Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

Comparative Evaluation of Post-Monsoon Crossroads Air Quality Variations in Major Cities of the Greater Dhaka Region

S. M. Sium[1*], Afrin Sharabony[2], Dr. Kazi Md. Fazlul Haq[3]

[1,2,3]Department of Geography and Environment, University of Dhaka, Shahbag, Dhaka, Bangladesh.*

Email: [2]afrin.sharabony.geoenv@gmail.com, [3]kazihaq.geoenv@du.ac.bd
Corresponding Email: [1]sm-63-2017618898@geoenv.du.ac.bd*

Received: 20 October 2023 **Accepted:** 06 January 2024 **Published:** 20 February 2024

Abstract: This study investigates the escalating issue of urban air pollution in Dhaka and its surrounding areas, focusing on the post-monsoon period. Utilizing Aeroqual Series 500 air quality monitors, this research measured concentrations of NO2, SO2, CO2, CH4, PM2.5, and PM10 at 24 strategically selected sites in Dhaka, Narayanganj, and Gazipur. The findings reveal elevated levels of NO2 across multiple regions, notably exceeding the standard threshold of 0.053 ppm, with Gulistan, Mirpur10, Gabtuli Darus-salam, Farmgate, and Savar exhibiting the highest concentrations. Additionally, Gulistan displayed a significant peak in SO2 levels at 0.3 ppm. Areas adjacent to the Buriganga River, specifically Lalbagh and Kadamtuli, were identified as heavily polluted as they have been characterized by strong odour and poor air quality. High concentrations of CH4 and CO2 were detected in the New Market, Zinda Park, and Jirani Bazar, surpassing established safe levels. The study highlights Dhaka's alarming average Air Quality Index (AQI) of 186.8, with a peak of 395 at Joydebpur Rail Station and a low of 110 at Panam City. This research underscores the critical need for enhanced air quality monitoring and control strategies in Dhaka, highlighting the severe health risks posed by industrial and vehicular emissions in rapidly urbanizing regions.

Keywords: Air Pollution, Greater Dhaka, Air Pollutants, Aeroqual 500, PM2.5 and PM10, AQI

1. INTRODUCTION

Air quality pertains to the state of air purity in a defined area and indicates the concentration of diverse pollutants and contaminants in the atmosphere, which can originate from natural sources (EPA, 2021). The presence and concentration of elements such as $PM_{2.5}$, PM_{10}, ground-

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

level O_3, NO_2, CO, SO_2 and volatile organic compounds are pivotal in determining air quality. This significantly influences public health, climate change, and overall quality of life (Mayer, 1999). $PM_{2.5}$ denotes fine particles measuring 2.5 micrometers or less in diameter, while PM_{10} signifies particles with a diameter of 10 micrometers or less (Donaldson et al., 2006). Urbanization and changing land use significantly contribute to worsening air quality in global cities, with urban population growth and land use alterations identified as key factors driving these challenges (Mayer, 1999). The air quality in urban areas is worse than in rural areas due to the higher emissions from vehicles and industries. Air pollution has become a major environmental challenge in Asia and the world (Carslaw & Ropkins, 2012). Urbanization and land use change can deteriorate air quality, particularly in urban areas, with negative consequences for urban populations. Again, weather parameters such as sunshine, temperature, wind direction, air pressure and rain affect how air pollutants are emitted, dispersed, changed, and deposited (Kinney, 2008).
Bangladesh has poor air quality and ranks low on the Environmental Performance Index (Haque et al., 2017). Dhaka, the capital and a crowded city, is the third most polluted megacity in the world (WHO, 2016). Air pollution harms the health and environment of the urban population (Kinney, 2008; Aleksandras Chlebnikovas et al., 2022). Industry, cities, and vehicles are the main sources of air pollution in Greater Dhaka. Reducing air pollution is an urgent challenge.

2. RELATED WORKS

Air pollution is a severe health threat in many developing countries. Cities like Bangkok, Cairo, Delhi, Mexico and Dhaka have very high levels of pollutants, above the WHO standards (Faiz, 1996). This harms many people, especially the vulnerable ones, and costs a lot. Dhaka city releases about 50 tons of lead every year, mainly in the dry season. During this period, the airborne particulate matter density exceeded 463 micrograms per cubic meter ($\mu g/m^3$) (DoE, 2012). Pollutants such as CO, HC, NOx, SO_2, lead, and carbon, produced by gasoline engines, are abundant in the air of Dhaka (Haque, et al., 2017). The EPA and the WHO have identified six pollutants as criteria air contaminants and set limits for their levels in the air. These pollutants are carbon monoxide (CO), lead (Pb), ozone(O_3), PM, Nitrogen dioxide (NO_2), and sulfur dioxide. They come from different sources and have different effects on health and the environment (Pavel et al., 2021). Dhaka is a significantly polluted city, and its surrounding areas, notably Gazipur and Narayanganj, are greatly affected by the sources of this pollution. Dhaka is the capital and the predominant commercial hub of Bangladesh. There are many industries around the city, such as garments, chemicals, and bricks. It also has a large population and large amount of traffic. These factors cause the pollution and worsen the air quality (Mahmud, 2011). Air pollution is caused by construction, biomass, and waste burning. Energy consumption increases with economic growth. Energy sources show the level of development of a country. There is a substantial escalation in various air pollutants—volatile organic compounds (VOCs), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxide (NO_x), suspended particulate matter (SPM), particulate matter of sizes $PM_{2.5}$ and PM_{10}—within Dhaka city (Masum, 2020). Air pollution in Dhaka is mainly caused by smoke, dust, gases, and fumes from industries and vehicles (Kudrat-E-Khuda, 2020).

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

3. METHODOLOGY

3.1 Study Area

Bangladesh has a tropical and subtropical climate, with a hot and rainy summer monsoon and a dry winter. The monsoon season lasts from June to October and the post-monsoon consists the months of October and November (Salam et al., 2003). The monsoon rain in Dhaka affects air pollution and these weather conditions also change the amount of air pollutants (Jacob and Winnerb, 2009). The pre-monsoon and post-monsoon seasons have different weather conditions that affect the air pollution levels in Dhaka (Begum, Hopke, and Markwit, 2013). Meteorological variables such as temperature, humidity, wind, and rain influence air pollutants' emissions, transport, and transformation (Jacob and Winnerb, 2009; Kinney 2008). Ambient air pollution levels are strongly influenced by meteorological factors, which vary seasonally. Therefore, meteorology is essential for understanding the spatial patterns of air pollution. (Espinosa et al., 2004; Karar et al., 2005). The Dhaka North City Corporation and Dhaka South City Corporation are the primary focus areas, encompassed by Gazipur and Narayanganj, respectively. Both of these cities are characterized by heavy industry and high population density. The northern part of Narayanganj recognized as a fringe area of the Dhaka South City Corporation, signifies an emerging urban region. This area further underscores the acceleration of air pollution due to intense economic activities within a densely congested locale.

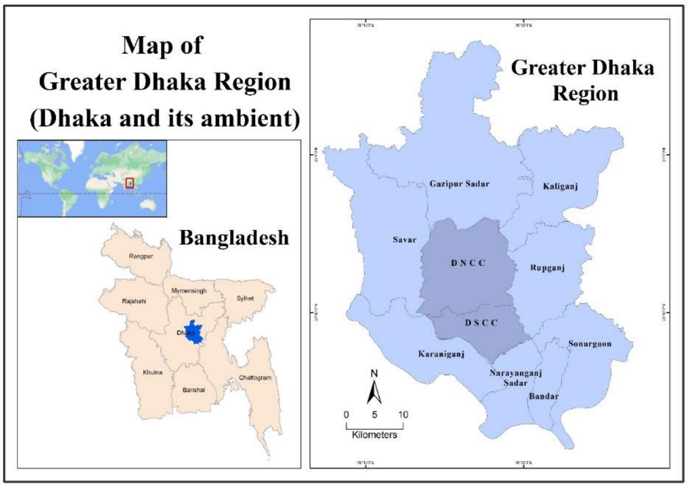


Figure 1. Greater Dhaka Region (Authors, 2023)

Objective of the study

This study aims to evaluate the air quality of Dhaka city corporations and its ambient regions.

