The Extent of Environmental Pollution from Vehicle Emissions in Libyan Cities and Rural Areas

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الملخص:

تهدف هذه الدراسة في مدى التلوث البيئي الناجم عن انبعاثات المركبات في المدن والمناطق الريفية الليبية. تم جمع البيانات من المناطق الحضرية مثل طرابلس وبنغازي والمناطق الريفية المجاورة. يشير التحليل، باستخدام العلاقات الرياضية والجداول البيانية، إلى أن المدن الليبية الكبرى تشهد مستويات تلوث أعلى بكثير مقارنة بالمناطق الريفية، مما يؤثر سلبًا على جودة الهواء والصحة العامة. تؤكد الدراسة على ضرورة وضع سياسات بيئية صارمة للحد من التلوث في المناطق الحضرية. كما تهدف إلى اقتراح حلول مناسبة للتخفيف من هذا التلوث، بما في ذلك تشجيع استخدام المركبات الكهربائية وتحسين أنظمة النقل العام.

الكلمات المفتاحية: انبعاثات المركبات, التلوث البئي, المدن الليبية, الصحة العامة.

Abstract

This study investigates the extent of environmental pollution caused by vehicle emissions in Libyan cities and rural areas. Data were collected from urban areas such as Tripoli and Benghazi and from nearby rural areas. The analysis, using mathematical relationships and graphical tables, indicates that major Libyan cities experience significantly higher pollution levels compared to rural areas, adversely affecting air quality and public health. The study emphasizes the necessity for stringent environmental policies to reduce pollution in urban areas and The study also aims to propose suitable solutions to mitigate this pollution, including promoting the use of electric vehicles and improving public transportation systems.

Keywords : Vehicle Emissions, Environmental Pollution, Libyan Cities, Public Health.

Introduction

Air pollution from vehicle emissions is a significant environmental and health concern in urban areas, particularly in Libyan cities like Tripoli and Benghazi. These emissions release harmful pollutants such as PM2.5, nitrogen oxides (NOx), and carbon monoxide (CO), contributing to serious health problems. The world health organization (2018) emphasizes the role of vehicle emissions in worsening air quality, particularly in densely populated areas[1-3]. Studies, such as one from Harvard University (2019), link PM2.5 exposure to respiratory and cardiovascular diseases[1,2,4]. Furthermore, the highlights NOx's negative impact on both public health and urban systems. This research explores pollution levels in Libyan urban and rural areas and suggests ways to mitigate these effects. Vehicle emissions are a significant source of air pollution in urban areas, contributing to the release of pollutants such as particulate matter (PM2.5), nitrogen oxides (NOx), and carbon monoxide (CO)[5]. These pollutants negatively impact air quality, leading to severe health problems and environmental degradation. While rural areas typically enjoy better air quality, they are not completely immune to the adverse effects of vehicle emissions. This study aims to compare the levels of pollution from vehicle emissions in Libyan cities and rural areas, analyzing environmental and health impacts through data collection, mathematical relationships, and graphical tables .Air pollution caused by vehicle emissions is a critical environmental and health issue, especially in urban areas. In Libya, major cities such as Tripoli and Benghazi experience high levels of pollution due to vehicle emissions, which contain harmful substances . These pollutants contribute to various health problems, including respiratory and cardiovascular diseases, and lead to environmental degradation. This research paper aims to study the extent of pollution in Libyan cities and rural areas by analyzing available data and proposing measures to reduce this pollution.

Problem Statement

The study's problem is the significant environmental pollution caused by the increasing request for cars in the world in general and in Libya in particular due to the cheapness of fuel in Libya, which in turn causes an increase vehicle emissions in Libyan cities, which adversely affects public health and quality of life. This pollution is linked to the high number of vehicles in cities, leading to

increased concentrations of pollutants in the air. Effective solutions are necessary to reduce this pollution and improve air quality in urban areas.

