

Briefing Note

High and Rising Air Pollution in Bangladesh

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Photo: Anna Subbotina



Executive Summary

Air pollution has emerged as a pressing concern in Bangladesh in recent years. Bangladesh has consistently been ranked among the top five most polluted countries in the world in terms of air pollution since 2018 (IQAir, 2022). Air pollution harms humans, the environment, and the economy. Particulate matter (PM), the worst air contaminant, endangers new-borns and pregnant women. Increased respiratory and cardiovascular disorders are the main health risks. However, a recent study by the World Bank has identified that air pollutants worsen mental health as well (World Bank, 2021). Due to this disease burden, individuals spend more on healthcare and miss more work, costing the economy.

Dhaka, home to more than 10 million people (BBS, 2022), is the fifth most polluted capital city in the world, among 116 capital regions in the world (IQAir, 2022). The air quality in the city varies throughout the year based on different seasons and months. To fully understand air pollution in Bangladesh, determine its causes, and take action, air pollution trends must be examined.

The seasonal trends of air quality in Dhaka city show that the winter season experiences the highest air pollution levels, while the monsoon season brings some improvement. However, air quality is bad year-round, putting vulnerable groups at risk. Construction, brick kilns, and city automobile emissions contribute to air pollution, along with meteorological factors. Climate change is also another significant factor that contributes to air pollution. As some air pollutants are also greenhouse gases, controlling air pollution will significantly help to tackle climate change.

The trend of the historical data shows that the air quality in Dhaka is likely to worsen over the next decade if measures are not taken. Countries like China showed the world that improving air quality is possible. China reduced the level of PM pollution by 50 per cent in just 6 years by regulating factories, installing more air quality monitoring devices, reducing the use of coal, and removing older vehicles from the roads (IQAir, 2023).

The human consequences of breathing poor-quality air in Bangladesh are significant. The government, institutions, and citizens need to work together for improving air quality urgently.

1. Current state of air pollution in Bangladesh and other Asian countries

In terms of air pollution, Bangladesh is ranked as the fifth most polluted country in the world and the second most polluted in the Central and South Asian region after Pakistan (IQAir, 2022). The worst identified pollutant in Bangladesh's air is PM which has been increasing since 1995 (Global Burden of Disease, 2019). PM is the deadliest air contaminant. PM_{2.5}

particles, with an aerodynamic diameter of less than 2.5 μm , enter the bloodstream by inhalation and induce respiratory and cardiovascular illnesses. Capital cities have PM_{2.5} concentrations due to urbanisation, high population density, many automobiles, and other air pollution sources. As per the regional capital city ranking, which is based on the average PM_{2.5} concentration in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), New Delhi is ranked second and Dhaka is ranked fifth for having the worst air quality in 2022, among 116 cities in the world (IQAir, 2022).

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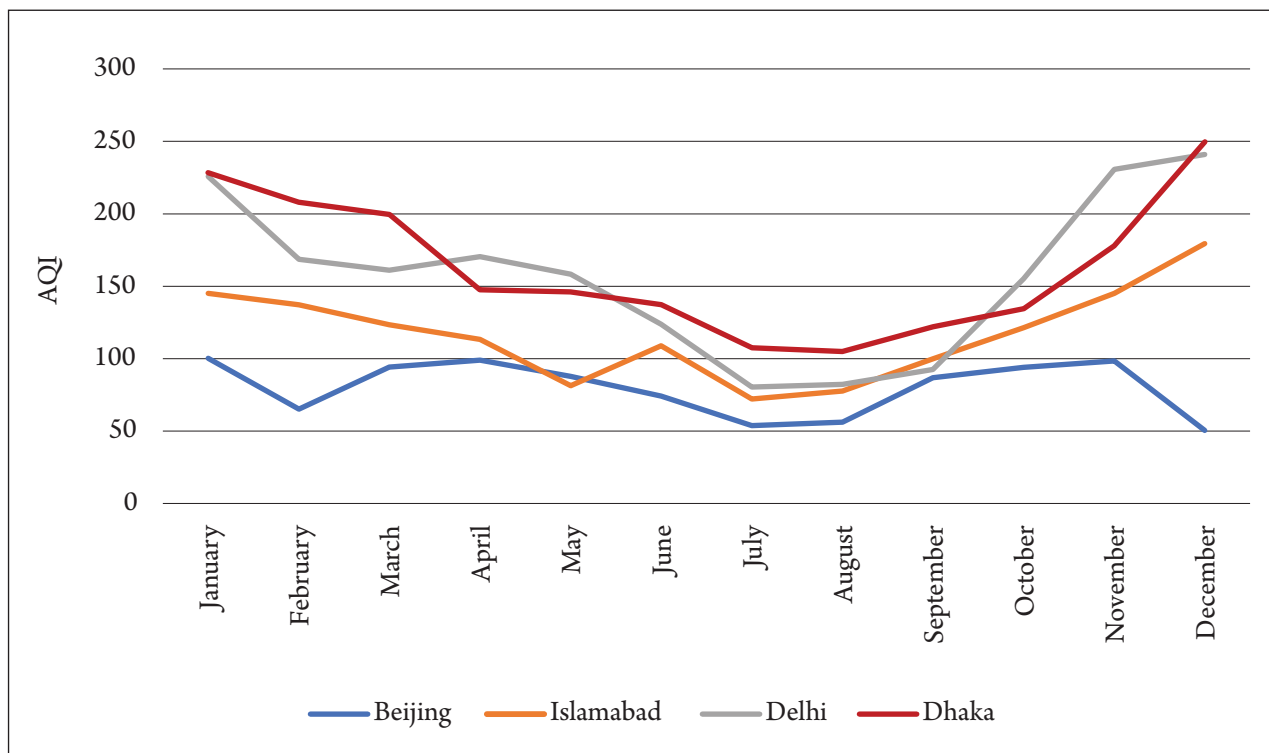
Examining the Air Quality Index (AQI) of these capital cities in the same year, Dhaka and New Delhi are found to have higher values in comparison with Beijing and Islamabad (Figure 1).