3.3 Method

3.3.1 Site Selection

Air quality data, including NO2, SO2, CO2, CH4, PM2.5 and PM10, were acquired during post-monsoon conditions from 24 designated sites located across Gazipur, Dhaka, and Narayanganj. These sites were categorized into five main zones:

ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

Developing Urban Areas: Greater Dhaka's developing urban areas combine new high-rise buildings, offices, and roads, attracting young professionals and families seeking modern living spaces outside the crowded city center.
Market Areas: The market areas in Greater Dhaka are the hubs of commerce and culture. Here, one can find everything from traditional bazaars to modern malls.
Recreational Spots: These areas in Greater Dhaka provide a peaceful space from urban life, with parks, lakes, and cultural centers where residents enjoy picnics, cultural events, and leisure activities in nature and amusement.
Near to Industrial Areas: These areas are less residential but vital to Dhaka's economy, housing numerous factories and forming the hub of the city's workforce.
Transportation Hubs: The city's major transportation hubs are crucial for connectivity and linking various parts of Dhaka and beyond through buses, trains, and the metro system.

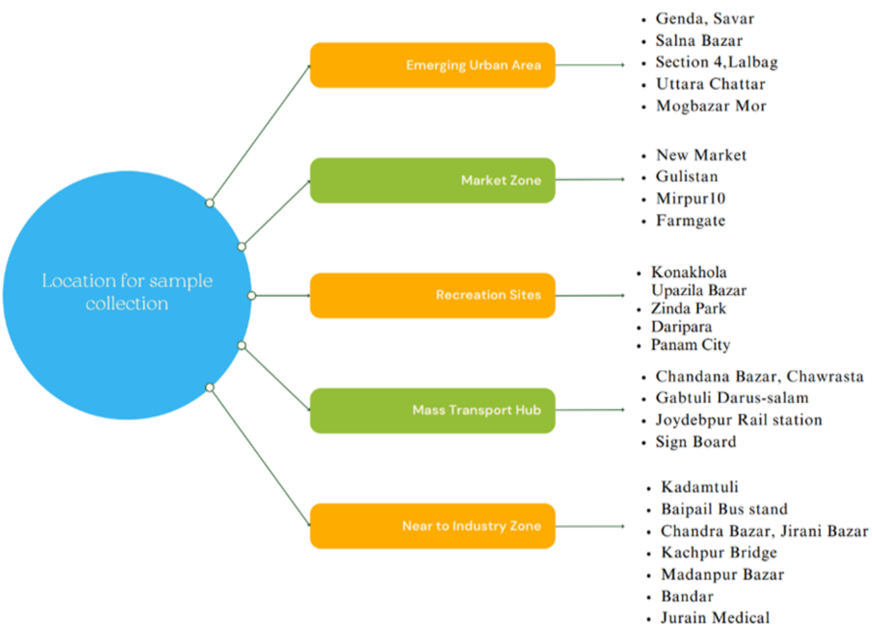


Figure. 2: Location from sample collection

3.3.2 Data Collection Instrument and Calculation

The data collection involved the use of a portable Aeroqual Series 500 air quality monitor to assess and record various air quality parameters at these specific locations. The Aeroqual 5000 is an advanced instrument for monitoring air quality conditions. This device is an expert in measuring several air pollutants like NO2, SO2, CO2, CH4, PM2.5, PM_{10} and others. Its ability to provide real-time data is important for environmental monitoring, especially in areas with potential air quality issues.

3.3.3 AQI Scoring Method

AQI calculation

$$I_{si} = \left(\frac{(Cobs - Cmin)(Imax - Imin)}{(Cmax - Cmin)} \right) + Imin$$

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

Where:

I$_{si}$ = Sub-index value of the observed pollutant
C$_{obs}$ = Observed pollutant concentration
C$_{max}$ = Maximum concentration of AQI color category of that contains ≤ **C**$_{obs}$
C$_{min}$ = Minimum concentration of AQI color category of that contains C$_{obs}$
I$_{max}$ = Maximum AQI value corresponding to ≤ **C**$_{max}$
I$_{min}$ = Minimum AQI value corresponding to **C**$_{min}$

AQI = Max (**I**si NO_2, **I**si SO_2, **I**si $PM_{2.5}$, **I**si PM_{10})

The selection of the Maximum Operator Method as the analytical approach is primarily due to its robustness in mitigating the issues of eclipsing and ambiguity that commonly affect other methods. Moreover, the synergistic effects of the combination of pollutants are not well understood, so a health-based index that combines or weights different pollutants is not feasible. Consequently, the Maximum Operator Method offers a more reliable and straightforward means of assessment under these conditions.

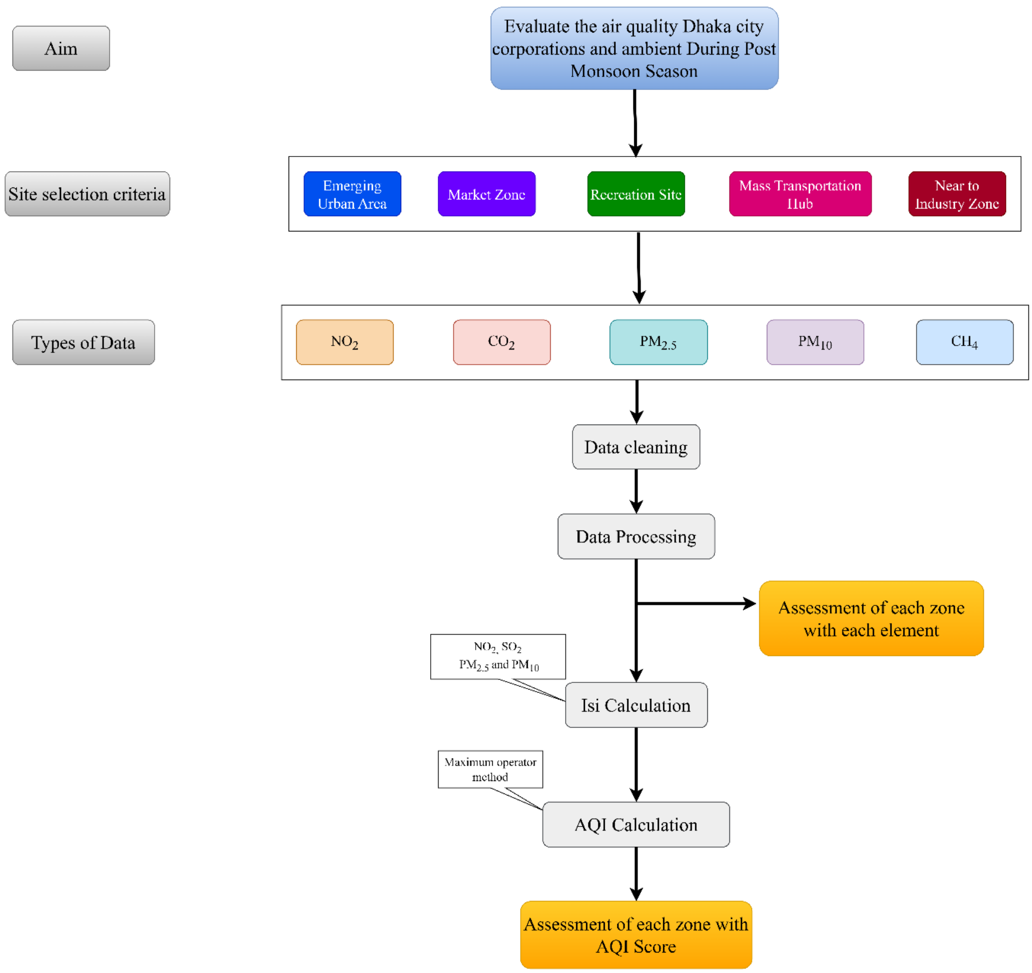


Figure 03. Research workflow

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

4. RESULT AND DISCUSSION

4.1 Emerging Urban Area

Dhaka city suffers from severe and harmful air pollution that affects public health.

