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Comprehensive Air Quality Index Assessment Incorporating NO_2, $PM_{2.5}$, PM_{10}, And O_3 In Ondo State, Nigeria

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ABSTRACT

This study conducted in Ondo State, Nigeria, employs an Air Quality Index (AQI) to evaluate the air quality in nine communities, focusing on pollutants like ozone (O_3), nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), and coarse particulate matter (PM_{10}). The study stands out due to its comprehensive examination of various pollutants and their combined impact on air quality. Satellite data from IQAir's AirVisual website was utilized to track pollution levels across these areas over six months. This data was then used to establish daily AQI values, offering a unified measure to assess air quality and related health risk. The AQI provides a holistic understanding of air quality in Ondo State, aiding in better evaluation of circumstances and potential health consequences. The research highlighted considerable air quality discrepancies across different locations, identifying $PM_{2.5}$ and NO_2 contributors poor air quality. These findings serve a reference for future monitoring and formulation.

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1. INTRODUCTION

A major environmental worry, air pollution endangers both human health and the general welfare of communities around the world (Manisalidis et al., 2020; Xu et al., 2022; Piracha and Chaudhary, 2022; Abulude et al., 2022). Due to rising urbanization, industrial activity, and automobile emissions, the issue of air quality in Nigeria is receiving more and more attention (Abulude and Abulude, 2021). A thorough evaluation of the spatial and temporal variation (Ridwana R et al., 2023) of the Air Quality Index (AQI) with a focus on important pollutants like nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}), and ozone (O_3) is necessary because Ondo State, which is located in southwest Nigeria, faces its fair share of air pollution issues.

A standardized metric for assessing and informing the public about air quality is the AQI (AirNow.gov, 2022). It provides a more thorough knowledge of the total air quality and associated health hazards by taking into account several contaminants at once. Decision-makers and the general public can use this multidimensional approach to take into consideration the various pollutant concentrations and their possible health impacts, allowing them to make wise decisions about exposure and mitigation measures (Abulude, 2021).

For the purpose of regulating air pollution and its effects, it is essential to comprehend the regional and temporal variation of the AQI in Ondo State. Spatial variations, which can be impacted by elements including proximity to industrial areas, traffic congestion, and weather conditions, refer to the variability in air quality levels among various sites within the state. On the other hand, temporal fluctuations describe alterations in air quality across time, including nocturnal, seasonal, and long-term trends. Factors including regular traffic patterns, industrial operations, weather patterns, and climatic conditions can have an impact on these changes (Abulude and Abulude, 2021).

The distribution and origins of air pollution can be better understood by looking at the regional and temporal fluctuation of the AQI in Ondo State. To enhance air quality and safeguard public health, targeted interventions and mitigation measures can be developed with the help of the identification of pollution hotspots and an understanding of the temporal patterns of pollutant concentrations. Additionally, understanding the AQI's regional and temporal variance can help with the creation of laws and regulations that aim to lower emissions and support sustainable development practices (Chen, et al.. 2022).

This publication intends to explore the regional and temporal variation of the AQI in Ondo State, Nigeria, with an emphasis on NO_2, $PM_{2.5}$, PM_{10}, and O_3 as major pollutants in order to fill these research gaps. We will evaluate the concentrations of these pollutants and their variations over time by examining the air quality data gathered from monitoring stations placed in strategic locations across the state. We will also look into any links between the AQI and results for public health in regions with various amounts of airborne pollutants.

The results of this study will help to improve awareness of the Ondo State, Nigeria, air quality condition and offer insightful information for policymakers, urban planners, and public health officials. The ultimate goal of this research is to advance sustainable development practices, support evidence-based decision-making, and enhance the general well-being of Ondo State's citize.

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2. METHODS

Table 1. Description of the towns monitored in the study

Towns	LGA	Coordinates
Owo	Owo	7.1989° N, 5.5932° E
Ondo	Ondo West	7.1000° N, 4.8417° E
Ilaje	Ese Odo	6.2585° N, 4.7692° E
Ilara-Mokin	Ifedore	7.3497° N, 5.1067° E
Akure	Akure South	7.2571° N, 5.2058° E
Iju	Akure North	7.3924° N, 5.2593° E
Ore	Odigbo	6.7518° N, 4.8779° E
Igbatoro	Akure South	7.1372° N, 5.3626° E
Oba-Ile	Akure North	7.2620° N, 5.2528° E

Ondo State is situated in the southwest of Nigeria (6.9149° N, 5.1478° E). On February 3, 1976, it was formed from the previous Western State. The state is bordered to the northeast by Ekiti State, to the east by Kogi State, to the south by Edo State, and to the west by Osun and Ogun States. Akure is the largest city in the state and the capital of Ondo.

The topography of Ondo State is varied, with coastal regions in the south, hilly terrain in the centre, and flat plains in the north. It is renowned for having a diverse ecosystem that includes woods, rivers, and mangrove swamps. Yorubas, the primary ethnic group in the area, make up the majority of the population in Ondo State. With the lush ground enabling the development of products including cocoa, palm oil, rubber, yam, cassava, maize, and vegetables, agriculture is a major economic activity in Ondo State. One of the main cocoa-producing areas in Nigeria is the state. Additionally important is fishing, particularly in coastal areas like Ilaje. Ondo State has experienced expansion in a variety of industries, including manufacturing, mining, and petroleum, in addition to agriculture. Natural resources of the state, including bitumen, limestone, clay, granite, and oil deposits, support its economic growth.

The locations (Table 1) used for this study are towns within Ondo State, Nigeria. They are described as follows: First, Owo, a notable town with a rich cultural legacy and historical significance, is found in the northern region of Ondo State. It is surrounded by lush greenery and set on an undulating landscape. Second, Ondo State's capital and largest city is Akure. It is well-situated and acts as a significant administrative and commercial hub. The city is distinguished by a blend of modern infrastructure (government buildings, markets, and commercial hubs). Third, the town of Ilara is situated in Ondo State's western region. It is renowned for its agricultural endeavours, and the majority of the locals are farmers. Ilara is located in a tranquil rural area surrounded by agriculture and vegetation. Cassava, maize, yams, and vegetables are among the crops that are grown by the community.

