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AMBIENT AIR QUALITY IN ONITSHA METROPOLIS

(A Publication Extraction from Evaluation of Air Pollutants in Onitsha Metropolis, Anambra State, Nigeria.)

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Abstract

Air pollutants and their concentration levels were measured at forty sampling stations within the study area. Detailed Air quality analysis was carried out. mean CO was 12.31ppm in the dry season and 5.27ppm in the wet season; mean TSP was 376.7µg/m^3 in the dry season and 464.9µg/m^3 and in the wet season; mean PM_{10} was 263.3µg/m^3 in the dry season and 313.1µg/m^3 in the wet season; mean $PM_{2.5}$ was 68.7µg/m^3 in the dry season and 62.2µg/m^3 in the wet season. Sulphur dioxide, nitrogen dioxide, and particulate matter exceeded stipulated NAAQS limits and pose a greater risk to public health. Onitsha Main Market and Central Part were the hotspots of particulate matter. Onitsha Main Market, Bridgehead, and Awada Layout are the worst affected by particulate pollution. Most people in the Onitsha metropolis are exposed to hazardous air quality in the dry season and unhealthy air quality in the wet season; respiratory, lung, and heart diseases may be prevalent in the study area. Health impact assessment should be conducted in Onitsha metropolis, residents should go for regular medical check-ups; air quality monitoring stations should be established around Onitsha metropolis. State government should enforce compliance laws and regulate the activities of industries in the areas.

Keywords: industries, Air Pollutants, pollution, State government

Introduction

First and foremost we are human beings created and replicated in the image of God far above animals and the plants for the primary purpose of advancing humanity and instituting the fear of God on his planet, earth. Now as human beings we are supposed to operate in a space, which brings about the environment – The Ecosystem. The ecosystem comprises of crops, animals,forests, bodies of water, and human beings, and this cohabitor should have harmony, boundaries, and quality life. That means it behooves now on man, God'scaretaker of his estate, the Earth to consciously and consistently create a balance and harmony on the environment, God's own estate. In the beginning of creation, God's original intention was to garnish the earth with good ambient air quality.
Meaning of Ambient Air Quality
What are Ambient Air and Ambient Air Quality?

1.2What does Ambient Air mean?

Ambient air is atmospheric air in its a natural state. It is what we breathe when the atmosphere when the atmosphere is not contaminated. Ambient Air is typically 78% Nitrogen and 21% Oxygen. (Safeopedia.com, 2018).

1.3What is Ambient Air Quality?

Ambient Air Quality is defined as the quality of outdoor air in our surrounding environment. It is typically measured near ground level away from direct sources of pollution.

1.4 Indoor and Outdoor Quality

Ambient air can be contaminated whether outdoors or indoors as the case may be. But the rates of exposure to outdoor or indoor air pollution do greatly vary between rural and urban areas, as well as between developed, developing, and undeveloped regions depending on the variation of car ownership, use, travel time, and spread of industrial facilities and lifestyle of the populace.

Outdoor Air Quality

Is the quality of Ambient Air in the open surrounding environment with little or no enclosures. The industrial sites, market places, mines, quarries, dales, valleys mountains, and canyons are a few examples of where outdoor pollution is observed.

Indoor Air Quality

The indoor air quality is the air quality witnessed within buildings and structures. Indoor air quality has an effect on the comfort and health of occupants, whether they are residential houses, shops, offices, and other buildings. Some of the indoor air pollutants are

carbon monoxide, carbon dioxide radon, volatile organic compounds, fibers, asbestos, ozone, burning biomass, and even pollutants from decaying household waste bins.

2.0Background to the Study

Air pollution is one of the current world's challenges. Air quality would remain pure or natural unpolluted if there is no introduction of pollutants via anthropogenic activities. Man through his activities pollutes the air he breaths and this results in his health problem and environmental damages Antai*et al.,* (2016a). Globally various measures have been taken to curtail the excesses of anthropogenic activities to reduce or probably eradicate air pollution; one of these measures is an assessment of air quality. Assessment of air quality is essential because it evaluates the present air pollution levels of a particular area. When the individual air pollutant concentration is determined or evaluated by the air quality assessment, the mitigation and remediation measures can be proffered.

