

(RESEARCH ARTICLE)



The impact of air pollution on urban health in Nigeria: Possible solutions

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Abstract

Air pollution has been a major topic of discussion due to its detrimental impact on health and the environment as a result of the urban population's explosive development and associated human activities. The main objective of the study is to give a critical review of the causes, impacts, and Nature-based Solutions (NbS) for reducing air pollution with an emphasis on urban centers in Nigeria. The study adopted natural approaches to address/improve air quality and lessen health risks related to the emission of hazardous substances. To work with nature rather than against it, however, there must be cooperation between the government and its agent, the community, non-governmental organizations, civil society, faith-based organizations, associations, union bodies, young people, women, and people with disabilities, as well as support from international organizations. The study carried out showed that human activities are the major source of air pollution in Nigeria through the release of harmful gaseous substances, carbon dioxide (CO₂), nitrogen oxide (NO₂) and greenhouse gas (GHG) emission, particles and heavy metal and this pollution is extremely dangerous due to the particles and substance discharged into the atmosphere. The findings contribute to the limited body of literature that already exists on the detrimental effects of ambient air pollution on respiratory health that are experienced by residents of urban cities in specific regions of Nigeria and other cities that are similar to those in Nigeria. In order to reduce air pollution in our urban centers, the study suggested adopting Nature-based Solutions (NbS).

Keywords: Air pollution; Urban cities; Human health; Nature-based Solutions (NbS); Sustainable development goal (SDG)

1. Introduction

A rise in human population was observed in the twentieth century as a result of significant improvements in agriculture's production and medical technology. According to UN estimates, the world's population is increasing at the rate of 1.14 % about 75 million people per year in 2012 [1]. The world population is anticipated to be 7.4–10.6 billion by 2050. Different environmental standards and remediation costs have contributed to the transfer of pollution-intensive sectors from nations with severe environmental regulations to others with few or no regulations by creating "pollution havens". Nigeria's population is also expected to increase by estimation to 400 million in 2050, and 733 million people by 2100, from approximately 200 million people in 2019 [2] making it the world's third most populated country after China and India. These estimations assume that the typical number of kids per mother will drop from 5.1 currently to 3.3 on average by 2050 and 2.2 children on average by 2100. In the event that the predicted reduction in fertility is reduced by half a child per mother, the population of Nigeria will reach 985 million by 2100. This expansion's potential benefits will only be realized if population increase is controlled and supported by broadly shared affluence. Rapid population growth combined with unreliable access to high-quality healthcare, education, and other public services will only serve to heighten the risk of unrest, encourage massive unplanned migration, and ultimately lead to regional and even global instability. A huge number of uneducated and unemployed youth pose a threat to the ongoing instability and security challenges [3]. The vulnerability to climate change adds to these demographic and socioeconomic problems. Nigeria is among the ten countries that are most vulnerable to climate change [4] due to extremes of weather condition, rising sea levels, and increasing land temperature [5].

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Air is one of the most significant elements of man's environment. An average human needs approximately 12kg of air each day [6], which is nearly 12 to 15 times more than the quantity of food eaten [7]. For human health and survival, clean and pure air is crucial. Air pollution is always the result of a deviation from the natural and normal composition of the air, which may have a negative impact on the living system, notably human life. [7]. Air pollution is the presence of one or more contaminants, such as dust, fumes, gas, mist, odour, smoke, or vapors, in the outdoor atmosphere in amounts and for long enough periods of time to endanger human, plant, or animal life or property or to unreasonably impede the comfortable enjoyment of life and property [8].

World Health Organization (WHO) identified four contaminants for which there is compelling evidence that they have an impact on human health. These are: particulate matter (PM), ozone (O₃), sulfur dioxide (SO₂), and nitrogen dioxide (NO₂) [9]. Among them, PM has drawn a lot of attention recently due to its detrimental effects on health. It is the most important indicator of urban air quality [10].

Vehicles have been identified to significantly influence urban air pollution. They now contribute largely to anthropogenic carbon dioxide and other greenhouse gases [11]. Greenbaum [12] has noted that the combustion of gasoline and diesel fuel is not the only factor in the emissions of a number of toxic compounds from car engines. Engine design and fuel properties work together to produce emissions.