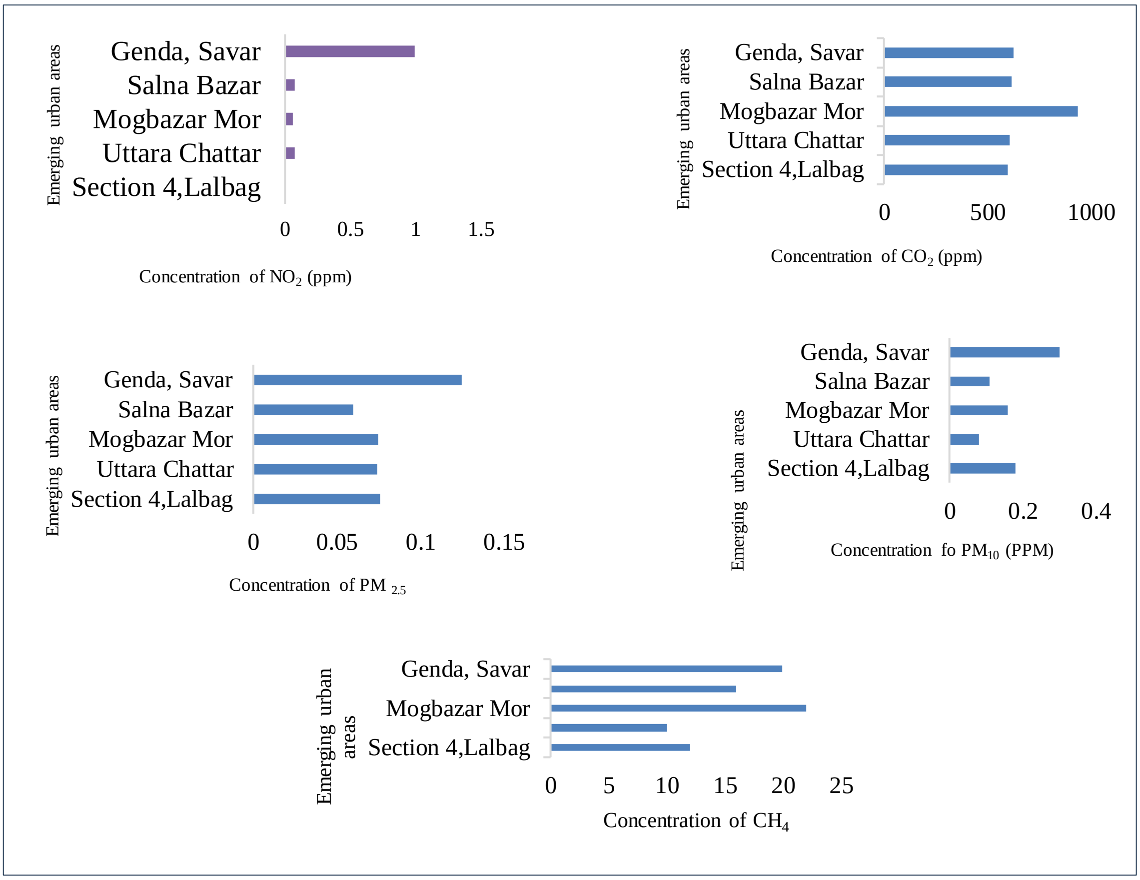


Figure 4. Air quality of emerging urban areas in Greater Dhaka

Air pollution reached its worst level in the winter of 1996-97, when the city had more lead in the air than any other place in the world (Ahmed and Hossain, 2008).
Emerging urban areas include Section 4, Lalbag, Uttara Chattar, Mogbazar Mor, Salna Bazar, Genda (Savar).
Concentrations of industries are notably prevalent in major urban areas such as Dhaka, Rajshahi, Chittagong, Khulna, and Narayanganj, according to Haque et al. (2017). The standard permissible value for NO_2 is 0.053 ppm. NO_2 is a reddish-brown poisonous gas with a strong, unpleasant smell. NO_2 forms from high temperature burning and from lightning strikes (Motalib and Lasco, 2015). NO_2 is a major air pollutant. NO_x harm our health in various ways, such as causing eye, head, and lung issues, and damaging our teeth over time (Nishimura et al., 2013). The standard permissible value for CO_2 is 400-1000 ppm. In terms of particulate pollution, the established annual mean standard for the nation is set at 15 parts per million (ppm).

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

The data shows that Genda, Savar, an urban area with numerous brick kilns, factories, and vehicles, records the highest levels of NO2, CO2, PM2.5, and PM10, peaking at 0.99 ppm. In contrast, the lowest pollutant levels are noted in Section 4, Lalbag, a more organized residential area with minimal traffic, with the lowest recorded value at 599 ppm. Uttara Chattar has the least CH4 levels at 10 ppm, attributed to its status as a newer, planned area with lower waste production. Meanwhile, Salna Bazar, near the dusty and busy Mymensingh Highway in Gazipur, exemplifies air pollution due to heavy vehicular movement. Savar, a key economic and communication hub in Dhaka's north, suffers significantly from air pollution, especially near brickfields that elevate CO2 levels while reducing oxygen, adversely affecting residents' respiratory health. Mogbazar, another Dhaka neighbourhood, experiences the highest CO2 concentration at 938 ppm and the highest CH4 levels at 22 ppm, indicating a dense population and extensive waste disposal activities.

4.2 Market Zones

Market zones, particularly crowded ones like Farmgate and Mirpur 10 in Dhaka North City Corporation (DNCC), along with New Market and Gulistan in Dhaka South City Corporation (DSCC), face significant pollution issues. Farmgate, serving as both a market zone and a transportation hub, records exceptionally high pollution levels. Here, NO2 concentration reaches 0.09 ppm, almost twice the standard limit, and PM10 levels are at 0.497 ppm, posing serious health risks to residents.