Many researchers have carried out air quality assessments in some major commercial cities in Nigeria. Onitsha is one of such cities with high commercial activities that may attribute to air pollution. Anthropogenic activities such as heavy truck movement, commercial vehicular movement, high vehicular traffic, heavy human congested/crowded areas, industrial activities, commercial market activities, mechanical workshop, and open waste dump, etc. may be the main causes of air pollution in Onitsha metropolisAntai and Osuji, (2017).

In Onitsha like any other commercial and industrial city in Nigeria, there has not been an accurate air quality database or Air Quality Impact Assessment (AQI) by any regulatory agencies responsible for such roles. Though there are project-specific air quality data that may not be made public. All these challenges are a result of the high cost of logistics for air quality data gathering as this regulatory agency cannot afford it (Antai, and Osuji, (2017).

Primarily, man through his anthropogenic activities causes air pollution that brings threats to man and his environment. Natural sources of air pollution are forest fire, volcanic eruption, and dust from the storm while man activities such as fossils fuels, household cooking, automobile movements are anthropogenic sources of air pollution (Antai *et al.,* 2016a).

These air pollutants have negative impacts and health implications. It is therefore penitent to regularly assess the air quality of the Onitsha metropolis by deploying the standard procedures and methodologies for air quality field data gathering, data storage, data analysis/management, and report writing (Antai *et al.,* 2016a). There are likely health issues that may arise from prevailing high air pollutants concentrations the public may be exposed to in the environment. These high air pollutants concentrations and the health implications can be computed using Pollutant Standard Index (PSI) and Air Quality Index (AQI) (Antai *et al.,* 2020a).

The pollutant standards index shows individual air pollutant concentration while the air quality index indicates all air pollutants concentration in a particular location per time and the potential health effects with color codes indicating the air quality rating (Antai *et al.,* 2020a).

The air pollutants dispersion rates and pattern can be statistically analyzed by computation and calculation of the minimum and maximum of each air pollutant concentration, standard deviation, and coefficient of variation in concentration of air pollutants; also critical air pollutants of a study area can also be determined by using exceeding factor (Antai*et al.,* 2020b).

There should be proactive regulations and effective enforcement of environmental laws and conventions to close the gap already created in air quality management in Nigeria generally and Onitsha in particular (Okecha, 2000; Efe, 2006; Gobo *et al.,* 2012; Antai*et al.,* 2016b; Antai*et al.,* 2020c).

1.2 Aim and Objectives

This research aims to assess the air quality trends of the Onitsha metropolis. The specific objectives are to:

1. Assess and evaluate the present concentration of the air pollutants in the sampling locations.
2. Identify the air pollutants strong sources and special spreading patterns
3. Evaluate the health and environmental effects of the air pollutant in the study area.

1.3 Statement of the Problem

Assessment of air quality trends of Onitsha metropolis cannot be under-emphasized. Onitsha is a hub of commercial and industrial activities. The anthropogenic activities in Onitsha metropolis are air pollution trigger-activities and these have been a big concern to the government and residents of Onitsha metropolis. It is noticeable that most residents of the Onitsha metropolis are complaining of air pollution-related diseases such as respiratory problems and some other health implications. This necessitated the reason for this study to help evaluate the present air pollution levels and profer the mitigation measures

1.4 Significance of the Study

This research is of great value to both the government and its agencies including the residents of the study area to expose the causes and sources of air pollution and the health implications. It will, however, help the government and its agencies for proper environmental management of Onitsha metropolis, while the proffered mitigation measures help to reduce the air pollutants and health-related problems, including environmental degradation.

1.5 The Scope of the Study

The scope of the study covers the Onitsha metropolis. Forty (40) sampling points and one control point were selected for the study and the following ambient are quality pollutants were measured, NO_2, SO_2, H_2S, NH_3, CO, VOCs, TSP, $PM_{10,}$ and $PM_{2.5}$.