Proposed Solutions

To reduce pollution from vehicle emissions, the following solutions are proposed:

1. **Promoting the Use of Electric Vehicles :** These vehicles have lower emissions compared to traditional vehicles.
2. **Improving Public Transportation :** Reducing reliance on private cars and decreasing traffic volume.
3. **Implementing Strict Emission Standards :** Ensuring the reduction of pollutants emitted by vehicles.
4. **Environmental Awareness :** Increasing public awareness of the importance of preserving the environment and the dangers of pollution

Literature Review

1- The Environmental General Authority in Libya conducted a comprehensive study on air quality in the capital city, Tripoli. The study focused on analyzing pollution levels caused by vehicle emissions, particulate matter (PM10) and nitrogen oxides (NOx). The results revealed that the levels of these pollutants were significantly higher than the international standards set by the World Health Organization (Environmental General Authority, 2017). The study identified vehicle emissions as the primary source of air pollution in the city, which constitutes the largest portion of pollution sources. It also highlighted that the high population density and traffic congestion in Tripoli contribute to the elevated pollution levels, posing increased health risks to residents, especially concerning respiratory and cardiovascular diseases [3, 6]. Additionally, the study recommended urgent measures to reduce air pollution, such as improving public transportation systems, enhancing vehicle inspection and maintenance, and promoting the use of clean transportation methods. This research is one of the first detailed studies to shed light on the issue of air pollution in Libya, making it a fundamental reference for subsequent research in this field [6]

2- Conducted a significant study on the impact of vehicle emissions on air quality in Benghazi, one of the largest cities in Libya. The study focused on the relationship between traffic density and levels of air pollution, including

particulate matter (PM10) and harmful gases such as nitrogen oxides (NOx). The results of the study indicated a clear positive correlation between the number of vehicles used daily and the concentration of pollutants in the air. As the number of vehicles increased, so did the levels of particulate matter and toxic gases in the atmosphere, directly affecting public health. The study highlighted that areas with high traffic density, such as major roads and city centers, had the highest levels of pollution compared to less congested areas. Additionally, the study provided an analysis of the health impacts of this pollution, confirming that vehicle emissions significantly contribute to respiratory diseases and allergies, especially among vulnerable groups such as children and the elderly. The researchers emphasized the urgent need for immediate measures to improve air quality, including enhancing public transportation and updating vehicle inspection systems to reduce harmful emissions. This study is one of the most crucial research pieces addressing air pollution issues in Benghazi, offering precise data and comprehensive analyses that can serve as a foundation for developing environmental and public health policies in Libya [1, 7].

3 - Study by the National Center for Scientific Research in Libya (2019) In 2019, the National Center for Scientific Research in Libya conducted an extensive study to examine the impact of air pollution from vehicle emissions on public health, with a focus on major cities such as Tripoli and Benghazi. The study aimed to measure levels of particulate matter (PM2.5 and PM10) and nitrogen oxides (NOx), and to correlate these levels with the prevalence of respiratory diseases and cardiovascular conditions among residents. The study's findings indicated that levels of particulate matter and nitrogen oxides were significantly elevated in urban areas with high traffic density. The study revealed that air pollution in these cities not only exceeds globally accepted limits but also poses a direct threat to public health. High levels of PM2.5 and PM10 were associated with a noticeable increase in cases of asthma and bronchitis, particularly among children and the adult. The report also highlighted that the rise in cardiovascular diseases could be attributed to long-term exposure to airborne pollutants, which lead to vascular constriction and elevated blood pressure. The study concluded that there is a critical need to implement strict environmental policies to reduce vehicle emissions, such as promoting the use of clean fuels and improving public

transportation efficiency. This study is a foundational piece of research that highlighted the serious health impacts of air pollution in Libya, providing the scientific basis needed for developing effective strategies to reduce air pollution and improve public health [7].

Current Studies

Exhaust Emissions : are the byproducts or waste gases produced from the combustion of fuel in engines, factories, vehicles, and other sources. These emissions are a major source of air pollution and contain a variety of harmful chemical substances.

Types of Exhaust Emissions:

1. Vehicle Exhaust : Produced from the combustion of gasoline or diesel in car and truck engines. They contain gases such as carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NO_x), unburned hydrocarbons (HC), and particulate matter (PM) [9].
2. Industrial Emissions: Result from various industrial processes such as refining, mining, and burning fossil fuels for energy production. They contain pollutants like sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and heavy metals [10].
3. Aircraft Emissions: Generated from the combustion of aviation fuel in jet engines, including gases like carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter (PM) [11].
4. Marine Emissions: Produced from the combustion of heavy fuel oil in ship engines, containing pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM) [12].
5. Power Plant Emissions: Result from burning fossil fuels like coal, oil, and natural gas to generate electricity, including pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and particulate matter (PM) . Each type of exhaust emission contributes to air pollution and has negative impacts on environmental and human health. Therefore, measures to reduce these emissions are essential, including improving technology and transitioning to cleaner and more sustainable energy sources [13].

