generated from waste decomposition and disposal handling activities.

2.4 Data Collection

Ambient air-quality data were collected using purposive sampling locations using a rechargeable battery-operated air-quality monitoring instrument. Measurement was carried out at the selected sampling locations using a rechargeable battery-operated air-quality monitoring instrument. Measurements were taken for selected various air quality parameters, including temperature, relative humidity, and pollutants like $PM_{2.5}$, PM_{10}, CO, CO_2, SO_2, NO_2, H_2S, NH_3, O_3, CH_4 and NOx. Additionally, well-structured questionnaires were used to gather data on waste dumpsite impacts on

environmental sustainability and human health, featuring demographic sections and utilizing a Five-point Likert Scale for responses. Meterological factors affecting pollutant dispersion were also taken into account during the assessment.

2.5 Questionnaire Administration

A structured questionnaire was distributed to residents in the study area to gather data on perceived environmental conditions and health effects linked to nearby dumpsites. Out of 394 questionnaires sent out, 353 completed responses were analysed. The questionnaire contained sections covering demographic characteristics of respondents, awareness of dumpsite activities, observed environmental conditions, and perceived health concerns associated with living near waste disposal sites. Response was obtained using five-point Likert scale where applicable.

2.6 Quality Assurance and Control

Standard procedure was followed during field sampling to ensure reliability and consistency of collected data. Sampling locations were carefully selected with measurements conducted using appropriate monitoring instruments, and data collection procedures were standardized across locations.

2.7 Data Analysis

Data was analysed using Statistical Package for the Social Sciences (SPSS), Version 23. Descriptive statistics were used to summarized the data. The mean concentrations and standard deviations of measured parameters were calculated for each sampling location. Comparative analysis was conducted to examine variations in pollutant concentrations between the control location, Eneka dumpsite and Obirikwere dumpsite.

2.8 Ethical Considerations

Participation in the survey was voluntary and respondents were informed about the purpose of the study, and collected information was treated confidentially**.** The study was conducted for academic and environmental assessment purposes.

3. Results

3.1 Ambient Air Quality Around Selected Waste Dumpsites

The ambient air quality assessment was conducted across three sampling locations comprising the control point, Eneka dumpsite and Obirikwere dumpsite. The measured parameters included methane (CH_4) and carbon dioxide (CO_2), carbon monoxide (CO), nitrogen dioxides (NO_2), sulphur dioxide (SO_2), particulate matter ($PM_{2.5}$ and PM_{10}), hydrogen sulphide (H_2S), ammonia (NH_3), and ozone (O_3). The results shown differences in air quality metrics between the control location and the waste dump sites. In general, higher concentrations of several particulate and gaseous pollutants were observed at the two dumpsites locations compared with the control area, indicating that waste disposal activities have an impact on the surrounding air conditions.

Table 3: Mean Concentration of Ambient Air Quality Parameters at Sampling Locations

Air parameter	Control	Eneke dumpsites	Obirikwere dumpsites	NESREA Limits
$PM_{2.5}$	0.0300 ± 0.010	0.077 ± 0.015	0.070 ± 0.010	
PM_{10}	0.067 ±0.015	0.150±0.040	0.090±0.010	
CO	2.833±0.737	5.167±0.115	6.800±1.058	10
CO_2	151.00±11.00	194.67±18.58	201.67±43.15	-
NO_2	0.079±0.002	0.143±0.345	0.091±0.009	0.05
SO_2	0	0.010±0.010	0.053±0.006	0.047
H_2S	0	0	0	0.011
NH_3	0	0	0	0.2
O_3	0	0	0	0.051
CH_4	0	0.093 ± 0.100	0.103 ± 0.005	

Source: Field Study Data

3.2 Variation of Particulate Matter Concentrations

Table 1 shows the concentration of particulate pollutants varied among the sampling locations. PM_{10} had a higher concentration around the dumpsite locations when compared with the control point, with Eneka show the highest recorded value (0.150±0.040 ppm), followed by Obirikwere (0.090±0.010 ppm), while the control location recorded 0.067 ±0.015 ppm. $PM_{2.5}$ concentration showed variation across locations with recorded values at Eneka (0.077 ± 0.015), Obirikwere (0.070 ± 0.010) and control location (0.0300 ± 0.010). The results therefore show higher measured concentration of both PM_{10} and $PM_{2.5}$ at the two dumpsite locations compared with the control location.