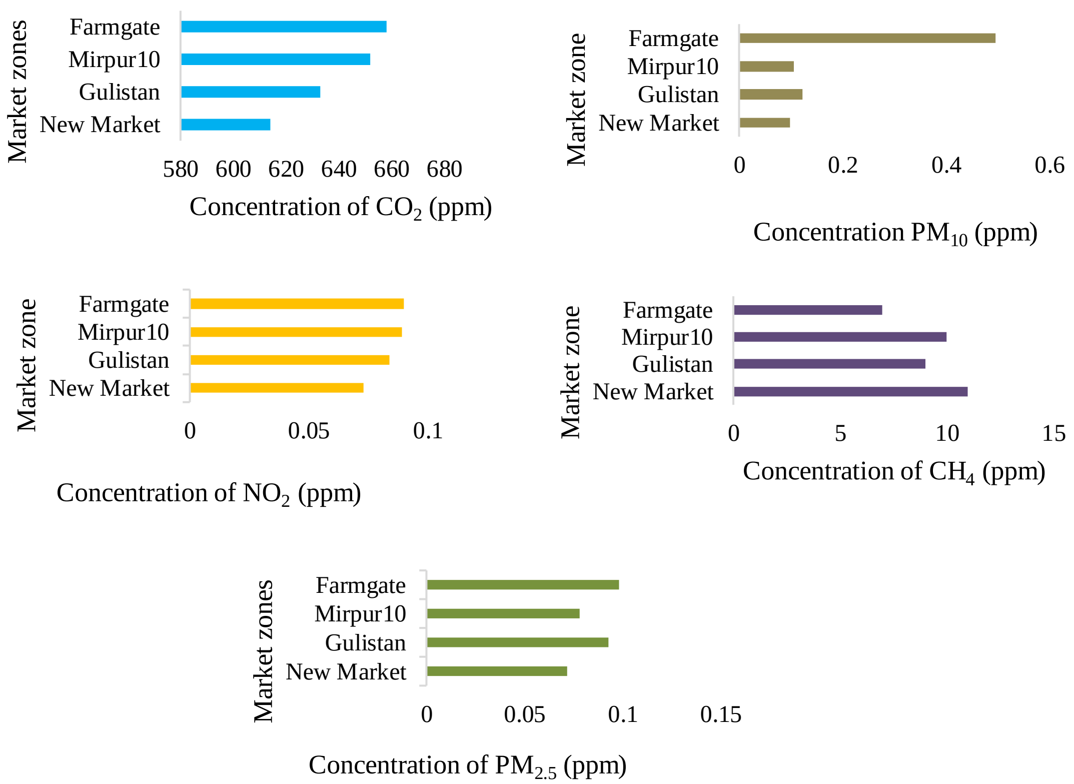


Figure. 5: Concentration of Pollutants in Market Areas

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

4.3 Recreation Sites

Figure 6. The concentration of major pollutants at the recreation sites

Panam city, Zinda park and Konakhola Upazila Bazar are located in the northern part of Narayanganj city corporation. These sites are located outside of Dhaka City Corporation and have a low population density. As a result, the level of air pollution has a downtrend. The ambient regions of Dhaka city are polluted as the city itself acts as a parent source for pollutants, while the fringe zones have less pollution due to healthy vegetation cover and less anthropogenic activities. Recreational sites around the greater Dhaka are less polluted than other categorized locations. Konakhola Upazila bazar (0.063ppm) and Panam City (0.061) have high concentrations of NO_2. Panam City has the lowest amount of PM10 and CH4, which follows 0.039 ppm and 10 ppm, respectively. Zinda Park has the highest $PM_{2.5}$ level (0.073 ppm), followed by Daripara (0.063), Konakhola Upazila Bazar (0.058ppm), and Panam City (0.039ppm). Konakhola Upazila bazar has the highest amount of CO_2 (630 ppm) among recreational sites. Zinda park also has the highest concentration of CH_4 (55ppm) because it is located beside Shapla Beel (Wetland with huge biomass residue). From these examples, it is crystal clear that all the recreational sites are located in the periphery or fringe zones of Dhaka

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

city while all the areas within the core of the city are much polluted and reaching an exhaustive level, which will adversely impact the public health of the residents.

4.4 Hubs for Transportation

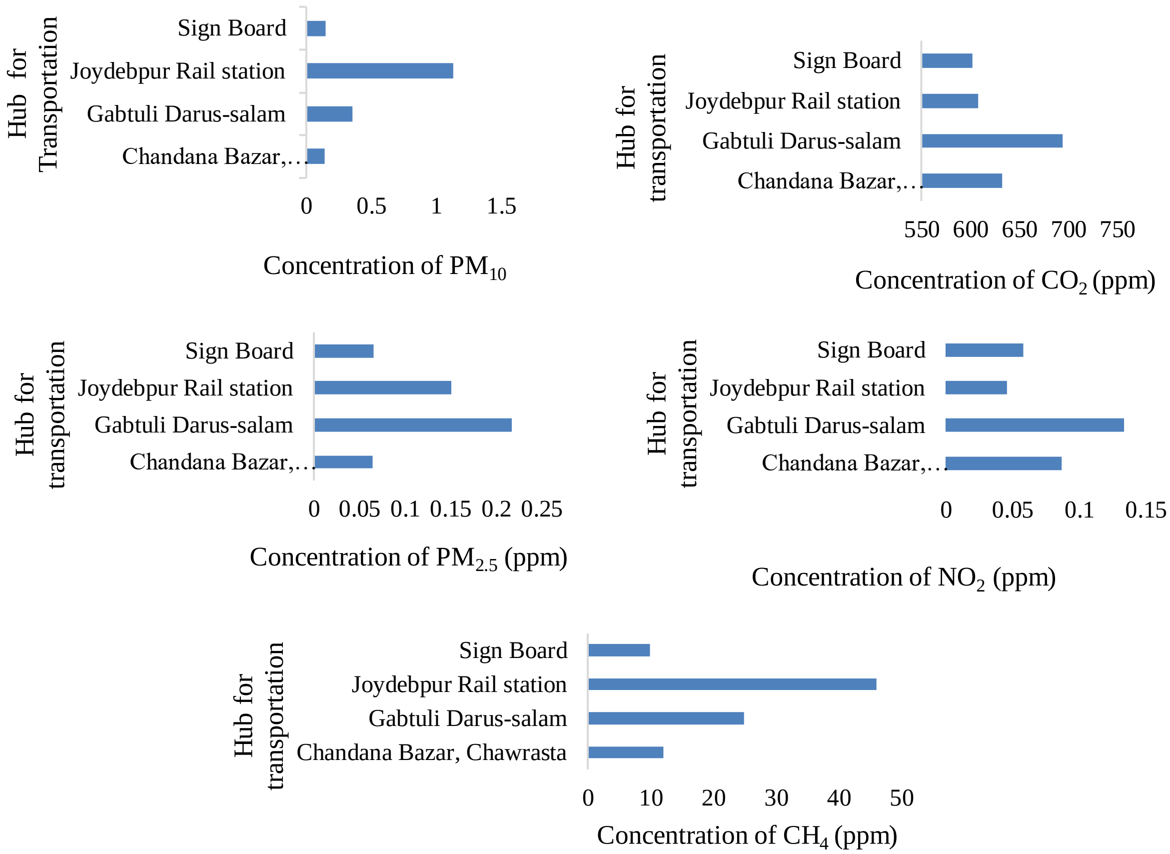


Figure 7. Concentration of major pollutants in hubs for transportation

Gabtuli Darus-Salam is a highly congested area in Dhaka City, with a lot of traffic from nearby bus terminals and roads. Darus-Salam has the worst air quality in the city, with $PM_{2.5}$ levels exceeding the national standards most of the time. Darus-Salam's air pollution is influenced by weather and wind direction, which carry pollutants from other sources (Rahman et al., 2019).