1.7 Description of the Study Area:

1.7.1 Location

It lies on the outer fringes of Eastern Nigeria. The datum point is Borromeo/Ziks roundabout within latitudes N 06^o 08'.801" and longitudes E 006^o 48'. 831" and Control (O) point at Ideani/Nnobi – Nkpor Rd junction in Idemili LGA which lies within latitudes N

06^{o} 05'. 282" and longitudes E 006^{o} 55'.891" which denote the approximate elevation of the stations in meters and is the datum level to which barometric pressure reports at the station referred, or the elevation of the ground in the vicinity of the stations. The site's central location is ZIK/BORROMEO junction which situates at an intersection adjoining four major streets in Onitsha.

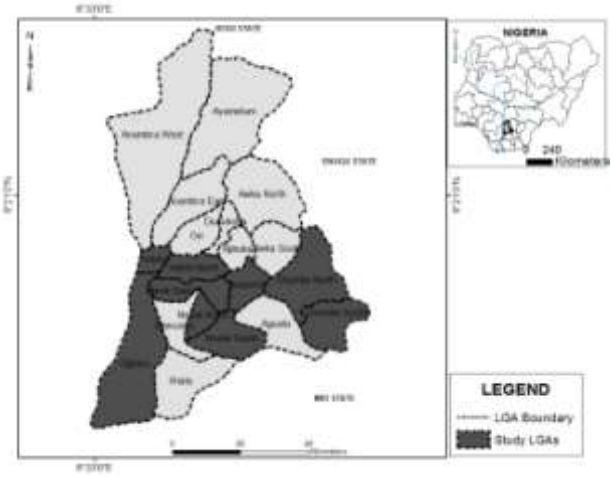

Figure 1.1: Map of Anambra State Showing Onitsha Metropolis.

2.3 Summary of Literature Review and Gaps Identified

Many research works on air quality have been carried out in Onitsha metropolis with the aims to assess and evaluate the sources, causes of air quality and proffer mitigations measures for the impacts of the air pollution in Onitsha metropolis. Also, some of these previous studies in the literature review reported data with air pollutants concentrations that exceeded both international and national standards, while some reported low concentrations in some areas.

However, none of these previous studies was able to cover the entire Onitsha metropolis for their studies to ascertain the spread of air pollution in the Onitsha metropolis. They did not also evaluate or assess all or some of the critical air pollutants as one study in each of the previous studies as reported in the literature reviews. Thus, this forms the basis for this present study.

1.0 Control of the Menace of Ambient Air Pollution

Challenges of Ambient Air in the environment are enormous, overwhelming, and hydra-headed. World Health Organisation (WHO, 1999) defines ambient air pollution as potentially harmful pollutants emitted by industries, households, cars, and trucks. Of all the pollutants, fine particulate matter has the greatest devastating effect on human health.

2.1 Air Quality Directive

There have been a gamut of air quality directives, ranging from Existing - Air Quality Environment – European Council Directive 1999/30/EC relating to limit values for Sulphur dioxide, nitrogen dioxide,

And also the UK and EU Air Quality Policy Context – Defra, UK (The action to manage and improve air quality is largely driven by European (EU) legislation; AAOD 2008/50/EC- ERA additional … Sept. 1996 on air quality assessment and management.

2.2 Ambient Air Quality Criteria

Ambient air quality criteria or standards are concentrations of pollutants in the air and typically refer to outdoor air.

2.3 Air Quality Management

Air quality management refers to all the activities a regulatory authority undertakes to help protect humans and the environment from harmful deleterious effects of air pollution.

Fig 2: Air Quality Management Process Cycle/USEPA 3 Aug. 2021

3.0 MATERIALS AND METHOD

3.1 Research Design

The study was designed to assess the air quality trend of the Onitsha metropolis. The design was done in accordance with the standard air quality assessment techniques such as sampling point selection, data collection, data storage, data processing, analysis and data interpretation.