In addition to having an impact on human health, air pollution also has an impact on how we view the built environment. In a developing nation like Nigeria, where urbanization is accelerating and there are several industrial and building projects underway [13], though, measures have been put in place to put the growing incidence of air pollution to a check, some experts have noted that air pollution is still increasing unabatedly in the major urban centres [14]. In the quest to find a long-term solution to this problem of air pollution, researchers have looked into several aspects of air pollution in urban centres. Examples include mitigating techniques for reducing air pollution [14]; the impact of traffic-induced turbulence on the dispersion of pollutants in streets, canyons, and nearby metropolitan areas [15]; a comparison of the concentration of expected vehicular pollution with the criteria for air quality for several time periods [16]; the growing knowledge and study on the effects and how to control air pollution can aid in guaranteeing sustainable development [17].

Air pollution is an issue that is directly related to the number of people residing in a region and the kind of activities they participate in. In a place where there is low population densities and low energy consumption, the impact of individuals causing pollution is minor. However, enormous amounts of pollutants are released into the environment where there is a high population, urbanization, and industrialization. It is undeniably true that pollution increases with population density and that a society's pollution becomes more complex and poignant as it becomes more sophisticated. This article investigates air pollution and control strategies in Nigerian urban areas based on the aforementioned fact.

2. Research methodology

The primary goal of this paper is to examine how air pollution affects urban health in Nigeria, but secondary data were not sufficient over the years. Descriptive statistics and charts were therefore used in this study to analyze and summarize the data. Thematic analysis was used to draw conclusions on architectural mitigating tactics for air pollution in the built environment.

3. Results

3.1. Descriptive Statistics

Table 1 below shows the mean, median and standard deviation of the particulate matter that was found in the atmosphere between 1990 and 2022 as 68.50, 69.63 and 4.63 respectively. It also has the minimum of 59.48, maximum of 76.05 and range of 16.57. This shows that the concentration of particulate matters (PM) that is in the atmosphere as a result of complex mixture of solids and liquids include carbon, complex organic chemicals, sulphates, nitrates, mineral dust, soot, and smog.

Table 1 Summary of the concentrations of the particulate matter, Carbon dioxide, Nitrogen oxide and Greenhouse gas emissions released into the atmosphere

PM 25	
Mean	68.50284
Standard Error	1.122252
Median	69.62588
Standard Deviation	4.627165
Sample Variance	21.41066
Kurtosis	0.032814
Skewness	-0.64112
Range	16.56892
Minimum	59.48445
Maximum	76.05337
Sum	1164.548
Count	17
Confidence Level (95.0%)	2.379069

Table 2 Individual concentrations of the particulate matter, Carbon dioxide, Nitrogen oxide and Greenhouse gas emissions released into the atmosphere

CO₂		NO₂		GHG	
Mean	101174.1	Mean	32976.17	Mean	284225.5
Standard Error	0.126442	Standard Error	0.231178	Standard Error	0.117642
Median	5.014631	Median	4.981081	Median	5.015796
Standard Deviation	0.565465	Standard Deviation	1.033861	Standard Deviation	0.52611
Sample Variance	0.31975	Sample Variance	1.068869	Sample Variance	0.276792
Kurtosis	0.456925	Kurtosis	-1.38702	Kurtosis	-1.38252
Skewness	-0.64884	Skewness	-0.11552	Skewness	-0.05695
Range	2.311625	Range	3.296687	Range	1.734159
Minimum	3.596219	Minimum	3.054771	Minimum	4.110619
Maximum	5.907844	Maximum	6.351458	Maximum	5.844779
Sum	100	Sum	100	Sum	100
Count	20	Count	20	Count	20
Confidence Level (95.0%)	0.264646	Confidence Level (95.0%)	0.483862	Confidence Level (95.0%)	0.246227

Table 2 above shows the mean, median and standard deviation of the individual substances that were found in the atmosphere between. This shows that their concentration increases according to the gaseous elements.