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Fourth, Iju is a town with a largely agrarian economy that is located in the northeastern region of Ondo State. The region is distinguished by a mixture of agricultural land, residential neighbourhoods, and small-scale economic ventures. The people of Iju are involved in farming, trading, and other small businesses, and the city is renowned for its calm and pleasant attitude. Fifth, the town of Igbatoro is situated in Ondo State's western region. Its location is in a rural area with a largely agrarian economy. The village is involved in farming, including the production of products like vegetables, maize, cocoa, and cassava. Igbatoro is renowned for its beautiful surroundings and tranquil atmosphere. Sixth, Ore, a bustling town in Ondo State, is located along the main transit route that connects Lagos to other regions of Nigeria. It functions as a significant transit hub and business hub. A combination of residential, business, and industrial districts define Ore. With the emergence of industries and a variety of businesses, the town has undergone substantial development in recent years. Seventh, Ilaje is a coastal region in Ondo State's southern region. It is renowned for its thriving fishing industry and marine resources. The fishing, commerce, and artisanal industries are the main sources of income for the Ilaje population. Beautiful beaches, mangrove swamps, and a thriving maritime culture define the region.

Eight, Oba-Ile, it is situated outside of Akure, the administrative centre of Ondo State. It is renowned for its residential communities, educational facilities, and modest business ventures. Oba-Ile provides a suburban setting with a blend of urban and rural surroundings. Last, in the middle of Ondo State stands the old town of Ondo. The town combines historic architecture with contemporary infrastructure. The population of Ondo is diversified and involved in a range of economic pursuits, such as services, trade, and agriculture.

This evaluation of AQI, NO_2, $PM_{2.5}$, PM_{10}, and O_3 in the study areas (Owo, Ondo, Ilaje, Akure, Ore, Ilara-Mokin, Igbatoro, Iju, and Oba-Ile) was done for a period of six months (March-August, 2022) using satellite data from IQAir's AirVisual (https://www.iqair.com/. Accessed 1st March 2022). IQAir's AirVisual platform collects data from various satellite sources, such as NASA's MODIS, NOAA's GOES, and the European Space Agency's Sentinel-5P. Satellite Data Processing is used to preprocess the satellite data to ensure its quality and compatibility for deriving pollutant concentrations, which involves data calibration, atmospheric correction, and quality control procedures specific to the satellite sensor used.

The data obtained was statistically analyzed using Minitab and Excel software.

3. RESULTS AND DISCUSSION

Table 2. The description of the minimum and maximum levels of the pollutants evaluated

Towns	AQI	NO_2 (µg/m^3)	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	O_3 (µg/m^3)
Owo	18.00-76.00	0.00-2.00	13.00-76.00	12.00-65.00	12.00-29.00
Ondo	12.00-72.00	0.00-1.00	5.80-72.00	11.00-72.00	21.00-27.00
Ilaje	25.00-115.00	1.00-3.00	22.00-115.00	20.00-114.00	14.00-45.00
Ilara-Mokin	22.00-91.00	0.00-3.00	19.00-91.00	18.00-89.00	11.00-32.00
Akure	23.00-94.00	0.00-3.00	20.00-94.00	18.00-94.00	11.00-31.00
Iju	11.00-30.00	2.00-14.00	0.00-28.0	5.00-30.00	8.00-19.00
Ore	9.00-66.00	0.00-1.00	0.00-63.00	0.00-66.00	9.00-24.00
Igbatoro	16.00-82.00	0.00-2.00	13.00-82.00	14.00-75.00	11.00-27.00
Oba-Ile	23.00-94.00	0.00-3.00	20.00-94.00	18.00-94.00	11.00-31.00

The minimum and highest amounts of the contaminants are shown in Table 2. Ilaje (25-115) and Akure (23-94), which are classified as orange and red, respectively, have the highest AQI scores. According to the pollution levels, this suggests that the air quality in these places

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is bad for sensitive populations or unhealthy for everyone. Residents in these locations are advised to limit their outdoor activities, especially if they are members of sensitive groups, and to seek medical attention if any adverse health effects occur.

Iju (9-66) and Ondo (12-72), which are classified as green and yellow, respectively, have the lowest AQI levels. As a result, the majority of individuals are not at risk from the poor to moderate air quality in these places. However, a very tiny proportion of persons who are extremely sensitive to air pollution may still have concerns about some pollutants. With AQI values ranging from yellow to orange, the remaining localities (Oba-Ile, Igbatoro, Ilara-Moki, and Owo) have air quality that is either moderately unhealthy for sensitive groups or unhealthy. Particularly if they are members of vulnerable groups, residents in these locations should be aware of the potential health impacts of air pollution and take precautions, such as refraining from prolonged or strenuous outdoor activity (Manisalidis et al., 2020).

Guidelines for global air quality are provided by the (WHO, 2021) for six major air pollutants: lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particle matter (PM), and ozone (O_3). These recommendations, which preserve public health and lessen the burden of disease, are supported by scientific evidence of the negative impacts of air pollution on human health. High NO_2 levels in the air might irritate the airways and result in inflammation, coughing, wheezing, or breathing difficulties. People who already have asthma or other lung conditions may be more severely affected by the effects of NO_2 and may need medical intervention. Long-term exposure to NO_2 can exacerbate chronic illnesses like bronchitis or emphysema and raise the risk of respiratory infections (WHO, 2003). Based on research showing that NO_2 has a negative health impacts, the WHO recommends an annual average guideline value of 40 µg/m^3 for this gas. However, many places around the world are above this standard, particularly in urban and industrial settings where there is a lot of traffic and other sources of NOx.

Iju has the highest NO_2 values (2-14 µg/m^3), which are below WHO guidelines but nonetheless reflect a moderate amount of NOx-related air pollution. Residents in this neighborhood should keep a close eye on their air quality as they can encounter some respiratory problems, especially if they have asthma or other lung conditions. Ondo and Ore have the lowest NO_2 readings (0–1 µg/m^3), which point to good air quality and little exposure to NOx pollution. Except for those who are extremely sensitive to air pollution, residents of these places are unlikely to experience any negative health consequences from NO_2. The NO_2 values at the other sites (Owo, Ilaje, Ilara-Mokin, Akure, Igbatoro, and Oba-Ile) vary from 0 to 3 µg/m^3, which similarly denotes good air quality and little exposure to NOx pollutants. Except for those who are especially sensitive to air pollution, residents of these places are unlikely to experience any negative health consequences from NO_2 (USEPA, 2023). The results of NO_2 demonstrate that most areas in Nigeria have relatively low levels of NOx pollution, which is one of the main causes of smog and acid rain. This is in contrast to the earlier results of AQI, which measure the overall amount of air pollution from many sources. However, due to traffic or other combustion sources, some places, like Iju, may have greater amounts of NOx pollution, which might harm the health of locals.