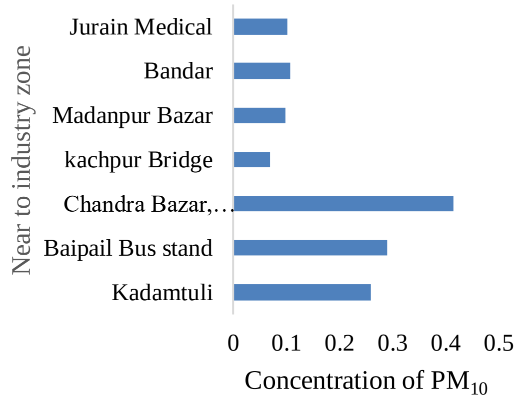
Location	Gabtuli Darus-salam
NO2	0.134
CO2	695
Pm2.5	0.217
Pm10	0.358
CH4	25

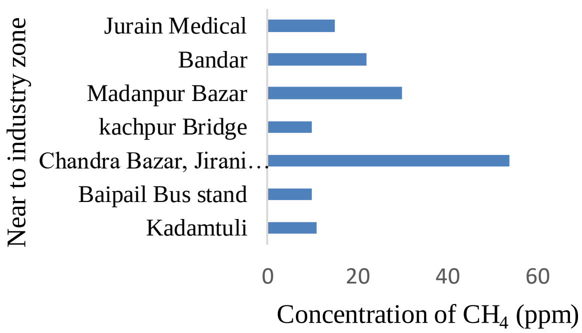
Figure 8. Concentration of pollutants in Gabtuli Darus-salam (Post monsoon, 2023)

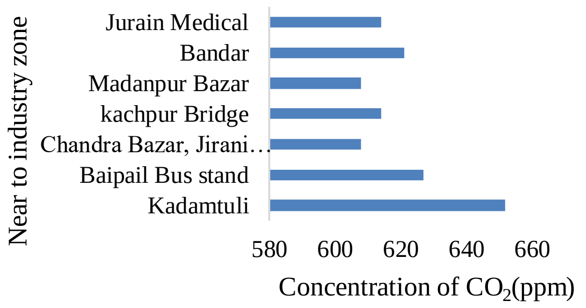
Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

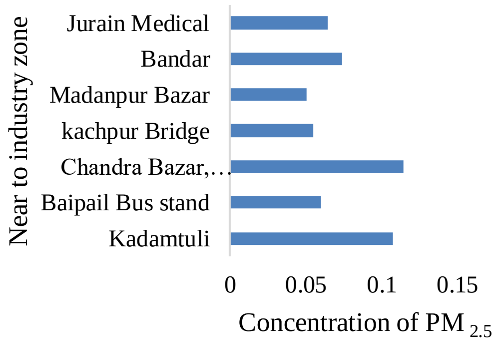
The authorized sulfur content in Bangladesh's diesel fuel was set at 5000 ppm, with a proposed reduction planned to reach 500 by 2014 and 2016 (DOE, 2015). Dhaka City has many textile industries around it. This causes a lot of heavy trucks to transport clothes using high-sulfur diesel, which adds to the SO_2 pollution in the city. The main cause of SO_2 in the air is the fossil fuels burned at brick kilns nearby (Randall et al., 2015).
Gazipur city is experiencing substantial physical expansion and a population rise (BBS, 2015). The area harbors the highest concentration of brick kilns within Gazipur district, closely followed by Narayanganj and Dhaka. Consequently, these brick kilns are anticipated to be major contributors to this district's PM2.5, SO2, and CO emissions (Guttikunda et al., 2013). PM2.5 levels exhibit an upward trajectory post-monsoon (October-November) (Mukta et al., 2020).
Narayanganj district benefits from its strategic location between two rivers, facilitating the transportation of industrial goods via boats and ships. However, this advantageous position also introduces several sources of air pollution. Heavy trucks transporting industrial products, coal and wood-burning brick kilns, exhaust emissions from long-route buses, and industrial dust emissions collectively contribute to air pollution (Rahaman, 2019). Additionally, water vessels utilizing diesel fuel further add to the pollution levels at the monitored Narayanganj site, impacting the area's air quality.

4.5 Near to Industry Zone









Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

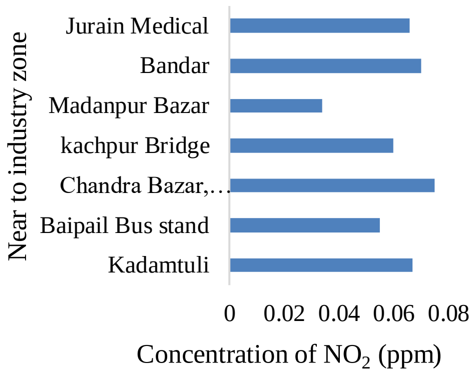


Figure 9. Concentration of major pollutants in hubs for transportation

The location with the highest NO_2 concentration is Chandra Bazar, Jirani Bazar, with 0.075 ppm. The location with the lowest NO_2 concentration is Madanpur Bazar, with 0.034 ppm. The average NO_2 level across all locations is 0.061 ppm, which is higher than the World Health Organization (WHO) standard of 0.04 ppm for annual mean exposure.

The location with the highest CO_2 concentration is Kadamtuli, at 652 ppm. The location with the lowest CO_2 concentration is Chandra Bazar, Jirani Bazar, at 608 ppm. The location with the highest $PM_{2.5}$ level is Chandra Bazar, Jirani Bazar, at 0.115 µg/m^3. The location with the lowest $PM_{2.5}$ level is kachpur Bridge, at 0.055 µg/m^3. The location with the highest PM_{10} level is Chandra Bazar, Jirani Bazar, at 0.415 µg/m^3. The location with the lowest PM_{10} level is kachpur Bridge, at 0.069 µg/m^3. The location with the highest CH_4 level is Chandra Bazar, Jirani Bazar, with 54 ppm. The location with the lowest CH_4 levels are kachpur Bridge, Baipail Bus stand, and Kadamtuli, with 10 ppm.

4.6 Concentration of SO_2

The recorded sulfur dioxide (SO_2) levels in Dhaka, Bangladesh reveal varying degrees of pollution across different locations. Notably, Gulistan demonstrates the highest SO_2 level at 0.3 parts per million (ppm), followed by Chandana Bazar, Chawrasta, and Fuldi Bazar at 0.2 ppm each. Conversely, areas such as New Market, Kadamtuli, and Farmgate display the lowest SO_2 levels, recorded at 0 ppm. Notably, 15 locations, including these three, report the lowest possible reading of SO_2. The average SO_2 level across these sites stands at 0.06 ppm, below the national standard of 0.12 ppm. Most of the locations are inside of Dhaka city corporation which indicates that Dhaka city corporation is polluted by all major air pollutants despite the categories.