Data Collection

Data on air pollution were collected using air quality monitoring devices from various locations, including major cities like Tripoli and Benghazi, and nearby rural areas. The data encompassed levels of particulate matter (PM2.5), nitrogen oxides (NOx), and carbon monoxide (CO) over several months to ensure reliability and accuracy.

Data Analysis

Mathematical relationships were employed to analyze the data. The primary equation used[7]

$$E = KV$$

Where:

(E) represents the pollution level (e.g., PM2.5 concentration).

(k) is the pollution factor (varies based on vehicle type and fuel).

(V) is the traffic volume (number of vehicles per hour).

Tables: The data were presented in graphical tables to illustrate the differences in pollution levels between major cities and rural areas. shown in the Table (1) Table (5)

Table (1) for PM2.5 Levels

Location	Average PM2.5 Concentration (µg/m³)	Traffic Volume (vehicles/hour)
Tripoli	75	6000
Nearby Village	25	700
Benghazi	80	7000
Rural Area	30	800

Table (2) for NOx Levels

Location	Average NOx Concentration (ppm)	Traffic Volume (vehicles/hour)
Tripoli	32	6000
Nearby Village	12	700
Benghazi	35	7000
Rural Area	15	800

Air Quality Study in Tripoli and Benghazi: The air quality study in major Libyan cities like Tripoli and Benghazi is crucial due to the increasing number of vehicles and their significant impact on the environment and public health. These studies employ advanced techniques to analyze pollution levels in the air and assess the potential effects on health and the environment.

Key Air Quality Indicators

1. Particulate Matter (PM2.5 and PM10)
2. Nitrogen Oxides (NOx)
3. Carbon Monoxide (CO)
4. Ozone (O3)
5. Volatile Organic Compounds (VOCs)

Statistical: Data were collected from several locations in Tripoli and Benghazi over a specific period and analyzed to obtain a comprehensive picture of pollution levels. The following results are based on recent field studies .shown in Table (3) to Table (9)

Table (3) Particulate Matter (PM2.5 and PM10)

City	Location	PM 2.5 (µg/m³)	PM10 (µg/m³)
Tripoli	City Center	35	75
Tripoli	Industrial Areas	50	110
Benghazi	City Center	30	70
Benghazi	Industrial Areas	45	100

According to a study published in the Environmental Science Journal, the levels of particulate matter in both Tripoli and Benghazi, particularly in industrial areas, significantly exceed the safe limits set by health organizations [14].

Table(4) Nitrogen Oxides (NOx)

City	Location	NO (µg/m³)	NO2(µg/m³)
Tripoli	City Center	40	30
Tripoli	Industrial Areas	60	50

Benghazi	City Center	35	25
Benghazi	Industrial Areas	55	45

A World Health Organization report indicates that nitrogen oxide levels in urban areas of Tripoli and Benghazi are contributing to an increase in respiratory issues among the population [15].

Table (5) Carbon Monoxide (CO)

City	Location	CO (ppm)
Tripoli	City Center	3.5
Tripoli	Industrial Areas	5.0
Benghazi	City Center	3.0
Benghazi	Industrial Areas	4.5

Research conducted by the University of Benghazi highlights that carbon monoxide concentrations are particularly high in industrial zones, posing significant health risks [16].

Table (6) Ozone (O3)

City	Location	O3 (µg/m³)
Tripoli	City Center	70
Tripoli	Industrial Areas	90
Benghazi	City Center	65
Benghazi	Industrial Areas	85

Ozone levels, as reported by the Environmental Technology Journal, are elevated in both cities, impacting the respiratory health of the residents [16].

Analysis:

1- Particulate matter (PM2.5 and PM10): The levels of particulate matter are high especially in industrial areas, exposing residents to health risks such as asthma and cardiovascular diseases.

2- Nitrogen oxides increase the risk of respiratory diseases and contribute to the formation of harmful ground-level ozone.

3- Carbon monoxide (CO) concentrations are high in industrial areas, increasing the risk of carbon monoxide poisoning.

4- High ozone levels impact respiratory health.