Based on the evidence of $PM_{2.5}$'s effects on health, the WHO suggests a yearly average guideline value of 10 µg/m^3 for this particle size. However, this level is exceeded in many places around the world, particularly in developing nations where air pollution poses serious risks to the environment and public health (Hussaini et al., 2022; Dong and Wang, 2023). Ilaje has the highest $PM_{2.5}$ value (22-115 µg/m^3), which is significantly higher than the WHO recommendation and denotes extremely poor air quality and excessive exposure to $PM_{2.5}$ pollutants. People who live in this area run the risk of suffering serious health consequences

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from $PM_{2.5}$, including cancer, cardiovascular and respiratory disorders, as well as early mortality. They ought to stay indoors, use air filters or masks, and get medical help if they have any symptoms. Iju (0-28 µg/m^3) has the lowest $PM_{2.5}$ rating, which is below or near the WHO standard and denotes good or moderate air quality and little exposure to $PM_{2.5}$ pollutants. Unless they are especially sensitive to air pollution, residents of this location are unlikely to encounter any negative health consequences from $PM_{2.5}$ (Burs et al., 2020; Li et al., 2021; Hormati et al., 2022). The $PM_{2.5}$ readings at the other locations (Owo, Ondo, Ilara-Mokin, Akure, Ore, Igbatoro, and Oba-Ile) vary from 13 to 94 µg/m^3, which are over the WHO recommendation and signify a poor or harmful level of air quality and moderate to high exposure to $PM_{2.5}$ pollutants. The $PM_{2.5}$ data obtained here were lower than those measured (2-51 µg/m^3). The health impacts of $PM_{2.5}$ on local residents may include respiratory and cardiovascular ailments, infections, or weakened lungs. They should avoid being outside as much as possible, wear air filters or masks, and often check the quality of their air.

The results of $PM_{2.5}$ show that most areas in Nigeria have relatively high levels of fine particle pollution, which is one of the most hazardous elements of air pollution for human health, compared to the previous results of AQI, which measure the overall level of air pollution from various sources. However, due to natural or meteorological variables, such wind or rain (Tuejeh et al., 2023), other places, like Iju, may have lower levels of fine particle pollution.

Based on the evidence of PM_{10}'s effects on health, the WHO suggests a 20 µg/m^3 annual average recommendation threshold for the particle size. However, this level is exceeded in many places around the world, particularly in developing nations where air pollution poses serious risks to the environment and public health.

Ilaje (20-114 µg/m^3) has the highest PM_{10} value, which is far higher than the WHO recommendation and denotes extremely poor air quality and substantial exposure to PM_{10} contaminants. PM_{10} can have serious health consequences for local residents, including respiratory and cardiovascular disorders, infections, and early mortality. They ought to stay indoors, use air filters or masks, and get medical help if they have any symptoms. Ore (0-66 µg/m^3), which is below or close to the WHO limit and denotes a satisfactory or moderate level of air quality and low exposure to PM_{10} particles, has the lowest PM_{10} value. Unless they are especially sensitive to air pollution, residents of this location are unlikely to encounter any negative health consequences from PM_{10}. The PM_{10} readings in the other locations (Owo, Ondo, Ilara-Mokin, Akure, Iju, Igbatoro, and Oba-Ile) range from 11 to 94 µg/m^3, which are over the WHO recommendation and signify a poor or dangerous level of air quality and moderate to high exposure to PM_{10} pollutants. The PM_{10} data obtained here were lower than those measured (91-137 µg/m^3) in India (Anand and Phuleria, 2022; Muhamad-Darus et al., 2011). The health impacts of PM_{10} on local residents may include respiratory and cardiovascular problems, infections, or lowered lung function. They ought to restrict their outdoor activities, wear air filters or masks, and keep a close eye on the air quality. The results of PM_{10} reveal that most areas in Nigeria have relatively high levels of coarse particle pollution, which is one of the common components of air pollution for human health, compared to the earlier results of AQI, which measure the overall level of air pollution from multiple sources (Motesaddi et al.,2017; Du et al., 2022; Hormati, et al., 2022). However, due to natural or meteorological variables, such as wind or rain, some places, like Ore, may have lower levels of coarse particle pollution.

Based on the evidence of ozone's negative impacts on health, the WHO recommends an 8-hour average guideline value of 100 µg/m^3. However, this limit is often exceeded around the

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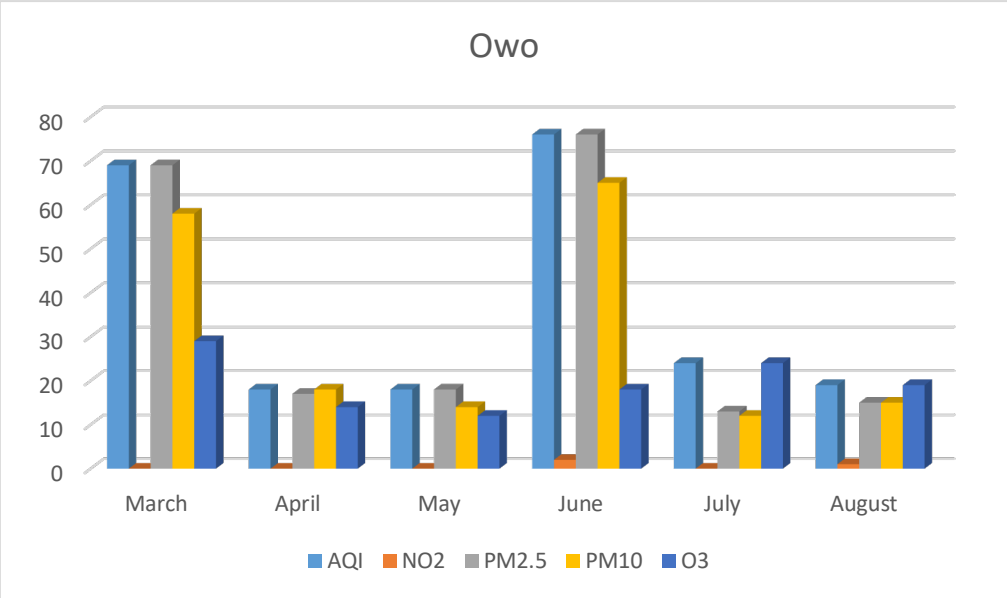
globe, particularly in urban areas with heavy traffic and industrial pollutants. These comparisons and consequences are based on the ozone levels you gave for several sites in Nigeria: Ilaje has the highest ozone rating (14–45 µg/m^3), which is below the WHO recommendation and denotes good or moderate air quality and little exposure to ozone pollutants. Ozone is not likely to have any negative health consequences on local residents, unless they have exceptionally sensitive respiratory systems. Iju (8-19 µg/m^3) has the lowest ozone rating, which is also below the WHO recommendation and denotes good air quality and very little exposure to ozone pollutants.