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

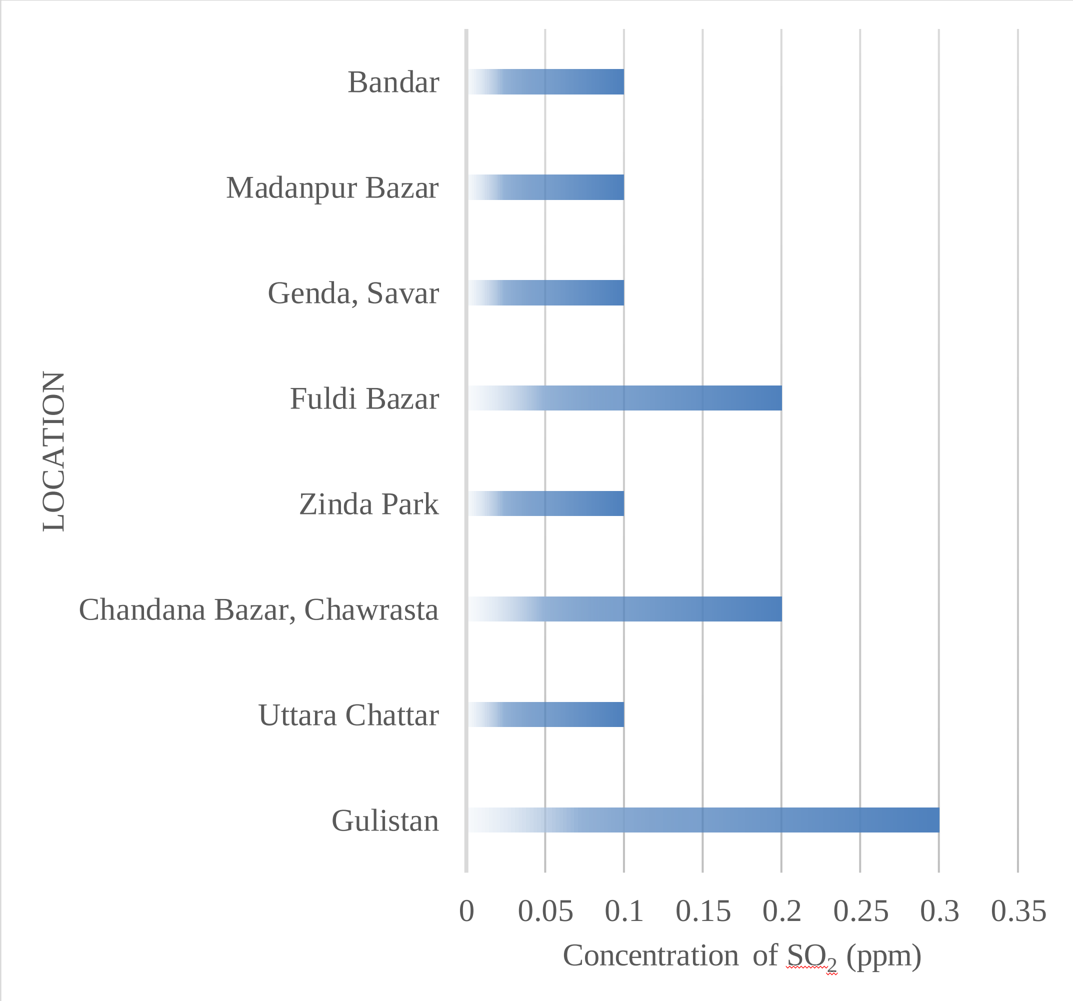


Figure 10. Concentration of SO_2

Brick kilns, a major contributor to SO_2 emissions due to coal combustion for energy, significantly impact the elevated levels of sulfur dioxide in Bangladesh's air. Addressing sources like brick kilns is crucial to improving air quality, aligning with national standards, and ensuring healthier living conditions and environmental sustainability (Rahman et al., 2019).

4.7 Air Quality Index (AQI)

The Air Quality Index (AQI) assesses how clean or polluted the air is and how it affects human health. It is usually a daily report based on national air quality standards. It helps the public to understand the air quality and the health risks of breathing polluted air (Majumder et al., 2023; Bishoi, et al., 2009). The AQI covers different pollutants and shows the overall status of the air quality. The AQI is a useful tool for EPA and other agencies to inform the public about the local air quality (Salam et al., 2008; Baldwin & Calkins, 2007)

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

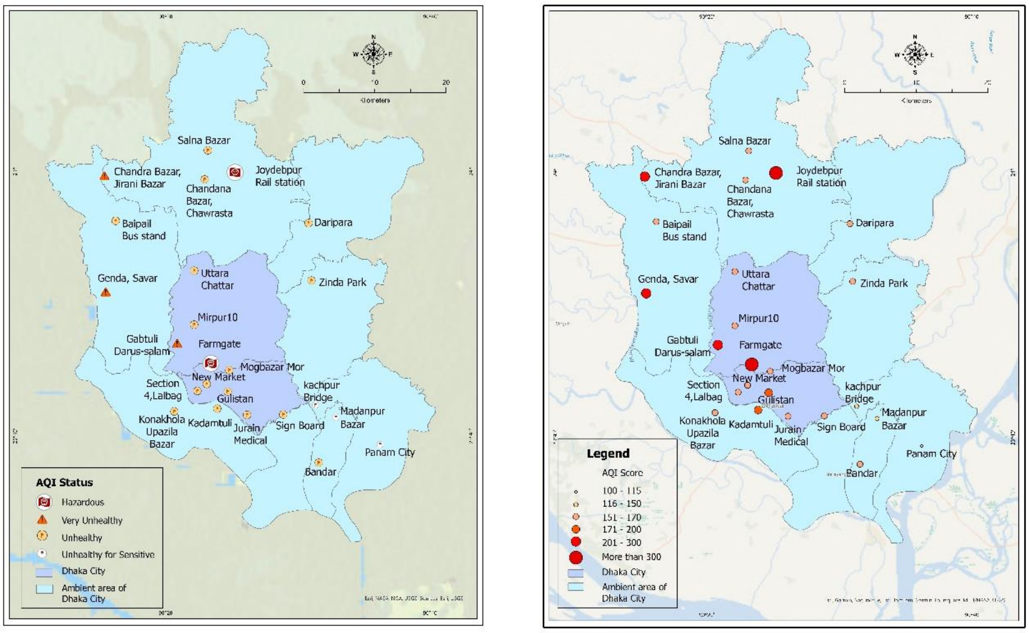


Figure 11. AQI of the sampling locations (Post monsoon, 2023)

Air pollution can cause temporary problems such as eye, throat, nose, and skin irritation, wheezing, coughing, chest tightness, and breathing difficulties. Some of these problems can be severe, such as asthma, pneumonia, bronchitis, and an increased risk of heart attack. Air pollution can also make people feel sick, with symptoms like headaches, nausea, and dizziness. These problems can get worse with long-term exposure to air pollution, which can damage the lungs, nerves, and reproductive organs and cause cancer and death (CASE, 2021). Many big and industrial cities have high dust and nitrogen oxides concentrations in the air (Zhao et al., 2019). It has been found that the air quality is affected by the population density and the area's economic activity (Cheng et al., 2023).

The AQI was assessed based on the concentrations of different pollutants, such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon dioxide (CO_2), particulate matter ($PM_{2.5}$ and PM_{10}), and methane (CH_4). The AQI ranges from 0 to 500, where higher values indicate worse air quality. The AQI is also classified into six categories, from good to hazardous, with different health implications for each category.

Level	Numerical Value
Good	0-50
Moderate	51-100
Unhealthy for sensitive groups	101-150
Unhealthy	151-200
Very unhealthy	201-300
Hazardous	301-500

Figure 12. Air Quality Index (EPA, 2014)

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

The study showed that AQI in Dhaka is very high and unhealthy for most of the locations, with an average of 186.8, which means that the air quality poses serious health risks to the population. The highest AQI was recorded at Joydebpur Rail station, at 395, followed by Farmgate, at 391. These locations are both hazardous, meaning that the air quality is extremely poor and can cause health emergencies for everyone. Significantly, both of these locales serve as pivotal transportation hubs, characterized by bustling traffic and play a crucial role as prominent business centers.