3.2 Population of the Study Area

The study area is Onitsha metropolis which comprises of Onitsha North LGA (Inland Town or Emu-Onitsha, Odoakpu, Omoba Phase 1 & 2 and OseOkwodu), Onitsha South LGA (Figge and Woliwo) in one hand and its environ (Part of Oyi, Idemili&Ogbaru LGAs) on the other hand. These areas which are included in sample mapping are parts of Ogbunike in Oyi LGA, Nkpor, Umuoji, Ogidi, Obosi, Abatete&Ideani in Idemili LGA and Okpoko &Iyiowa-Odekpe in Ogbaru LGA. On the whole, about five local government areas are involved in this research.

The population of Onitsha may not be exact and therefore is predictive. Just like other modern cities of the world, the population of the study area has been on a steady increase right from the inception of the area. The earliest estimate of the population was given by Adolphe Burdo in the year 1800 where he estimated the population to be 15,000 persons (Okoye, 1975). Since the population progression is not arithmetic but geometric, then the prediction will be an annual increase of 35%. From 1800 to 2019 =219 years.Therefore the population estimate for Onitsha = (15,000 x 219) 35% = 1,149,750.

Now, if the environmental population estimate is multiplied with a factor of 3.5 of the population of 1, 149, 750 = 4, 024, 125.

3.3 Sample and Sampling Techniques

The research adopted the sampling point's selection and field data collection standard procedures. A total of forty sampling points and one control point were selected and used for the study across the Onitsha metropolis. The sampling points were selected in accordance with World Health Organization (WHO) 2005 guidelines for sampling point selection.

3.4 Nature/Sources of Data

Air quality data were collected *in-situ* from primary sources in the field via portable air quality instruments.

4.0 DETERMINATION OF AIR QUALITY INDEX OF THE STUDY AREA

The Air quality indices (AQI) were computed using mean values of criteria pollutants (SO_2, NO_2, CO, $PM_{10,}$ and $PM_{2.5}$). The computed AQI for each sampling station in the dry and wet seasons in Onitsha and its environs are shown in Table 4.3, while plots of corresponding AQI are shown in Figure 4.34. This section satisfies objective 3 of the study.

4.1 Assessment of Air Quality Index in the Dry Season

The air quality indices computed for the study area in the dry season (Table 4.3 and Figure 4.34) show unhealthy air quality (151 - 200) around stations SP7, SP8, and SP20, which are Main Market/Bida Road/Bright Street/ New Mkt Road Junction, Otu Onitsha, OseokwaOdu Market/Main Market/ Old Mkt Road Junction, Otu Onitsha and Ogbunike Building Materials (Km 8 Onitsha-Enugu Express Road respectively. This unhealthy air quality may potentially affect the exposed population, thus, poses serious health concerns as the people in these areas may experience serious health effects such as respiratory symptoms, lung and heart diseases. According to Chen and Copes (2013), this level of air pollution is capable of exacerbating or triggering asthma attacks in susceptible people. Similarly, stations SP1, SP5, SP6, SP9, SP10, SP25 and SP36 (Odoakpu Upper Iweka Flyover, Uga Road Building Materials/PH Road, Figge, Niger Head Bridge By Timber Market, Figge, OseokwaOdu Market/Main Market/ Old Mkt Road Junction, Otu Onitsha, Akpaka GRA/Nigeria Prisons, Akaroa/Minaj Junction, Obosi and Second Niger Bridge Head, Ogbaru LGA respectively) show very unhealthy air quality (201 – 300). This may pose a more serious effect on public health. The exposed public may suffer from respiratory, lung, and cardiovascular diseases (Khan and Siddiqui, 2014). Other stations (Table 4.3 and Figure 4.34) show hazardous air quality (301 – 500) in the dry season. This can severely affect the health of the general public. It may aggravate existing respiratory diseases, such as asthma and chronic bronchitis (Chen and Copes, 2013; Khan and Siddiqui, 2014). Short-term exposure may cause damage to the central nervous system. It may also result in mortality, particularly among the elderly and children.