Ozone is also not anticipated to have any negative health consequences on local residents. The ozone levels at the other places (Owo, Ondo, Ilara-Mokin, Akure, Ore, Igbatoro, and Oba-Ile) range from 11 to 32 µg/m^3, which are likewise below the WHO standard and signify good to moderate air quality and low to moderate exposure to ozone pollutants. Except for those who already have lung diseases or are exposed for extended periods of time, residents in these places are also unlikely to encounter any negative health impacts from ozone. The results of ozone demonstrate that most areas in Nigeria have comparatively low levels of ozone pollution, which is one of the common components of smog for human health, compared to the previous results of AQI, which measure the overall amount of air pollution from numerous sources. But in other places, like Ilaje, natural or climatic elements like wind or sunlight (Widyastuti et al., 2021) may cause ozone pollution levels to be higher.



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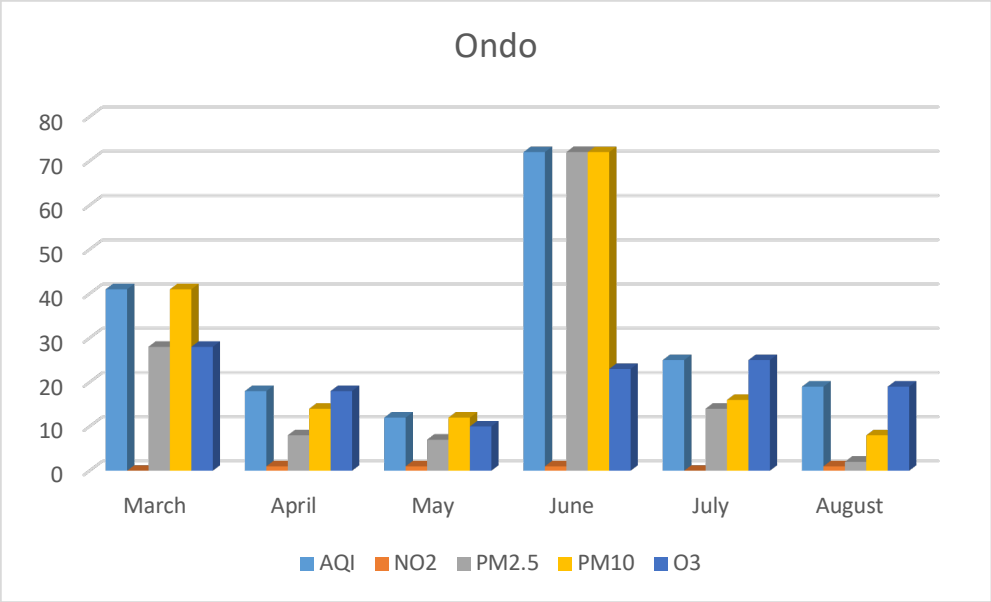

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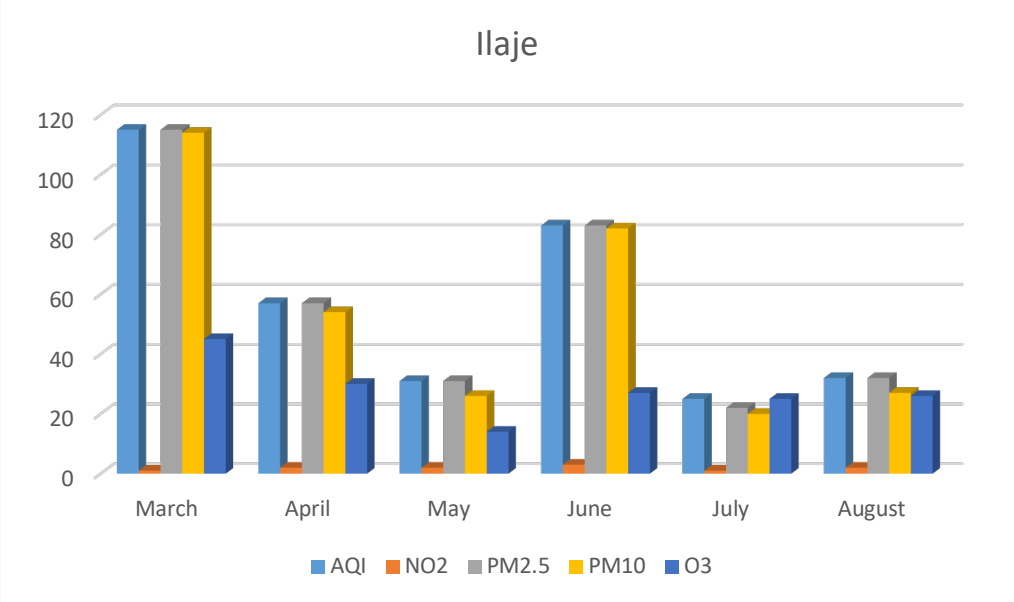

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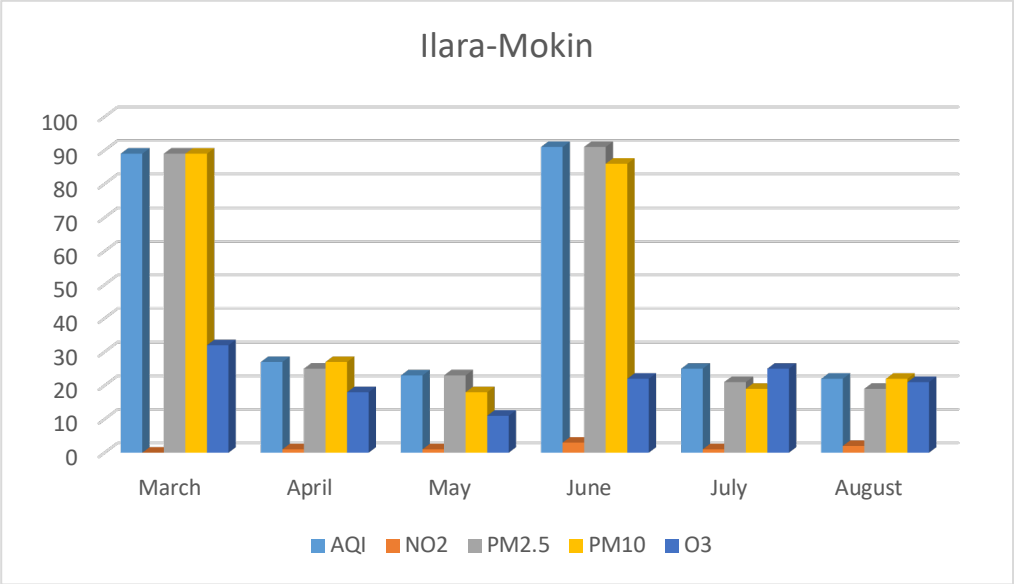