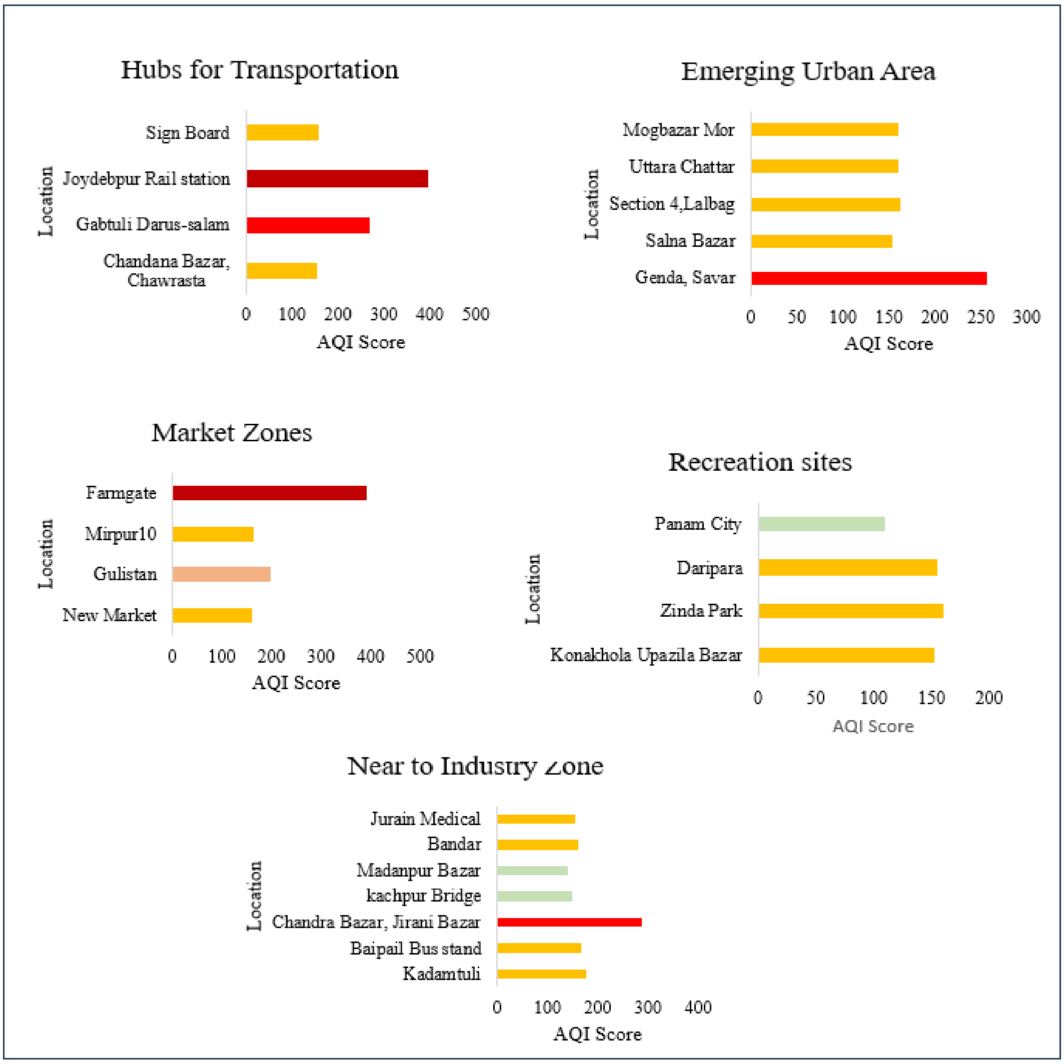


Figure 13. AQI Score of different zones (post-monsoon, 2023)

The lowest AQI was recorded in Panam City (110), followed by Madanpur Bazar (139). These locations are both unhealthy for sensitive groups, meaning that the air quality is still worse and can cause health problems for some people, especially those who are sensitive to air pollution. The air quality varies across different locations in Dhaka, depending on the sources and levels

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

of pollution. For example, locations that have high traffic congestion, such as Gulistan, Mogbazar Mor, and Farmgate, tend to have higher AQI values, as they are exposed to more vehicle emissions. The locations that have industrial activities, such as Gabtuli Darus-salam, Chandra Bazar, and Genda, tend to have higher AQI values, as they are exposed to more industrial emissions. The locations that have agricultural activities, such as Konakhola Upazila Bazar and Zinda Park, tend to have lower AQI values, as they are exposed to less urban pollution.

5. CONCLUSION

Air pollution is a severe problem in urban areas, especially for health. This is caused by human activities that emit more pollutants. It is worse in developing countries than developed ones (Dockery & Pope, 1994; Kato et al., 1991; Dockery et al., 1989). The air quality in cities is worsening fast and causing global environmental issues. It can affect people's health and the weather and climate of nearby areas (Bhaskar & Mehta, 2010). The study in Greater Dhaka unveiled alarming levels of pollutants, highlighting risks to public health and the environment. The pollution levels vary by season, location, and human activity. Dhaka is expanding in all dimensions, reducing the space for quality life. Due to brick kilns and factories, densely populated areas like Genda and Savar showed high NO2, CO2, PM2.5, and PM10. Conversely, organized zones like Lalbag had lower emissions. Market areas such as Farmgate and Gulistan exhibited elevated NO_2 and particulate matter levels, while New Market showed higher CH_4 concentrations. Recreational sites had comparatively less pollution, but some areas showed concerning NO_2, CO_2, and PM_{10} levels. Air pollution is increasing due to industrialization, urbanization, and construction. It is worse in the dry season. The primary sources of pollution are vehicles, industries, and waste burning. PM_{10} is a tiny particle that can harm health.
Traffic and industry worsen the air quality in Darus-Salam and Greater Dhaka. Many sources, such as textiles and diesel, increase the SO2 levels. People can use less and more intelligent transport, but the government must act. This study shows how human activities, industrialisation, and geography affect air quality. The study urges policies and actions to reduce air pollution and protect health and the environment.

6. REFERENCES

1. Abdul Motalib, M., & D. Lasco, R. (2015). Assessing Air Quality in Dhaka City. International Journal of Science and Research (IJSR), 4(12), 1908–1912. https://doi.org/10.21275/v4i12.sub159291
2. Ahmed, S., & Hossain, I. (2008). Applicability of air pollution modeling in a cluster of brickfields in Bangladesh. Chemical Engineering Research Bulletin, 12, 28-34.
3. Baldwin, R., & Calkins, D. (2007). Bangladesh urban air quality management: An institutional assessment. Washington, D.C.: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/456251468210889617/Bangladesh-urban-air-quality-management-an-institutional-assessment