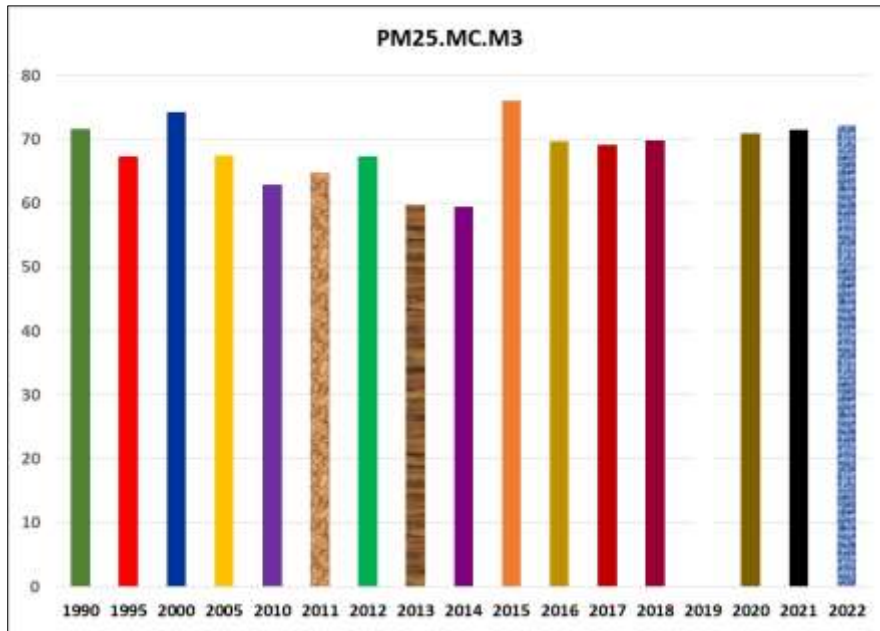


Figure 1 Particulate Matter (PM2.5) generated from 1990 to 2022

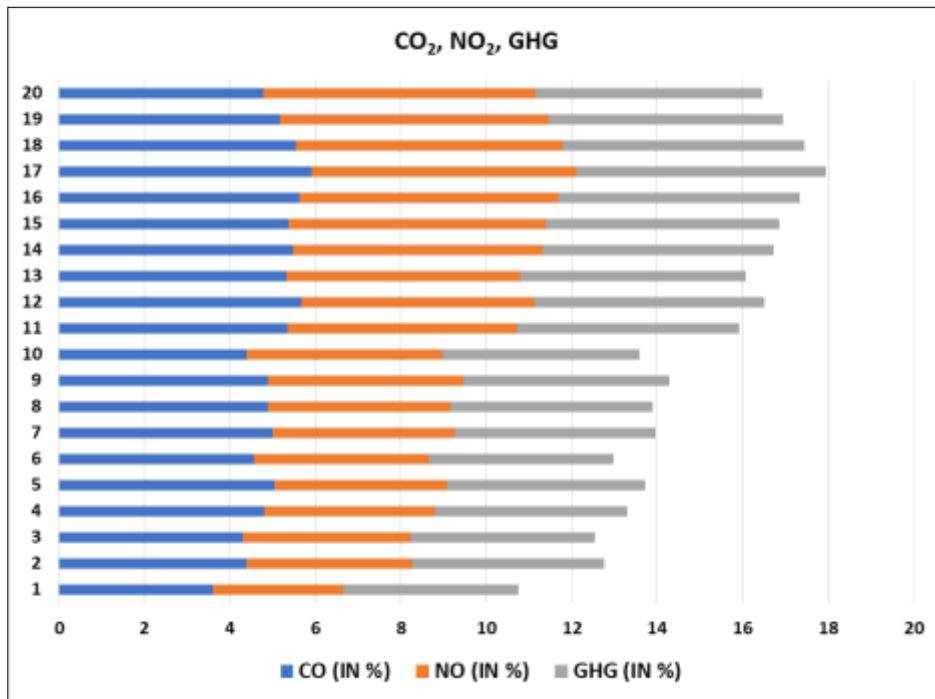


Figure 2 CO₂, NO₂, GHG elements found in the air

4. Discussion

According to the data gathered above, the study agreed with the work of [18, 19] that every minute, numerous harmful gaseous substances, including carbon dioxide (CO₂), nitrogen dioxide (NO₂), greenhouse gas (GHG) emission, particles, and heavy metals, are released into the atmosphere. The cumulative effect of these substances is what is causing the ozone layer to thin as confirmed by [18], making the environment unsafe and unhealthy for all living organisms, including people, animals, and plants. Men's activities, especially those carried out in urban and commercial locations, significantly increase the discharge of hazardous substances, which inadvertently raises the risk of respiratory organ, pulmonary, and cardiovascular diseases. Birth defects, kidney, and liver failure are examples of other disorders. However, the study confirmed according to the work of [19] that air pollution is increasing, which can result in some of

the common health issues like fatigue, sneezing, irritation, shortness of breath, and neurobehavioral problems, an indication that a prolonged period of air pollution may have an effect on the nervous system of the exposed persons. The variable (CO₂) represents Carbon dioxide which measures the amount of harmful carbon in the atmosphere as a result of gaseous emissions coming from burning of fossil fuel, industrial activities, residential emission, crop production, livestock production and general waste. The mean value is 101174.1 metric tonnes, the median is 5.01 metric tonnes and the standard deviation is 0.57 metric tonnes. The minimum and maximum values are 3.6 and 5.9 respectively. The variable (NO₂) stands for Nitrogen dioxide which measures the number of nitrogen in the atmosphere due to emissions from crop production waste, livestock waste and burning fossil fuel. The mean, median and standard deviation are 32976.17, 4.98, and 1.033 metric tonnes respectively. However, the minimum and maximum values are 3.0548 and 6.3515 respectively. The variable (GHG) means Greenhouse gas emission which is the total harmful gaseous substance released into the atmosphere. This is