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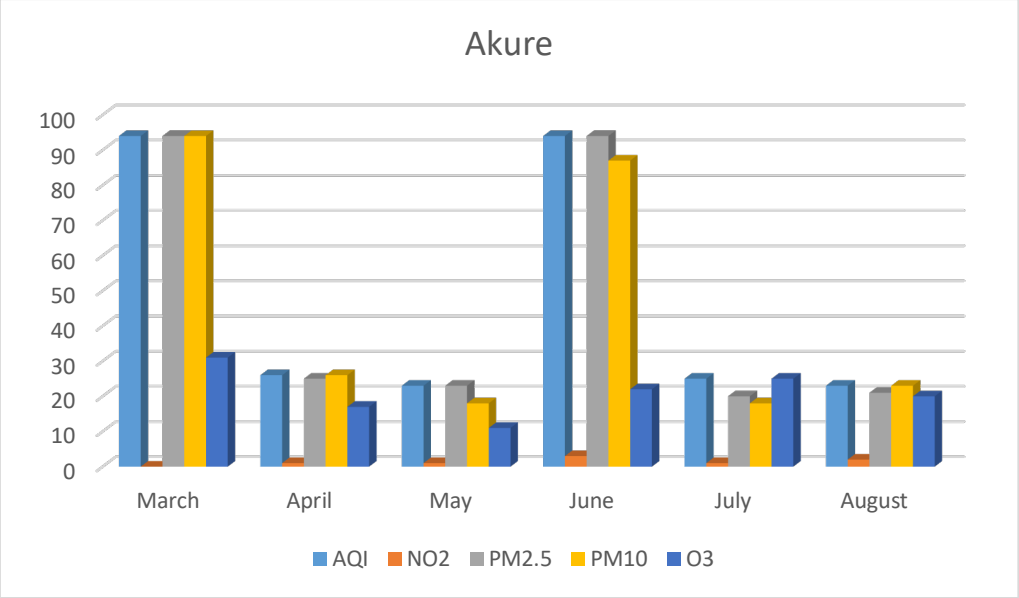

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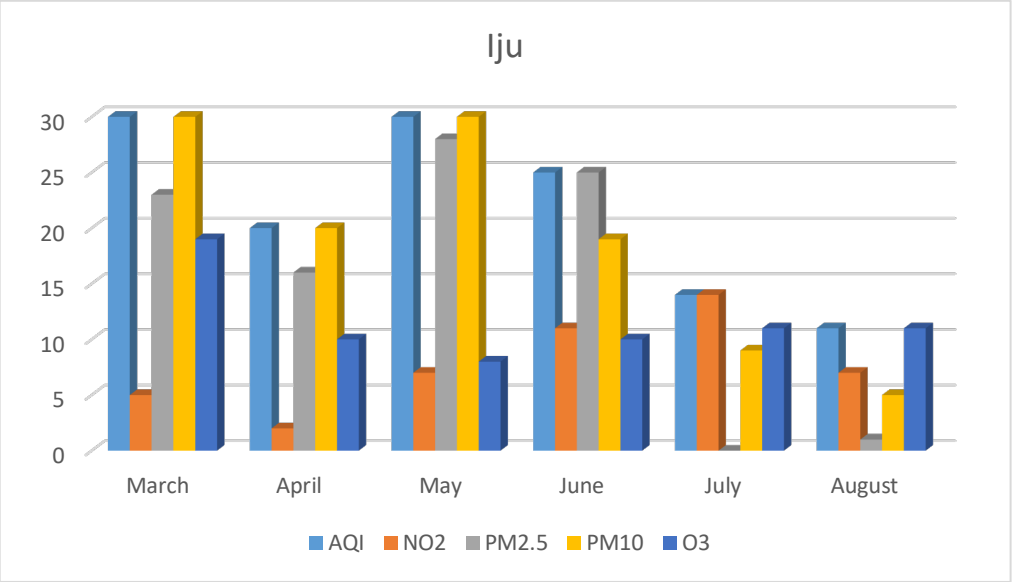

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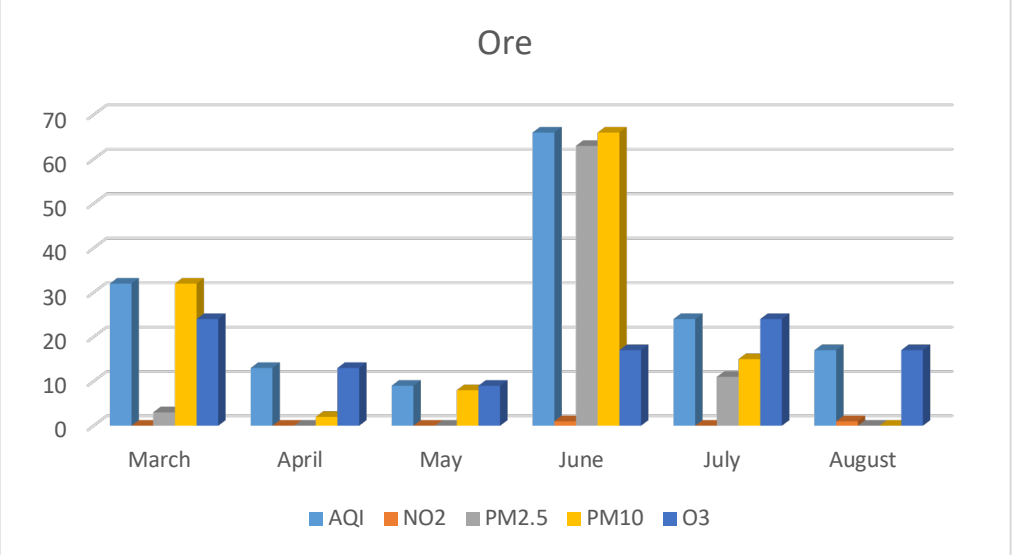

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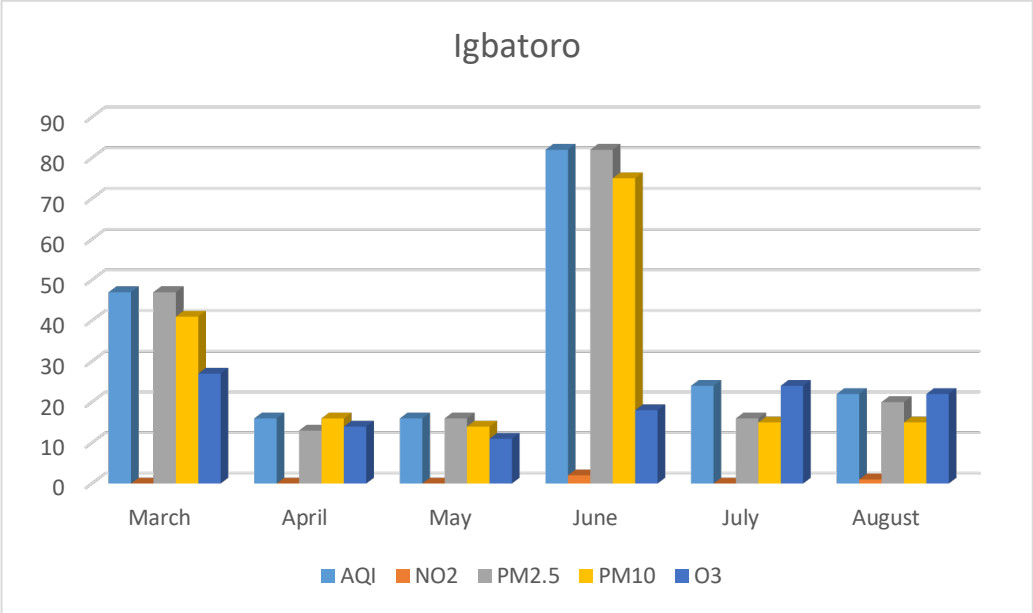