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

4. Bishoi, B., Prakash, A., & Jain, V. K. (2009). A comparative study of air quality index based on factor analysis and US-EPA methods for an urban environment. Aerosol and Air Quality Research, 9(1), 1-7.
5. Donaldson, K., MacNee, W., & Stone, V. (2006). ENVIRONMENTAL POLLUTANTS Particulate Matter, Ultrafine Particles. Elsevier EBooks. https://doi.org/10.1016/b0-12-370879-6/00132-0
6. Mayer, H. (1999). Air pollution in cities. Atmospheric environment, 33(24), 4029-4037.
7. EPA. (2021). What is Air quality. Retrieved from What is Air quality.
8. Haque, H. A., Huda, N., Tanu, F. Z., Sultana, N., Hossain, M. A., & Rahman, M. H. (2017). Ambient air quality scenerio in and around Dhaka city of Bangladesh. Barisal University Journal, 4(1), 203-218.
9. Department of Environment, Government of Bangladesh. (2012). Air Pollution Reduction Strategy for Bangladesh, Final Report. Dhaka.
10. Prothom Alo . (2023, August 7). Dhaka's air quality "moderate" this morning. Prothomalo. https://en.prothomalo.com/environment/pollution/h5kqcttztn
11. Salam, A., Bauer, H., Kassin, K., Ullah, S.M., Puxbaum, H., 2003. Aerosol chemical characteristics of a mega-city in Southeast Asia (Dhaka, Bangladesh). Atmospheric Environment 37, 2517e2528
12. Rahman, M. M., Mahamud, S., & Thurston, G. D. (2019). Recent spatial gradients and time trends in Dhaka, Bangladesh, air pollution and their human health implications. Journal of the Air & Waste Management Association, 69(4), 478–501. https://doi.org/10.1080/10962247.2018.1548388
13. Palmer, P. I., Jacob, D. J., Fiore, A. M., Martin, R. V., Chance, K., & Kurosu, T. P. (2001). Air mass factor formulation for spectroscopic measurements from satellites: application to formaldehyde retrievals from the global ozone monitoring experiment. Journal of Geophysical Research, 106, 14539-14550.
14. Randall, S., B. Sivertsen, S. S. Ahammad, N. D. Cruz, and V. T. Dam. 2015. Emissions Inventory for Dhaka and Chittagong of Pollutants PM10, PM2.5, NOx, SOx, and CO.
15. Salam, A., Hossain, T., Siddique, M. N., & Alam, A. S. (2008). Characteristics of atmospheric trace gases, particulate matter, and heavy metal pollution in Dhaka, Bangladesh. Air Quality, Atmosphere & Health, 1, 101-109.
16. Guttikunda, S. K., B. A. Begum, and Z. Wadud. 2013. Particulate pollution from brick kiln clusters in the Greater Dhaka Region, Bangladesh. Air Qual. Atmos. Health 6 (2):357–65. doi:10.1007/s11869-012-0187-2
17. Majumder, A. K., Patoary, M. N. A., Nayeem, A. A., & Rahman, M. (2023). Air quality index (AQI) changes and spatial variation in Bangladesh from 2014 to 2019. Journal of Air Pollution and Health, 8(2), 227–244.
18. Mukta, T. A., Hoque, M. M. M., Sarker, M. E., Hossain, M. N., & Biswas, G. K. (2020). Seasonal variations of gaseous air pollutants (SO2, NO2, O3, CO) and particulates (PM2.5, PM10) in Gazipur: an industrial city in Bangladesh. Advances in Environmental Technology, 6(4), 195–209. https://doi.org/10.22104/aet.2021.4890.1320
19. Dockery, D. J., & Pope, C. A. (1994). Acute respiratory effects of particulate air pollution. Annual Review of Public Health, 15, 107.

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

20. Dockery, D. W., Speizer, F. E., Stram, D. O., Ware, J. H., Spengler, J. D., & Ferris, B. G. (1989). Effects of inhalable particles on respiratory health of children. American Review of Diseases, 139, 134.
21. Kato, N., Ogawa, Y., Koike, T., Sakamoto, T. S., Sakamoto, & Group R. (1991). Analysis of the structure of energy consumption and the dynamics of emissions of atmospheric species related to the global change (SOx, NOx and CO2) in Asia. NISTEP Report no 21, 4th Policy-oriented Research Group, National Institute of Science and Technology Policy, Tokyo.
22. Carslaw, D. C., & Ropkins, K. (2012). Openair—an R package for air quality data analysis. Environmental Modelling & Software, 27(28), 52–61.
23. Mahmud, I. (2011, December). Air pollution cost TK 124 billion a year in Dhaka city. (Paper presented at the 4th. Annual Meeting of the Dhaka Public Health Association, Dhaka)
24. Pavel, M. R. S., Zaman, S. U., Jeba, F., Islam, M. S., & Salam, A. (2021). Long-Term (2003–2019) Air Quality, Climate Variables, and Human Health Consequences in Dhaka, Bangladesh. Frontiers in Sustainable Cities, 3. https://doi.org/10.3389/frsc.2021.681759
25. Kudrat-E-Khuda. (2020). Causes of Air Pollution in Bangladesh's Capital City and Its Impacts on Public Health. Nature Environment and Pollution Technology, 19(4), 1483–1490. https://doi.org/10.46488/nept.2020.v19i04.014
26. Nishimura, K., Galender, J.M. and Roth, L.A. 2013. Early life air pollution and asthma risk in minority children. Ame. J. of Respir. Crit. Care Med., 188(3): 309-318.
27. Kinney, P. L. 2008. Climate change, air quality, and human health. Am. J. Prev. Med. 35 (5):459–67. doi:10.1016/j. amepre.2008.08.025.
28. Begum, B. A., P. K. Hopke, and A. Markwitz. 2013. Air pollution by fine particulate matter in Bangladesh. Atmos. Pollut. Res. 4 (1):Elsevier:75–86. doi:10.5094/APR.2013.008
29. Jacob, D. J., and D. A. Winnerb. 2009. Effect of climate change on air quality. Atmos. Environ. 43 Elsevier Ltd:51–63. doi:10.1016/j.atmosenv.2008.09.051.
30. Aleksandras Chlebnikovas, Dainius Paliulis, Jolita Bradulienė, & Januševičius, T. (2022). Short-term field research on air pollution within the boundaries of the large city in the Baltic region. Environmental Science and Pollution Research, 30(34), 81950–81965. https://doi.org/10.1007/s11356-022-23798-9
31. Bhaskar, B. V., & Mehta, V. M. (2010). Atmospheric Particulate Pollutants and their Relationship with Meteorology in Ahmedabad. Aerosol and Air Quality Research, 10(4), 301–315. https://doi.org/10.4209/aaqr.2009.10.0069
32. Espinosa, A.J.F., Rodriguez, M.T. and Alvarez, F.F. (2004). Source Characterisation of Fine Urban Particles by Multivariate Analysis of Trace Metal Speciation. Atmos. Environ. 38: 873–886
33. Karar, K., Gupta, A.K., Kumar, A., Biswas, A.K. and Devotta, S. (2005). Statistical Interpretation of Week Day/week End Differences of Ambient Gaseous Pollutant, Vehicular Traffic and Meteorological Parameter in Urban Region of Kolkatta. J. Environ. Sci. Eng. 47: 164–175.

Journal of Environmental Impact and Management Policy
ISSN: 2799-113X
Vol : 04, No. 02 , Feb-Mar 2024
http://journal.hmjournals.com/index.php/JEIMP
DOI: https://doi.org/10.55529/jeimp.42.1.18

34. Imran Khan Apu. (2023). Exploring the Ecological and Public Health Implications of Brick Manufacturing in a Suburban Municipality of Bangladesh: A Comprehensive Case Study. https://doi.org/10.20944/preprints202311.0263.v1
35. Faiz, A., Weaver, C. S. and. Walsh, M. P. (1996), Air Pollution from Motor Vehicles: Standards & Technologies for Controlling Emissions, WB, USA.
36. Clean Air and Sustainable Environment (CASE) (2021). 'Daily Air Quality Report on 24/2/2021' [Internet]. Available from:I. Hossain et al. International Journal of Research in Engineering, Science and Management, VOL. 4, NO. 7, JULY 2021 115 http://case.doe.gov.bd/index.php?option=com_conte nt&view=article&id=2686:air-quality-index&catid=8:aqiarchives&Itemid=32
37. Zhao, X., Zhou, W., Han, L., & Locke, D. (2019). Spatiotemporal variation in PM2.5 concentrations and their relationship with socioeconomic factors in China's major cities. Environment International, 133, 105145. https://doi.org/10.1016/j.envint.2019.105145
38. Cheng, J., Li, F., Liu, L., Jiao, H., & Cui, L. (2023). Spatiotemporal Variation Air Quality Index Characteristics in China's Major Cities During 2014–2020. Water Air and Soil Pollution, 234(5). https://doi.org/10.1007/s11270-023-06304-w
39. EPA. (2014). Air Quality Index: A Guide to Air Quality and Your Health. Washington, DC: Environmental Protection Agency.