4.2 Assessment of Air Quality Index in the Wet Season

Computed air quality indices in the wet season (Table 4.3 and Figure 4.34) show good air quality (0 – 50) around stations SP2, SP8, SP20, SP25, and SP28 (Ochanja Market Round-About Odoakpu, OseokwaOdu Market/Main Market/ Old Mkt Road Junction, Otu Onitsha, Ogbunike Building Materials (Km 8 Onitsha-Enugu Express Road, Akaroa/Minaj Junction, Obosi and Ngbuka-Obosi/Old Spare Parts Market). These areas indicate satisfactory air quality with little or no health concern. Stations SP5, SP7, SP9, SP10, and SP12 (Uga Road Building Materials/PH Road, Figge, Main Market/Bida Road/Bright Street/ New Mkt Road Junction, Otu Onitsha, Old Nkisi Road/Ridge Road (Holy Trinity), European Quarters, Akpaka GRA/Nigeria Prisons and DMGS/All Saints Cath/Ziks Round About, Inland Town) show moderate air pollution (50 – 100) in the wet season. This indicates that the quality of air around these stations poses a minor risk to public health; sensitive people may experience respiratory symptoms. The air quality indices around stations SP1, SP3, SP6, SP13, SP17, SP22, SP23, SP24, SP26, SP29, SP31, SP32, SP33, SP35, SP37, SP38, and SP40 show unhealthy air quality for sensitive groups (101 - 150). This may likely affect people with lung and heart diseases; asthmatics, children and the elderly are at greater risk (Khan and Siddiqui, 2014). The computed air quality indices around stations SP4, SP11, SP14, SP15, SP16, SP21, SP27, SP30, SP34, and SP36 show unhealthy air quality (151 – 200). This level of air pollution in these areas poses serious effects to public health. Short-term exposure may irritate the nose, eyes, and throat (Khan and Siddiqui, 2014), long term exposure may trigger asthma attacks in susceptible people (Chen and Copes, 2013; Khan and Siddiqui, 2014). Similarly, computed air quality indices around stations SP18, SP19, and SP39 show very unhealthy air quality (201 – 300). This level of air pollution may adversely affect the general public. It can trigger respiratory problems resulting in coughing, sore throat, breathlessness and wheezing (Chen and Copes, 2013; Khan and Siddiqui, 2014).

Table 1.1 : Air Quality Index of the Study Area

Station	Dry season		Wet season	
	AQI	Colour code	AQI	Colour code
SP1	266		104	
SP2	320		46	
SP3	315		121	
SP4	301		154	
SP5	218		83	
SP6	283		120	
SP7	163		81	
SP8	177		44	
SP9	257		83	
SP10	245		51	
SP11	340		168	
SP12	306		70	
SP13	421		127	
SP14	381		165	
SP15	384		213	
SP16	500		190	
SP17	398		119	
SP18	416		224	
SP19	335		236	

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SP20	165		17	
SP21	364		155	
SP22	389		117	
SP23	324		114	
SP24	331		134	
SP25	267		38	
SP26	318		150	
SP27	493		191	
SP28	432		46	
SP29	476		148	
SP30	452		184	
SP31	414		112	
SP32	446		124	
SP33	328		126	
SP34	362		154	
SP35	492		108	
SP36	290		194	
SP37	539		104	
SP38	452		128	
SP39	458		225	
SP40	371		107	