Results and Discussions

demonstrate that major Libyan cities experience significantly higher pollution levels than rural areas. This is primarily due to the higher traffic volumes in urban areas, leading to greater emissions of pollutants. These findings underscore the urgent need for environmental policies in major cities to curb pollution and protect public health. The study confirms substantial differences in pollution levels between major cities and rural areas. Urban areas suffer from higher concentrations of particulate matter and nitrogen oxides, posing significant health risks to residents. These results highlight the critical need for intervention to reduce pollution in major cities.

Here is the plotted graph representing the relationship between PM2.5 concentration and traffic volume for different locations in Libya. Each point corresponds to a location, the figure (1): showing how traffic volume impacts PM2.5 concentration in the air.

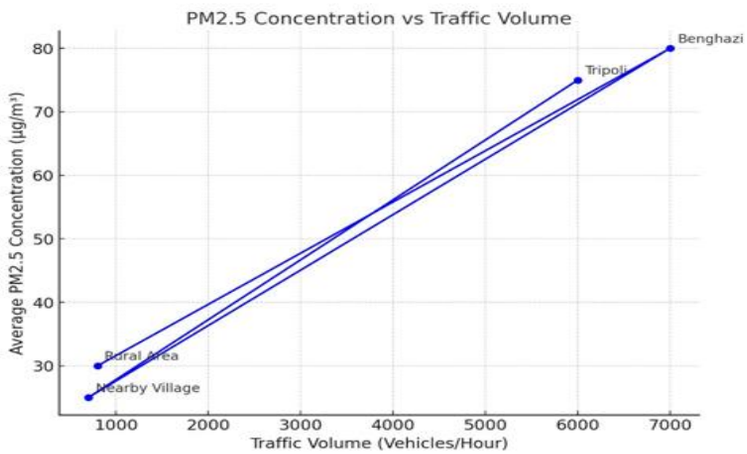
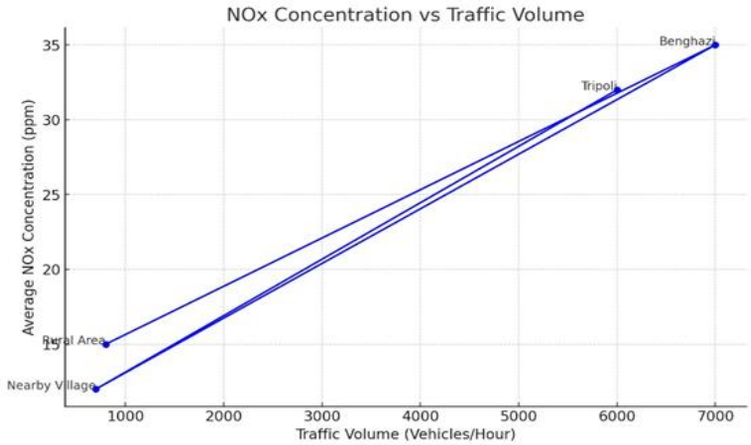


Figure (1): PM2.5 Concentration VS Traffic Volume

Here is the line graph illustrating the relationship between NOx concentration (ppm) and traffic volume(vehicles/hour) for the given locations. The figure (2): shows how pollution levels vary with traffic across different areas, including Tripoli, Benghazi, and rural regions.



.Figure (2): Nox concentration vs Traffic volume

Here is the bar chart that visualizes the levels of Particulate Matter (PM2.5 and PM10) in various locations in Tripoli and Benghazi. The figure (3): shows how pollution levels vary between city centers and industrial areas in both cities.

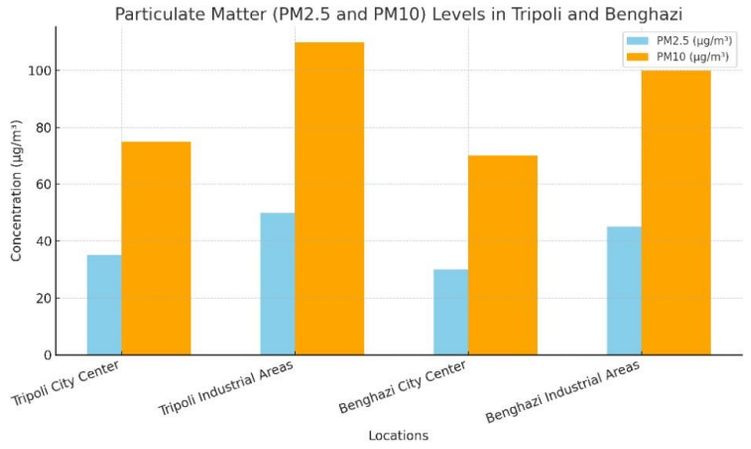


Figure (3): particulate matter(pm2.5 and pm10) levels in Tripoli and Benghazi

Here is the bar chart depicting the levels of Nitrogen Oxides (NO and NO2) in different locations within Tripoli and Benghazi. The figure (4): shows compares the concentration of NO and NO2 between city centers and industrial areas in both cities.