the combination of gaseous substances like Sulphur dioxide (SO₂), Carbon dioxide (CO₂), Nitrogen dioxide (NO₂), Methane (CH₄), carbon black, soot, smog, particles (PM₁₀, PM_{2.5}) and heavy metals. The mean, median, standard deviation values are; 284225.5, 5.0158 and 0.5261 in metric tonnes respectively. The minimum and maximum values are 4.1106 and 5.8448 respectively.

4.1. Adopting Nature-Based Solutions in Addressing Air Pollution

This study discovered according to the work of [20] that Nature-based solutions are very important in mitigating the problems of air pollution. These Nature-based solutions are utilized to enhance air quality and lessen the health risks brought on by the emission of toxic substances. It can be used to gainfully engage/employ more people to earn a living if correctly executed. Nature-based solutions, as defined by the IUCN 2016 definition, are measures to preserve, sustainably manage, and restore natural or modified ecosystems that solve societal concerns successfully and actively, giving advantages for both human welfare and biodiversity. However, because they are long-lasting, affordable, and advantageous in numerous ways, nature-based solutions can be employed to reduce air pollution in metropolitan areas. They can be used to address a variety of issues, such as cutting back on carbon emissions and resolving social issues including economic inequality, food security, and other injustices. They offer numerous options, for instance, to improve one's health. For instance, it is well recognized that adding vegetation to urban areas boosts the immune system and encourages improved mental health and improved ecosystem management can stop the spread of diseases including those that cause coughing, sneezing, dizziness, COVID-19 etc.

To address the climate and biodiversity emergency our planet is facing, there must be cooperation between the government and its agent, the community, non-governmental organizations, civil society, faith-based organizations, associations, union bodies, young people, women, and people with disabilities. This cooperation also needs to be supported by international organizations, UN agencies, the World Health Organization, and the World Bank Group. Applying nature-based solutions is therefore essential to reaching the Sustainable Development Goals (SDG).