3.3 Variation of Gaseous Pollutants

Table 1 also indicates Carbon monoxide concentrations increased at the dumpsite locations compared with the control point. The control site indicates a mean CO concentration of 2.833±0.737 ppm, while Eneke recorded 5.167±0.115 ppm and Obirikwere recorded 6.800±1.058 ppm. Similarly, Carbon dioxide CO_2 concentrations recorded higher values at the dumpsite locations. The control point had 151.00±11.00 ppm compared to Eneka with 194.67±18.58 ppm and Obirikwere with 201.67±43.15. Nitrogen dioxide concentration were higher at dumpsite locations, with the control location recording 0.079±0.002 ppm compared with Eneke and Obirikwere recording 0.143±0.345 and 0.091±0.009 respectively. SO_2 was not detected at the control site but was observed at Eneke (0.010±0.010) and Obirikwere recording the highest value (0.053±0.006). Methane was found only at the waste dump locations, with Eneka (0.093 ± 0.100) and Obirikwere (0.103 ± 0.005).

3.4 Comparison of Air Quality Paremeters Between Dumpsites and Control Location.

Values in Figure 3 represent mean concentrations (ppm) with error bars indicating standard deviation. The results indicate that the waste dump sites influenced ambient air quality. Parameters associated with combustion activities and waste decomposition and combustion activities, including CO, CO_2, NO_2, SO_2, and CH_4, showed increased concentrations around dumpsite locations compared with the control point with CO_2 recording the highest. The presence of methane at dumpsite locations and other

pollutants indicates active decomposition processes and the presence of burning activities occurring within the waste disposal areas.

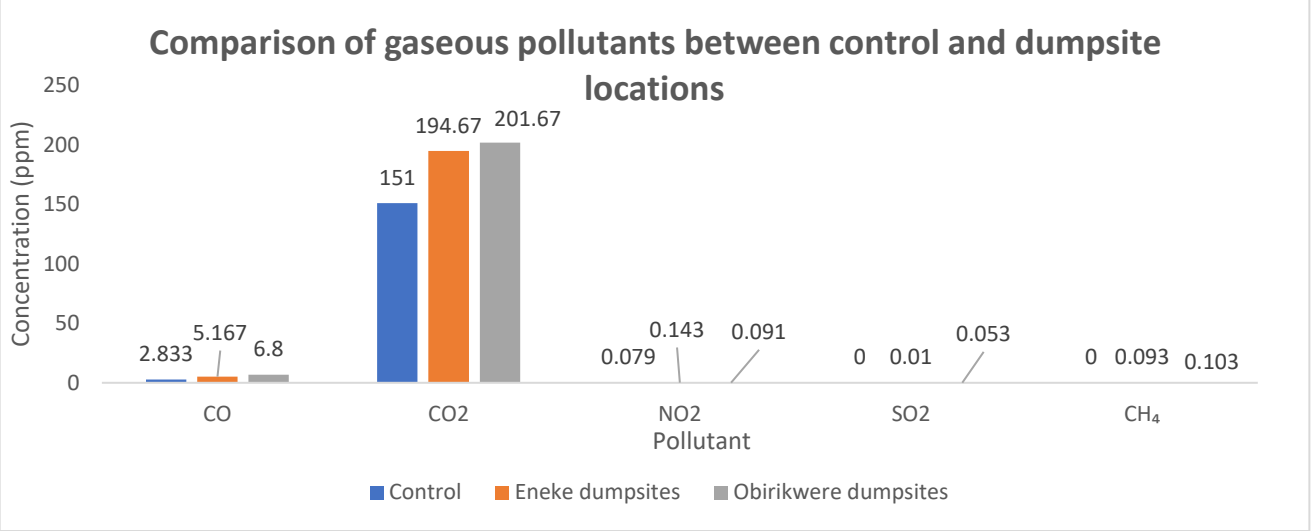


Figure 3: Comparison of gaseous pollutant concentrations between the control location and dumpsite sites.