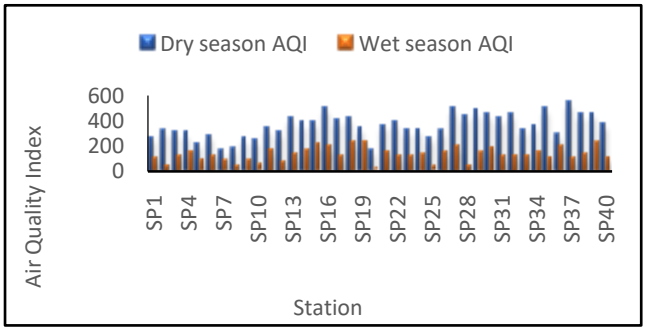

Figure 3.1: Air Quality index of Onitsha Study Area

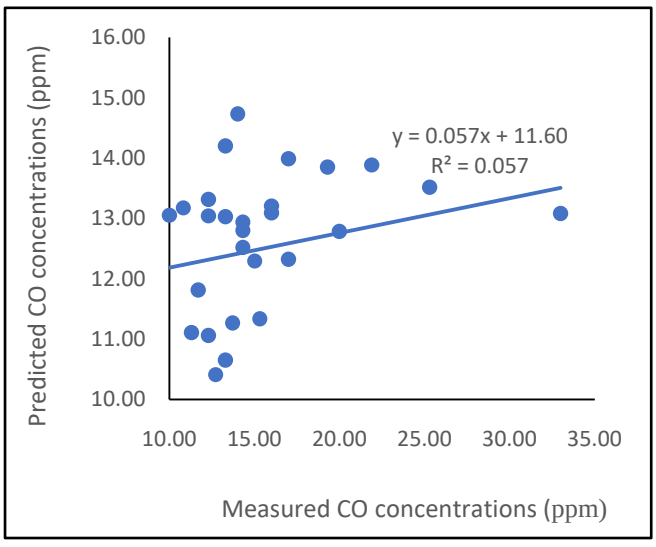

Figure 4.1: Goodness of Fit between Predicted and Measured CO Concentrations in the Dry Season

SUMMARY, CONCLUSION, AND RECOMMENDATION

5.1 Summary

A study on the assessment and modeling of air quality trends in Onitsha metropolis, Anambra State, Nigeria has been carried out. The study was conducted to assess the level of air pollutant concentrations, identify hotspots, and determine air pollutants distribution in the study area. The study methodology includes research design, field investigation, and air quality monitoring. Relevant literature was extensively searched and reviewed as part of the data acquisition processes. Sampling type, sampling technique, and procedure were done through instrumentation; while data analysis and modeling were carried out using statistical software.

Wind direction is predominantly Northeast in the dry season and South-west in the wet season. Temperature levels in the area were found to be higher in the dry season than in the wet seasons. Conversely, relative humidity levels were higher in the wet season than in the dry seasons.

Result indicates that SO_2 showed a mean concentration of 1.86ppm in the dry season and 0.73ppm in the wet season; NO_2 showed a mean concentration of 1.71ppm in the dry season and 0.30ppm in the wet season; the mean value of H_2S was 1.54ppm in dry season and 0.42ppm in the wet season; VOCs showed a mean value of 0.91ppm in the dry season and 0.01ppm in the wet season. Similarly, the mean concentration of CO was 12.31ppm in the dry season and 5.27ppm in the wet season; ammonia showed a mean value of 1.31ppm in the dry season and 0.16ppm in the wet season. Furthermore, TSP showed a mean concentration of 376.7µg/m^3 in the dry season and 464.9µg/m^3 and in the wet season; PM_{10} showed mean concentrations of 263.3µg/m^3 in the dry season and 313.1µg/m^3 in the wet season; the mean concentration of PM_7 was 182.2µg/m^3 in the dry season and 213.9µg/m^3 in the wet season; the mean concentration of PM_4 was 102.6µg/m^3 in the dry season and 102.6µg/m^3 in the wet season; $PM_{2.5}$ showed a mean concentration of 68.7µg/m^3 in the dry season and 62.2µg/m^3 in the wet season; while PM_1 showed a mean concentration of 46.5µg/m^{3}in the dry season and 32.3µg/m^3 in the wet season. The concentrations of SO_2 in the area were found to be high in the dry season compared to the wet season. The mean values of SO_2 exceeded permissible limits in both the dry and wet seasons. The mean values of NO_2 far exceeded both the FMEnv and NAAQS permissible limits. The mean concentrations of CO exceeded the stipulated limit in the dry season, but within the limit in the wet season. The mean TSP concentrations in the dry and wet seasons exceeded FMEnv permissible limit by 7.84% and 51.36% respectively; the dry and wet season mean values of PM_{10} exceeded NAAQS permissible limit by 75.5% and 108.7% respectively; while, the dry and wet season mean values of $PM_{2.5}$ exceeded NAAQS permissible limit by 96.3% and 77.7% respectively.SO_2 and NO_2 hotspot is observed around the Nkpor area dispersing from the central region of the study area to the North Eastern and Western parts. SO_2 has a great influence on a larger part of the study area, but less on Main Market, Onitsha, and