It is crucial to remember that the Paris Agreement addressed both climate change adaptation and mitigation by setting goals for lowering harmful emissions and pollution and raising human well-being, respectively. The European Union's Green Deal, which supports green jobs in a variety of fields such as recycling, green building, the development, installation, and maintenance of renewable energy sources, and the restoration of ecosystems like wetlands and forests, is a good example of a program intended to support progress toward those goals. Adopting nature-based solutions can take many different forms, such as green and blue infrastructure projects including restoring wetlands and forests, climate-smart agriculture, agroforestry, and urban greening. In hybrid efforts, nature-based solutions can also be coupled with "grey," or constructed, solutions. Last but not least, nature-based solutions can take the shape of soft strategies intended to alter how institutions, markets, people, and policy are operated. Making the distinction between actions taken to slow down global warming and those taken to aid local communities in adjusting to climate change is perhaps worthwhile at this stage. As already discussed, climate change mitigation efforts often focused on reducing CO₂ emissions or ensuring that CO₂ is stored in vegetations and soils in order to help have breathable air for a healthy living. Climate change adaptation, on the other hand, aims to help people by reducing their exposure to hazardous events such as floods, storms and droughts and/or prepare them for such events.

The following Nature based solutions can be adopted to address the air pollution in urban centres in Nigeria

4.1.1. Green Technologies

This will help a long way in reducing the emission that is coming out from fossil fuel energy generation if the government can adopt the following green technologies: solar energy, wind energy, bio-energy, hydropower-energy, hydrogen energy, wave energy and geothermal energy as the main sources of power.

4.1.2. Blue Transportation

It is of note that transportation is one of the leading causes of air pollution in urban areas around the globe due to the burning of fossil fuels, old/ outdated engines, quality of oil, second hand vehicles and the list goes on. Though, investing in non-fossil fuel vehicles such as hydrogen (green and blue), biogas, gas and electric vehicles will not only improve the quality of breathable air but also improve healthy living and environment.

4.1.3. Home Gardens

Home gardens are being used to help people develop income-generating alternatives to livelihoods based on rain-fed agriculture and forestry. Sustainably irrigate and fertilize gardens, support livestock and poultry while also providing vegetables and fruit.

4.1.4. Green Infrastructures

Green infrastructures such as green building with green roofs is another recognized measure to reduce urban air pollution, rainwater runoff and cooling buildings. Investing in green infrastructure can also yield important environmental benefits to both man and animals. Such initiatives will be increasingly necessary as climate change continues to drive up global temperatures.

4.1.5. Establishing parks with plenty of trees

This is another great initiative that is widely acceptable in combating urban heat. Parks with their plants, trees and shrubs can also act as biofilters for polluted air while serving as water retention areas in the case of stormwater or riverine flooding (thus reducing the need for grey, or engineered infrastructure investments). Parks can also be combined with community gardens to provide locally-grown food and areas for community interaction.

4.1.6. Periodic Sanitation

Regular environmental sanitation, such as once a week for commercial buildings and once a month for homes, will go a long way toward enhancing the air quality and fostering a healthy lifestyle by reducing the amount of trash that can litter the streets and encouraging sustainable waste segregation, which can be another source of income through repair, re-use, refurbishment, and recycling.

4.1.7. Encouraging Ecological Literacy

This is important in giving women and children a voice in combating air pollution and encouraging them to participate in nature-based initiatives. This is borne out by the example of country like Sri Lanka, where youth and children are the pioneers of a nationwide ecosystem-based disaster risk reduction project, undertaking activities such as mapping natural assets and livelihoods within the village.

4.1.8. Reforestation

The government need to launch the initiative or encourage private investors and non-governmental organizations to invest heavily in reforestation projects as well as sustainable, alternative livelihoods as opposed to cutting down the trees for cooking or as form of livelihoods. The aim is to diversify livelihood for people that live in slums or communities that might otherwise be dependent on employment from palm plantations and unsustainable forest harvesting. Reforestation is one sure way of providing healthcare to millions of people, therefore I conclude by saying "A healthy people breed a healthy Nation"

5. Conclusion

From our study we can see that human activities are the major source of air pollution in the urban areas of Nigeria. It is observed that air Pollution pose a significant risk factor to respiratory, pulmonary, and cardiovascular diseases and birth abnormalities due to the particles and substances released into the atmosphere. However, some of the common health concerns associated with air pollution include dizziness, irritation, shortness of breath, and neurobehavioural issues, an indication that over a prolonged period, the pollutant may have an effect on the nervous system of the exposed individuals. The findings of this study provided additional evidence and strength to few existing literatures on the adverse respiratory health effects of ambient air pollution, faced by people living in the urban cities in some parts of Nigeria and similar urban cities elsewhere. The role of other confounders acting synergistically to cause a more serious and deleterious effect is obvious. The results have important policy implications for the introduction of stringent

measures towards reducing ambient air pollution in our urban centers, such as better air quality management through the adoption of Nature-based Solutions (NbS).