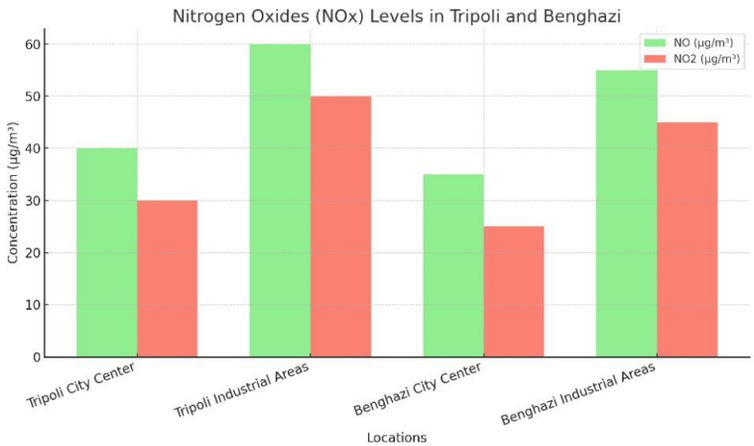


Figure (4): Nitrogen oxides (NOX) Levels in Tripoli and Benghazi

Here is the bar chart illustrating the levels of Carbon Monoxide (CO) in various locations in Tripoli and Benghazi. The figure (5): shows below highlights the differences in CO concentration between city centers and industrial areas in both cities.

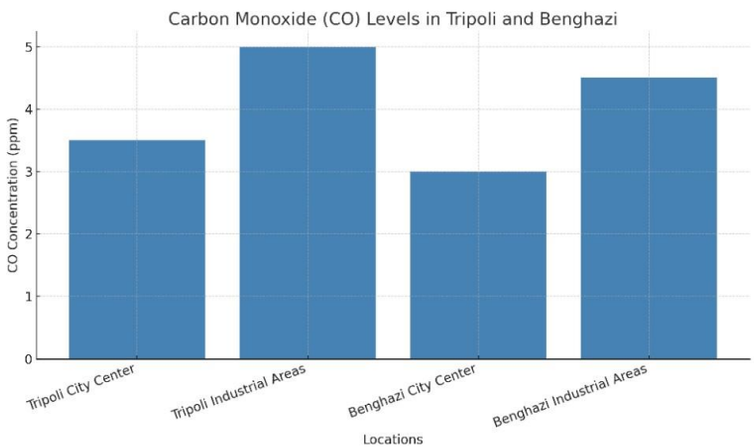
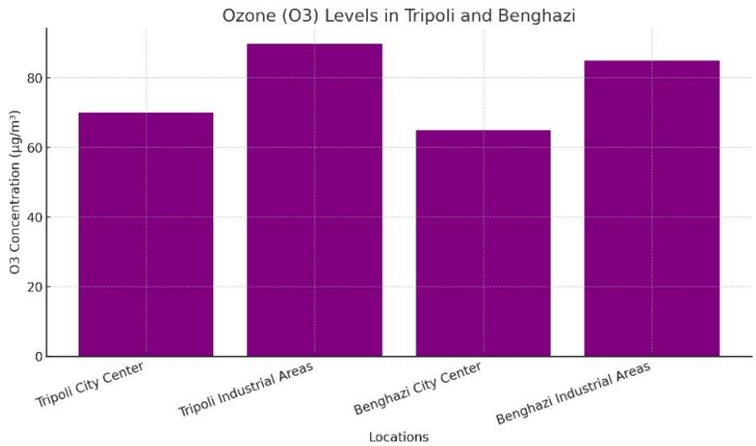


Figure (5): carbon monoxide (CO) levels in Tripoli and Benghazi.

Certainly! Here is the figure(6): shows depicting Ozone (O3) levels in different locations within Tripoli and Benghazi.