4. Discussion

The study provides an assessment of the influence of selected waste dump sites on ambient air quality in Obio-Akpor Local Government Area, Nigeria. The findings demonstrated variations in air quality parameters between the control location and areas influenced by waste disposal activities. Higher concentrations of gaseous pollutants such as CO, CO_2, NO_2, SO_2, and CH_4 were observed in Eneka and Obirikwere compared to the control area indicating that waste disposal activities contribute to changes in the atmosphere of the surrounding environments.

The increased concentration of carbon monoxide recorded at the dumpsite area may be associated with the uncontrolled burning of waste, anthropogenic activities, incomplete cobustion processes within waste disposal areas. The highest CO concentration was recorded at Obirikwere (6.800$\pm$1.058 ppm), then Eneka recorded 5.167$\pm$0.115 ppm compared with the control location (2.833$\pm$0.737 ppm). Open burning remains a practice in many urban cities to manage waste but it releases incomplete combustion products such as CO and particulate pollutants into the atmosphere. Krecl et al. (2021) underlined that the open-burning of municipal solid waste (MSW) is ineffective due to insufficient oxygen availability and inadequate temperature regulation. This incomplete combustion leads to the release of toxins, including particulate matter (PM), carbon monoxide (CO), and other gases, into the environment without any pollution mitigation measures. Ramadan et al. (2022) reported that waste combustion activities were identified as important contributors to atmospheric pollution around open dumpsites. The open incineration of municipal solid waste is a major worldwide contributor to air pollution, marked by the unregulated burning of assorted waste products at open landfills, along thoroughfares, and within residential zones (Umide et al., 2026).

Carbon dioxide concentrations were also recorded higher at both dumpsite locations compared with the control site. Carbon dioxide (CO_2) concentrations recorded higher values at the dumpsite locations.

Obirikwere had the highest CO_2 with 201.67±43.15 ppm, followed by Eneka with 194.67±18.58 ppm, while the control point had 151.00±11.00 ppm. The elevated levels of CO_2 may be attributed to combustion activities within the various dumpsites. Ndubueze et al. (2025) underlined that CO_2 contains a large proportion of biodegradable substances, which goes through decomposition and produce carbon-containing gases. Surya et al. (2026) underlined that open burning emits significant amounts of carbon dioxide (CO_2) into the atmosphere, contributing to global climate change by trapping heat. The open burning of municipal garbage, vegetation and agricultural waste rapidly converts stored carbon into CO_2 which surpasses the capacity of natural carbon sinks affecting the climate.

The findings also show the existence of methane near the dumpsite, which indicates the influence of waste breakdown processes. Methane was found only at the waste dump locations, with Eneka (0.093 ± 0.100) and Obirikwere (0.103 ± 0.005), while methane was not detected at the control location. Kannankai and Devipriya (2024) underlined those fires in landfills result from the self-combustion of waste under conditions that enhance aerobic decomposition, leading to a rise in temperature from the presence of methane. Additionally, methane (CH4) pockets trapped in the landfill can further fuel these fires and promote their spread.

The study also observed increase in nitrogen dioxide concentrations around the dumpsites. Nitrogen dioxide concentration were higher at dumpsite locations, Eneke recording 0.143±0.345 and Obirikwere recording 0.091±0.009 compared with the control location recording 0.079±0.002 ppm. Nitrogen dioxide emissions around the disposal sites may originate from combustion activities, decomposition-related chemical processes and burning of synthetic waste materials. Taha et al. (2025) underlined that the presence of elevated nitrogen oxide concentrations is environmentally important due to their contribution to atmospheric chemical reactions and may increase the associated risks with respiratory irritation among exposed populations. NOx exposure is a significant environmental health risk that affects millions of people worldwide, particularly in cities and industrialised regions (Yang et al., 2022).