Air pollution can be prevented only if everyone plays his part. Private individuals, governments, top industry players and private firms should stop using toxic substances that cause air pollution in the first place. This would require the cessation of all fossil fuel-burning processes; from transportation, industrial manufacturers to home use of coolants such as refrigerators and air conditioners. This is an unlikely scenario at this time. However, we have to make rules which set stringent regulations on industrial and power supply manufacturers and handlers. The regulations are to be designed to further reduce harmful emissions into the Earth's atmosphere.

Policy recommendation

This paper is proposing various recommendations to government and policy makers which its adoption and implementation will help cushion/ reduce the effect of air pollution in urban areas in Nigeria. The following are the policy recommendations;

- **Laws and Regulations:** There should be proper laws and regulations in place and the existing laws should be updated to accommodate the current situations. Such laws if in place, should be effectively coordinated between relevant authority and departments in charge of making sure air pollution is reduced by discouraging burning of fossil fuels, use of substandard electronics, energy appliances and environmental disasters. However, if the regulators failed to regulate, there should be a sanction for such agency to that effect.
- **Tax Incentives:** There should be tax incentives in place for those that adhere to cutting down of air pollutions in their homes and offices. Government should make sure industries, firms and households that agree to cut down their burning of fossil fuels, burning of fuel woods, electronic appliances and adopt green technology through the use of electric vehicle, solar energy, bio-energy, energy efficient and climate-friendly electronic appliances etc. are given any of these tax incentives; tax rebate, tax break, tax-cut, tax holiday, tax waiver etc. This will attract more industry players, private firms, organizations and households to willingly want to go into adoption of green technology apart from helping them cut cost. It also gives the environment good air quality and reduces diseases that are airborne.
- **Gardens and Parks:** Government should make it a matter of importance to encourage more gardens with different trees and vegetations and parks too should be surrounded by trees and some vegetations in all urban city centers across the country. This will go a long way to absorb the carbon dioxide and particles released into the air. The environmental management system should make it a matter of urgency that all parks have trees planted around them. Trees should also be planted on our major highways, houses and relaxation areas.
- **Green Buildings:** The design and construction of our buildings should be such that it is environmental-friendly. The building engineers, architects, and surveyors should have the basic knowledge of green buildings. Our buildings should have a stipulated percentage of greenery which should be mandatory to all building contractors, engineers and architects. The building should contain green roofs, planting of trees in the compound, green fence, green/bio facades and nurturing of small plants at home. This will improve the quality of breathable air and the climatic condition of our environment. The government needs to advocate for sustainable green architectural buildings in Nigeria and most importantly in urban centers.
- **Knowledge and Advocacy:** Most people may know about climate change, air pollution and probably hear about greenhouse gas effect but not many people know how and what to do to prevent themselves or what they can do to reduce the emissions. This is the reason why government must back words with actions, educate a sizeable number of our youths in schools that will go home and educate their peers, friends and family, employer/employees, civil societies, non-governmental organizations, faith-based organizations, different associations, cooperatives, unions, and youth leaders of various organizations to help further educate people in their community and grassroots. It is the responsibility of everyone as well as the government to know and tell others about the effect of climate on our environment and health, and take actions towards mitigating it and adapt to the new conditions we found ourselves before it is too late.
- **Addressing Sustainable Development Goal (SDG) 3:** The government needs to embrace SDG 3 by calling for a healthful society and be cognizant of the environmental threats posed by carbon dioxide emission and take measures possible for resilience to protect its populations against these threats. Adaptations and mitigations to address climate change, is going to transform the health and wellbeing of the people, health systems, health outreach, and address the social determinants of health and environmental determinants of health all in a holistic manner.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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