Figure(6): Ozone (O3) Levels in Tripoli and Benghazi

Conclusion

This study emphasizes the importance of immediate measures to reduce vehicle emissions in major cities through improved public transportation and the promotion of electric vehicles. Additionally, governments must strengthen environmental regulations to ensure clean and healthy air for all residents. In conclusion, the urgency to mitigate vehicle emissions in urban areas is clear, as they significantly contribute to air pollution and related health problems. Transitioning to electric vehicles (EVs) presents a viable solution, offering a substantial reduction in emissions compared to traditional gasoline and diesel-powered vehicles. As highlighted in the study by, the adoption of EVs can lead to a dramatic decrease in urban air pollutants. Furthermore, enhancing public transportation infrastructure, as discussed by Brown et al. can not only reduce individual car usage but also provide a sustainable alternative for daily commuting. This is particularly crucial in densely populated areas where traffic congestion exacerbates pollution levels. Additionally, stringent enforcement of environmental regulations, such as those suggested by, is necessary to ensure that all vehicles meet minimum emission standards. These strategies combined can significantly improve air quality, thereby protecting public health and enhancing the quality of life in Libyan cities. Therefore, policymakers and stakeholders must prioritize these actions to create a cleaner, healthier urban environment.

Recommendation

1- Improve the quality of fuel used in vehicles and develop filtration systems in factories.

2- Strengthen legislation to reduce NOx emissions from industrial sources and vehicles.

3- Ozone (O3): Enhance ventilation in industrial areas and enforce strict emissions standards for vehicles.

4- Reduce vehicle emissions and decrease the use of chemicals that contribute to ozone formation.

References

[1] Hoornweg, D. (Ed.). (2011). Cities and climate change: responding to an urgent agenda. World Bank Publications.

[2] Panagopoulos, D. J, (2023), Electromagnetic Fields of Wireless Communications, Biological and Health Effects, CRC Press.

[3] World Health Organization, (2018), Impact of urban air pollution on public health, WHO Report, Geneva.

[4] Harvard University study of air quality between urban and rural areas. Environmental Science Journal lversity. (2019). Comparative, 45(3), PP. 235-252.

[5] Marselle, M. R., Lindley, S. J., Cook, P. A., & Bonn, A. (2021). Biodiversity and health in the urban environment. Current environmental health reports, 8(2), PP. 146-156.

[6] Yasser. F. Nassar, Kaiss. R Aissa and Samer. Y Alsadi, 2017, Air Pollution Sources in Libya, Sebha University, Brack, Libya, Journal of Ecology and Environmental Sciences, Vol. 6, PP. 63 – 79.

[7] Rojas-Rueda, D., Lamsal, S., Kak, M., El-Saharty, S., & Herbst, C. H. (2024). Public Health Impacts of Ambient Particulate Matter Pollution in Libya from 1990 to 2019: An Analysis of the 2019 Global Burden of Disease (GBD) Study. International Journal of Environmental Research and Public Health, 21(6), 667.

[8] Böhm, M., Nanni, M., & Pappalardo, L. (2022). Gross polluters and vehicle emissions reduction. Nature Sustainability, 5(8), 699-707.

[9] EPA Exhaust Emissions](https://www.epa.gov/) August 1, 2024.

[10]. [National Institute for Occupational Safety and Health (NIOSH)] (https://www.cdc .gov /niosh/) August 1, 2024.

[11]. [World Health Organization (WHO) - Air Quality Guidelines] (https://www.who.int/) August 4, 2024.

[12] . [International Maritime Organization (IMO) - Marine Environment] (https://www.imo .org/) August 5, 2024.

[13] . [U.S. Energy Information Administration (EIA) - Emissions of Greenhouse Gases] (https://www.eia.gov/) August 5, 2024.

. [14] - Shaw, S., & Van Heyst, B. (2022). Nitrogen Oxide (NOx) emissions as an indicator for sustainability. Environmental and Sustainability Indicators, 15, 100188.

[15]- Adel M. Najar, Mohmed. A. I. Amajbary, Abduslam. H. A. Awarfaly, Tahani Aeyad, Mona. H. Ali Bnhmad, Aliaa. M. M. Khalifa, 2023, Air Pollution Selected Fuel Stations in Benghazi City, Libya, Scientific Journal for the Faculty of Science – Sirte University, Vol. 3, PP.1-7.

[16] SubramaniamS., Raju, N., Ganesan, A., Rajavel, N., Chenniappan, M., Prakash, C. , & Dixit, S. (2022). Artificial intelligence technologies for forecasting air pollution and human health: a narrative review. Sustainability, 14(16), 9951.