Nnobi junction area in the dry season. Nkpor remains the area with the highest SO_2 concentrations; while the main market is the least affected area in the wet season. NO_2 has a great influence on Nkpo, Omagba Phase 2, and EnuOnicha area, but less on Main Market, Wuliwo, Awada layout, Obosi, and BridgeHead area. Napo and Southern BridgeHead is the most affected, while Main Market and Nnobi junction (East of Obosi) is the least affected area by NO_2 pollution in the dry season. CO hotspot was observed around Main Market in the dry season with least influence around Fegg, GRA Phase 1, and Nnobi junction. CO concentrations were relatively low in the wet season. Main Market, Nkpo, and Onitsha areas were found to be the epicenter of CO pollution in the dry season.

H_2S hotspot was observed around the Southern Part of the study area in the dry season with a great influence on a larger part of the study area. H_2S hotspot was observed around Bridge Head, Onitsha, Woliwo, and North East of Obosi area in the wet season. Figge, Enu-Onicha, and main market are the least affected area by H_2S pollution. NH_3 hotspot was observed around the Southern Part of the study area dispersing northward in the dry season; while NH_3 hotspots were observed around Bridge Head, Onitsha, Woliwo, and North East of Obosi area in the wet season. Interpolated concentrations of NH_3 are highest around Awka Old road junction. Fegg, Enu-Onicha, and the main market are the least affected area by NH_3 pollution. VOCs hotspot was observed around the Southern part of the study area close to Awada Layout in the dry season with influence around Obosi and Nkpor areas. The concentrations of VOCs were generally low in the wet season. PM_{10} hotspot was observed around the Main Market in the dry season, while the hotspot was observed close to Onitsha in the wet season. Main market area and Onitsha are the worst affected by PM_{10} pollution in the dry season, while Bridgehead and Awada Layout are the worst affected in the wet season. End-Onicha, Figge, and Obosi are the least affected. In the dry season, a $PM_{2.5}$ hotspot was observed around the Central Part of the study area dispersing along the North East- South West region. Bridgehead and Awada Layout are the worst affected, while Enu-Onicha is the least affected. $PM_{2.5}$ hotspot was localized around the Onitsha area in the wet season with Main Market, Bridge Head, Figge, and Obosi being the least affected. Transportation activities, the combustion of fossil fuel by industrial activities electric generators, dust particles from untarred roads, and local combustion activities were identified as the main sources of air pollution in the study area.

Computed coefficient of variations showed that all pollutant concentrations have a high deviation from the mean in the wet season compared to the dry season, which is due to the irregular dispersion pattern observed in the wet season.

The computed air quality indices showed that most people in the Onitsha metropolis are exposed to hazardous air quality in the dry season and unhealthy air quality in the wet season. This poses a serious risk to public health and may cause lung and heart diseases and respiratory problems such as coughing, sore throat, breathlessness, and wheezing asthma among people. Sensitive people such as asthmatics, children, and the elderly are at greater risk.

5.2 Conclusion

This study was carried out to assess air quality trends and evaluate pollutant concentration in Onitsha metropolis, Anambra State, NigeriaMost people in Onitsha metropolis are exposed to hazardous air quality in the dry season and unhealthy air quality in the wet season; respiratory, lung, and heart diseases may be prevalent in the study area. Health impact assessment should be conducted in Onitsha metropolis, residents should go for regular medical check-ups; air quality monitoring stations should be established around Onitsha metropolis. The state government should enforce compliance laws and regulate the activities of industries in the areas.

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