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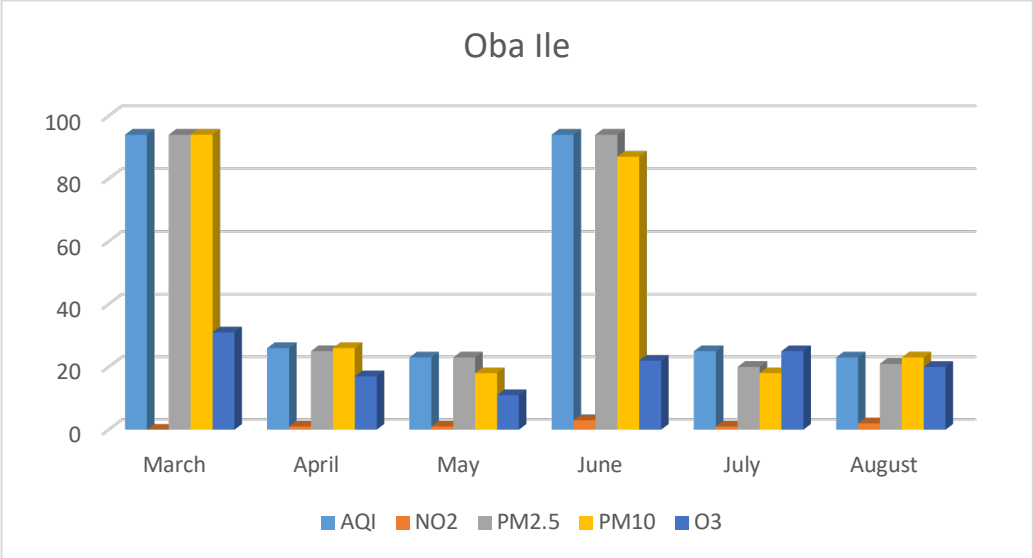

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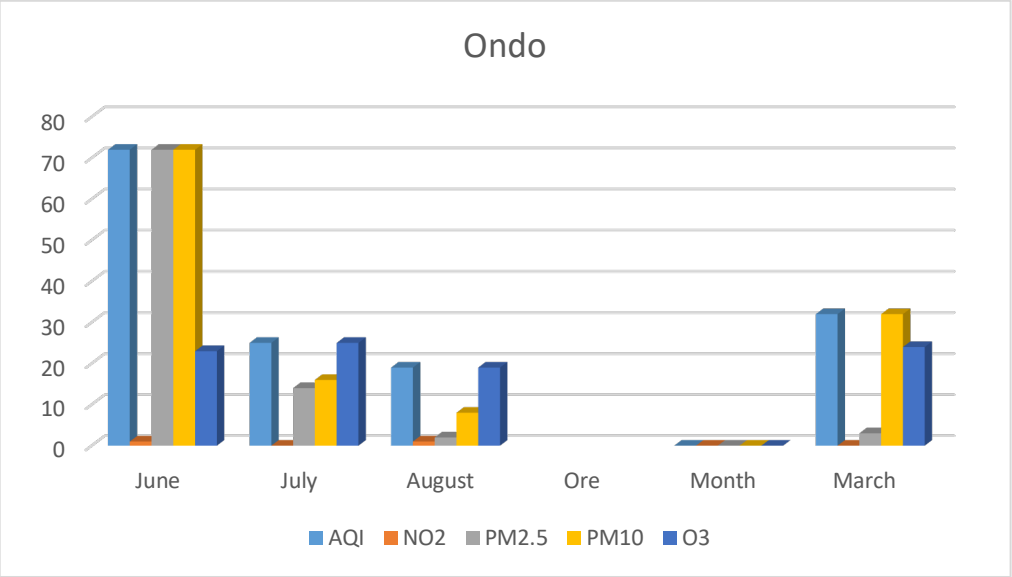

(j)

Figure 1 (a-j). Concentrations of the pollutants assessed between June and August in this study.

The pollution levels for the months of March through August are shown in Figures 1a through 1j. A number of variables, including weather, seasons, time of day, sources of emissions, location, and human activities, might affect the levels of AQI, $PM_{2.5}$, PM_{10}, and O_3. At Owo, Ondo, Ilaje, Ilara-Mokin, Akure, and Oba-Ile, these levels may be higher in March and June for the following reasons: Nigeria has its dry season from March and June, which means there is less rainfall and more dust in the air. This may raise the concentrations of $PM_{2.5}$ and PM_{10} from unmanaged sources, like sandstorms or soil erosion. In Nigeria, the hot season includes these months, which implies there is a greater amount of sunlight and warmer temperatures. O_3 concentrations may rise as a result of photochemical processes involving other air contaminants. There is a chance that these months will coincide with times when more people are engaging in activities that increase air pollution from a variety of sources, such as construction sites, factories, burning biomass (such as wood or crop residues), dumping waste (in open areas or in landfills), and diesel generators or coal-fired power plants.

The months of July and August are seen to have relatively low $PM_{2.5}$ and PM_{10} values in all the towns. The Nigerian rainy season, which brings increased precipitation and less airborne dust, may be the cause. This can lower the levels of $PM_{2.5}$ and PM_{10} from unmanaged sources including sandstorms and soil erosion. Additionally, the months are a portion of Southwest Nigeria's cool season, which means there is less sunlight and cooler temperatures. This can affect the creation and removal of $PM_{2.5}$ and PM_{10} by lowering the quantities of O_3 via photochemical interactions between other airborne contaminants. the decline in human activities that produce less air pollution from different sources, such as traffic jams, industrial emissions, burning biomass (like wood or crop residues), disposing of waste (like open burning or landfilling), or generating electricity (like with diesel generators or coal-fired plants) (Odukoya et al., 2019; Han et al., 2019). These actions have the potential to lower the concentrations of $PM_{2.5}$, PM_{10}, O_3, and other pollutants that affect AQI.