Sulphur dioxide (SO_2) was not detected at the control site but was observed at Eneke (0.010±0.010) and Obirikwere recording the highest value (0.053±0.006). The occurrence of sulphur dioxide at dumping sites may be associated with the incineration of sulphur-laden refuse and the breakdown of organic and industrial waste elements (Pokorna & Zabranska, 2015). EPA (2023) underlined that short-term exposure to sulphur dioxide (SO_2) adversely affects the respiratory system, particularly in vulnerable populations like asthmatic children. Elevated SO2 concentrations result in sulphur oxides (SOx) and particulate matter contamination, causing numerous health issues. From an environmental perspective, SO_2 harms plant life, induces acid precipitation that impacts ecosystems, and generates haze that diminishes visibility in national parks and historical sites. Hence, continuous exposure to sulphur dioxide may contribute to respiratory discomfort, particularly among individuals living or working close to emission sources.

Particulate matter concentrations also varied across sampling locations. PM_{10} had a higher concentration around the dumpsite locations when compared with the control point, with Eneka show the highest recorded value (0.150±0.040 ppm), followed by Obirikwere (0.090±0.010 ppm), while the control location recorded 0.067 ±0.015 ppm. $PM_{2.5}$ concentration showed variation across locations with recorded values at Eneka (0.077 ± 0.015), Obirikwere (0.070 ± 0.010) and control

location (0.0300 ± 0.010). Increased particulate matter around dumpsites may result from waste handling activities, exposure of waste materials to wind erosion, movement vehicles and burning activities (Surya et al., 2026). Hence, particulate matter represents an important air quality indicator because fine particles can remain suspended in the atmosphere and may affect respiratory health when inhaled over prolonged periods.

Continuous exposure to pollutants from uncontrolled waste disposal poses environmental air pollution risks in urban areas, despite some pollutants being within regularly limits. Variations in pollutant concentrations due to climatic conditions, waste composition, and proximity to disposal sites necessitate enhanced waste management practices in Obio-Akpor Local Government Area.

5. Conclusion

The study analysed the impact of waste disposal dumpsites on air quality in Obio-Akpor Local Government Area, River State, Nigeria. It discovered that air quality was negatively affected, with increased concentrations of pollutants such as CO, CO_2, NO_2, SO_2, and CH_4 and particulate matter near the dumpsites. The existence of methane at landfills and increased gaseous contaminants suggests that waste breakdown has a role in atmosphere emissions. Despite certain pollutant concentrations being compliant with regulatory standards, extended exposure presents hazards to ecological and public well-being. The study concluded that inefficient waste management practices affect air quality and advises sustainable measures such better collecting waste, recycling, controlled disposal, banning open burning, and regular air quality monitoring to mitigate pollution and safeguard the health of the community.

6. Recommendations

The following recommendations are proposed based on the findings of the study:

1. Improved Methods of Waste Collection: The necessary waste-management authorities should enhance their waste collection systems by reducing prolonged municipal solid waste accumulation in open disposal areas.
2. Controlled Waste Disposal: Waste should be properly disposed of using the appropriate managed and controlled disposal facilities rather than uncontrolled open dumping.
3. Minimisation of Open Burning: Open burning of solid waste should be discouraged especially around residential and commercial areas because of its potential contribution to particulate and gaseous emissions.
4. Waste segregation and Recycling: Greater emphasis should be placed on waste segregation, recycling and recovery of reusable materials to minimize the quantity of waste requiring final disposal.
5. Regular Air-quality Monitoring: Ambient air-quality monitoring should be conducted periodically around active waste disposal locations to identify changes in pollutant concentrations and support environmental management decisions.
6. Further Research: Future studied should include larger numbers of sampling locations, repeated measurements across different times and longer monitoring periods.

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