Comparing Ilaje to the other towns in this study, Ilaje has a higher overall AQI for contaminants. Ilaje is a seaside community in Ondo State, Nigeria, where many residents rely

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on fishing as their primary source of income. However, Ilaje is also impacted by violence and environmental deterioration brought on by oil production, which might worsen the area's air pollution levels (Abosede, 2017). Oil spills and gas flare-ups from the oil industry expose Ilaje to airborne harmful pollutants like PM, SO_2, NO_2, CO, and other gases that can be released in huge quantities. The plant and aquatic life that can help minimize air pollution can be harmed by oil spills because they can poison the soil and water (Odukoya et al., 2019; Han et al., 2019; Grifoni et al., 2020; Sattar et al., 2022). Violent disputes over ownership of land and resources, which may involve the use of guns, explosives, or fire, have an impact on the neighborhood. These may release more PM, CO, and other airborne contaminants. Conflicts can also impede people from engaging in their normal social and economic activities, leaving them more susceptible to the impacts of air pollution. The town is also close to the Atlantic Ocean, which may have an impact on the local temperature and weather. The dispersion and removal of air pollutants can be impacted by the moisture and wind that the ocean might bring. The water can improve or worsen Ilaje's air quality based on the time of year and day.

Table 3. Description of AQI Basics for Ozone and Particle Pollution

Towns	**Owo**	**Ondo**	**Ilaje**	**Ilara-Mokin**	**Akure**	**Iju**	**Ore**	**Igbatoro**	**Oba-Ile**
Mean	37.30	29.00	57.20	46.20	47.50	21.67	26.83	34.50	47.50
Colour Code									
Value of Index	0-50		51-100	101-150	151-200	201-300		301 and above	
AQI Basics Class	Good	Good	Moderate	Good	Good	Good	Good	Good	Good

According to the U.S. EPA, AQI values are divided into six categories, each with a different color and health implication (USEPA, 2022): Green (0-50): Good. Yellow (51-100): Moderate. Orange (101-150): Unhealthy Red (151-200): Unhealthy. Purple (201-300): Very Unhealthy. Maroon (301-500): Hazardous.

Table 3 shows the description of AQI of the pollutants. The Air Quality Index (AQI) is a standardized measure used to communicate the quality of the air and its potential health effects to the public. The AQI is typically categorized into different ranges or levels, with each range indicating a specific level of air quality and associated implications.

A score of 1 to 50 (Good) on the AQI denotes satisfactory air quality. This shows that the general public can breathe easily without suffering negative consequences in all of the tows, with the exception of Ilaje. It suggests that the levels of pollutants like NO_2, $PM_{2.5}$, PM_{10}, and O_3 are still rather low. Within this range, people can go outside and exercise without having to worry too much about health problems linked to air pollution. Whereas moderate air quality is defined as levels between 51 and 100 (Moderate). Most people still find it tolerable in general. Sensitive populations, such as those with respiratory disorders, the elderly, and youngsters, however, could feel a little pain or suffer negative effects. It suggests that there may be a modest increase in the amount of air pollutants like NO_2, $PM_{2.5}$, PM_{10}, or O_3 that may irritate the respiratory system or aggravate pre-existing medical disorders. Sensitive people should avoid extended outdoor exposure during this time frame and adopt the appropriate safety measures.

It is crucial to keep in mind that the effects of different AQI ranges can change based on the precise contaminants and their quantities. Varying pollutants have varying health consequences, and depending on the time of day and the location, they can contribute

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differently to the overall AQI. When evaluating the effects of various AQI levels, it is necessary to take into account the specific pollutant contributions and their accompanying health standards. All things considered, the AQI from these places gives the general public useful information about the air quality and enables people to make educated decisions about outdoor activities and potential health hazards linked to various levels of air pollution.

4. CONCLUSION

Using satellite data and a standard AQI metric, this study examined the regional and temporal fluctuations of air quality in Ondo State, Nigeria. The findings showed large regional variations in pollution levels, with $PM_{2.5}$ and NO_2 serving as the primary causes of the state's poor air quality. The study also produced a town-specific air quality index (AQI) for more precise and localized evaluations of air quality and its effects on human health. The levels of AQI, $PM_{2.5}$, PM_{10}, and O_3 at Owo, Ondo, Ilaje, Ilara-Mokin, Akure, and Oba-Ile, were higher in March and June. The months of July and August are seen to have relatively low $PM_{2.5}$ and PM_{10} values in all the towns. Comparing Ilaje to the other towns in this study, Ilaje has a higher overall AQI for contaminants. The results offer important data for future monitoring, policy development, and raising public awareness of the problem of air pollution in Ondo State. The study aims to advance sustainable development and enhance the state's population's quality of life.

5. REFERENCES

Abosede Omowumi Babatunde. "Environmental Insecurity and Poverty in the Niger Delta: A Case of Ilaje." *African Conflict and Peacebuilding Review, vol. 7*, no. 2, 2017, pp. 36–59. DOI: https://doi.org/10.2979/africonfpeacrevi.7.2.02

Abulude, F.O. (2021). Right and Cheap Information on Air Quality: The Cases of Real-time AirQuality Index Monitors (Satellite and Phone apps). *Academia Letters, Article 3401*. DOI: https://doi.org/10.20935/AL3401

Abulude, F.O., Abulude, I.A. (2021). Monitoring Air Quality in Nigeria: The Case of Center for Atmospheric Research-National Space Research and Development Agency (CAR-NASRDA). *Aerosol Sci Eng 5*, 478–498. DOI: https://doi.org/10.1007/s41810-021-00116-3

Abulude, F.O., Arifalo, K.M., Kenni, A.M., Akinnusotu, A., Oluwagbayide, S.D., and Sunday, A. (2022). Air Quality Index Levels Of Particulate Matter (Pm2.5) In Yenogua, Nigeria. *Jurnal Geografi Gea 22*(2), 95-105.

Abulude, F.O. Oluwafemi, M.O., Arifalo, M.., Elisha, J.J., Kenni, A.M. (2023). Assessment of Indoor Household Air Quality Using SentinAir's Cost-effective Sensor. *Tropical Aquatic and Soil Pollution 3*(1), 15-23.

AirNow.gov (2022). AQI basic. Air quality index. https://www.airnow.gov/aqi/ (accessed 21st May 2022).

Anand, A.; Phuleria, H.C. (2022). Assessment of indoor air quality and housing, household and health characteristics in densely populated urban slums. *Environment, Development, Sustainability, 24*, 11929–11952. DOI: https://doi.org/10.1007/s10668-021-01923-x

Burns, J., Boogaard, H., Polus, S., Pfadenhauer, L.M., Rohwer, A.C., van Erp, A. Turley, R., and Rehfuess, E.A. (2020). MInterventions to reduce ambient air pollution and their effects on health: An abridged Cochrane systematic review. *Environment International. Volume 135*, February 2020, 105400, DOI: https://doi.org/10.1016/j.envint.2019.105400

Chen, Hu, Guoqu Deng, and Yiwen Liu. (2022). "Monitoring the Influence of Industrialization and Urbanization on Spatiotemporal Variations of AQI and PM2.5 in Three Provinces, China" *Atmosphere 13*, no. 9: 1377. https://doi.org/10.3390/atmos13091377

Dong, D. and Wang, J. (2023). Air pollution as a substantial threat to the improvement of agricultural total factor productivity: Global evidence. *Environment International. Volume 173*, March 2023, 107842. DOI: https://doi.org/10.1016/j.envint.2023.107842

Du, W. and Wang, G. (2020). Indoor Air Pollution was Nonnegligible during COVID-19 Lockdown. *Aerosol Air Qual. Res. 20*: 1851–1855. DOI: https://doi.org/10.4209/aaqr.2020.06.0281

Grifoni, M., Rosellini, I., Angelini, P., Petruzzelli, G., Pezzarossa, B. (2020). The effect of residual hydrocarbons in soil following oil spillages on the growth of Zea mays plants. *Environmental Pollution. Volume 265*, Part A, October 2020, 114950. DOI: https://doi.org/10.1016/j.envpol.2020.114950

Han, M.; Zhang, J.; Chu, W.; Chen, J.; Zhou, G. Research Progress And Prospects Of Marine Oily Wastewater Treatment: A Review. *Water 2019*, 11, 2517. DOI: https://Doi.Org/10.3390/W11122517

Hormati M, Mohammadi MJ, Iswanto A H, Mansourimoghadam S, Taifi A, Maleki H, Fakri Mustafa Y, Fouladi Dehaghi B, Afra A, Taherian M, Kiani F. (2022). Consequences and health effects of toxic air pollutants emission by industries. *JAPH. 7*(1), 95-108.

Husaini, D.C., Reneau, K., and Balam, D. (2022). Air pollution and public health in Latin America and the Caribbean (LAC): a systematic review with meta-analysis. *Beni Suef Univ J Basic Appl Sci. 2022; 11*(1), 122. DOI: doi: 10.1186/s43088-022-00305-0

Li, W., Yang, G., and Li, X. (2021). Correlation between PM2.5 pollution and its public concern in China: Evidence from Baidu Index. *Journal of Cleaner Production. Volume 293*, 15 April 2021, 126091. DOI: https://doi.org/10.1016/j.jclepro.2021.126091

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in public health, 8*, 14. DOI: https://doi.org/10.3389/fpubh.2020.00014

Mardiansjah, F.H. and Rahayu, P. (2020). Perkembangan Kawasan Pekrotaan Kecil di Pinggiran Kota Pekalongan. *Jurnal Geografi Gea, 20* (2): 151-168.

Motesaddi, S., Hashempour, Y., and Nowrouz, P. (2017). Characterizing of Air Pollution in Tehran: Comparison of Two Air Quality Indices. *Civil Engineering, 3*(9), 749-758. DOI: http://dx.doi.org/10.21859/cej-030911

Muhamad-Darus, F.; Zain-Ahmed, A.; Latif, M.T. (2011). Preliminary Assessment of Indoor Air Quality in Terrace Houses. *Health and the Environment Journal, 2*, 8-14.

Odukoya, J.; Lambert, R.; Sakrabani, R. (2019). Understanding The Impacts Of Crude Oil And Its Induced Abiotic Stresses On Agrifood Production: A Review. *Horticulturae, 5*, 47. DOI: https://doi.org/10.3390/Horticulturae5020047

Piracha, A.; Chaudhary, M.T. (2022). Urban Air Pollution, Urban Heat Island and Human Health: A Review of the Literature. *Sustainability, 14*, 9234. DOI: https://doi.org/10.3390/su14159234

Ridwana, R., Himayah, S., Rabbi, M. F. A., Lugina, I. M. A., Al Kautsar, A., & Sakti, A. D. (2023). Monitoring Aerosol Optical Depth for Air Quality Through Himawari-8 in Urban Area West Java Province Indonesia. JURNAL GEOGRAFI, 15(2), 182-194.

Sattar, S., Hussain, R., Shah, S.M., Bibi, S., Ahmad, S.R., Shahzad¸A¸Zamir, A., A., Rauf, Z., Noshhad, A., and Ahmad, L., (2022). Composition, impacts, and removal of liquid petroleum waste through bioremediation as an alternative clean-up technology: A review. *Heliyon. Volume 8*, Issue 10, October 2022, e11101. DOI: https://doi.org/10.1016/j.heliyon.2022.e11101

Setiacahyandari, H.K., Rachmawati, A.A. Sumuna, A.A.K., Khairunnisa, A.T., Anindita, L.C., Udzkhiyati,L.U., and Suprayogi, S. (2022). Analysis of Surface Water Potential for Domestic Water Use in Gunungkidul Ecoregion. *Jurnal Geografi Gea, Volume 22*, Number 2, 165-175. DOI: https://doi.org/10.17509/gea.v22i2.48209

Tuejeh, H., Meylani, E.S., and Jalaludin, M. (2023). The Effect of Temperature on The Development Of Seagrass In The Waters Of Pramuka Island, Kepulauan Seribu Regency, Jakarta, Indonesia. *Jurnal Geografi Gea, Volume 23*(1), 1-7.

Xu, X.; Yang, H.; Li, C. Theoretical Model and Actual Characteristics of Air Pollution Affecting Health Cost: A Review. Int. J. Environ. Res. *Public Health 2022, 19*, 3532. DOI: https://doi.org/10.3390/ijerph19063532

USEPA (2022). What is the Air Quality Index (AQI)? Patient Exposure and the Air Quality Index | US EPA. (Accessed 21st May 2022).

USEPA (2023). Basic information about NO2. Nitrogen dioxide (NO2) Pollution, Basic Information about NO2 | US EPA (Accessed 21 May 2022).

WHO Regional Office for Europe (2003). Health Aspects of Air Pollution, Chapter 7 Nitrogen dioxide, Section 7.2 Answers and rationales.

WHO (2021). WHO Global Air Quality Guidelines. WHO Global Air Quality Guidelines (Accessed 21st May 2022).

Widyastuti, M., Suprayog, S., Hadi, M.P., Christato, ., Tivianton, A., Fadilah, G.O., and Rahmawati, L. (2021). Study Of Groundwater Vulnerability To Pollution In The Tambakbayan Watershed In 2006 And 2017. *Jurnal Geografi Gea, Volume 21*(1), 1-15. DOI: https://doi.org/10.17509/gea.v21i1.28368.g14618