A location's AQI assesses its ambient air quality. On a scale of 0 to 500, greater numbers indicate lower air quality. New Delhi has more air pollution than Dhaka in April-May and October-November. Dhaka had the highest AQI in December 2022 among all the cities shown in Figure 1. Rainy seasons have lower AQI than dry seasons because monsoons wash away air contaminants. However, lack of rainfall, low relative humidity, and dry soil worsen air quality in Bangladesh in winter.

Beijing had the lowest AQI in December, and overall good air quality in 2022 (Figure 1). Beijing had better air quality in 2022 than Dhaka, New Delhi, and

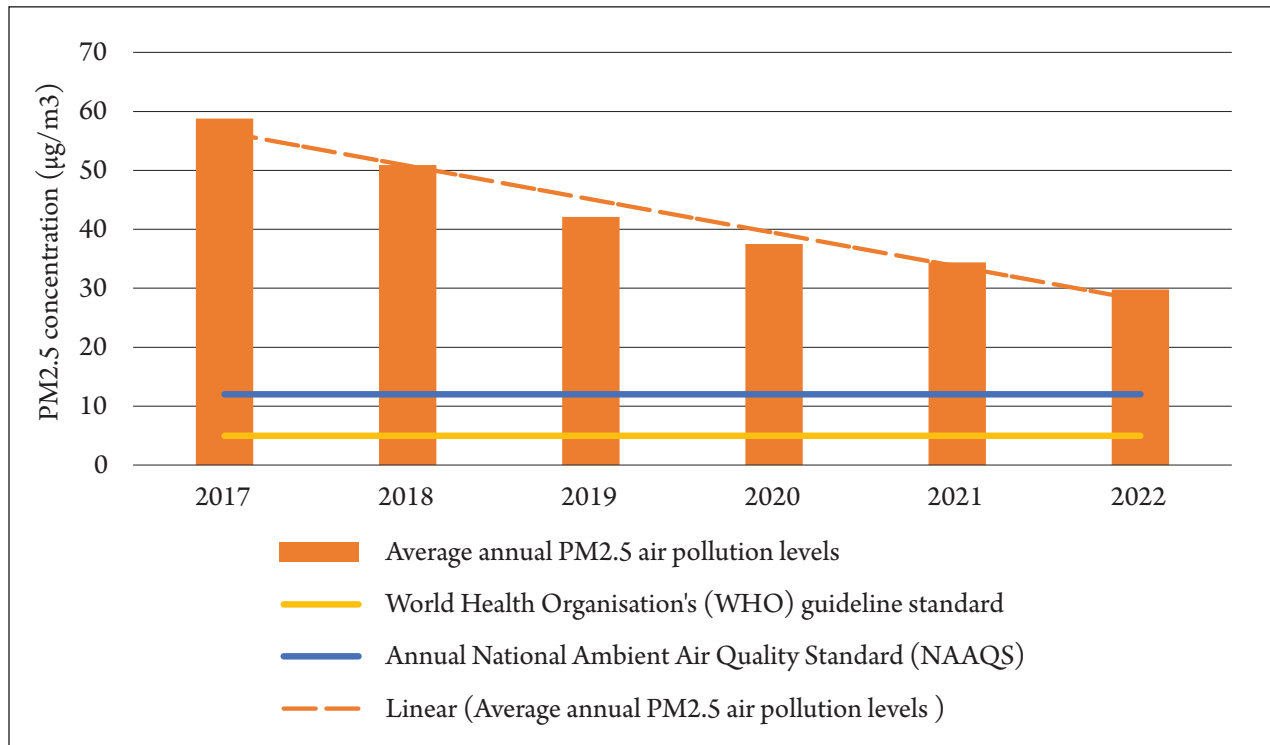
Islamabad. Previously, this was not true. Just a decade ago, major Chinese cities were the most polluted in the world, with Beijing residents coining the phrase 'Airpocalypse' to characterise the deadly haze. (Pike, 2022). Beijing issued its first "orange" smog warning in 2014, indicating visibility below 200 metres and PM2.5 levels over 700 $\mu\text{g}/\text{m}^3$ in most areas for extended periods (Nan & Chun, 2013). These levels surpass WHO recommendations, which limit daily PM2.5 levels to 15 $\mu\text{g}/\text{m}^3$ for more than 3-4 days per year (WHO, 2021). Beijing's air quality has improved greatly from being routinely subjected to PM2.5 levels that were immeasurable by monitoring to its current moderate air pollution (AirNow, 2022). Figure 2 shows that the concentration of PM2.5 in Beijing's air was 29.8 $\mu\text{g}/\text{m}^3$ in 2022, which indicates that the city reduced the level of particulate matter pollution by 50 per cent in just 6 years (IQAir, 2022).

Figure 1: International Comparison of Monthly AQI in 2022



Source: Authors' illustration using data from U.S. Embassy Bangladesh Air Quality (AirNow, 2022).

Figure 2: Average Annual PM2.5 Air Pollution Levels in Beijing



Source: Authors' illustration using data from IQAir (IQAir, 2023).

2. Seasonal trends of air quality and possible causes

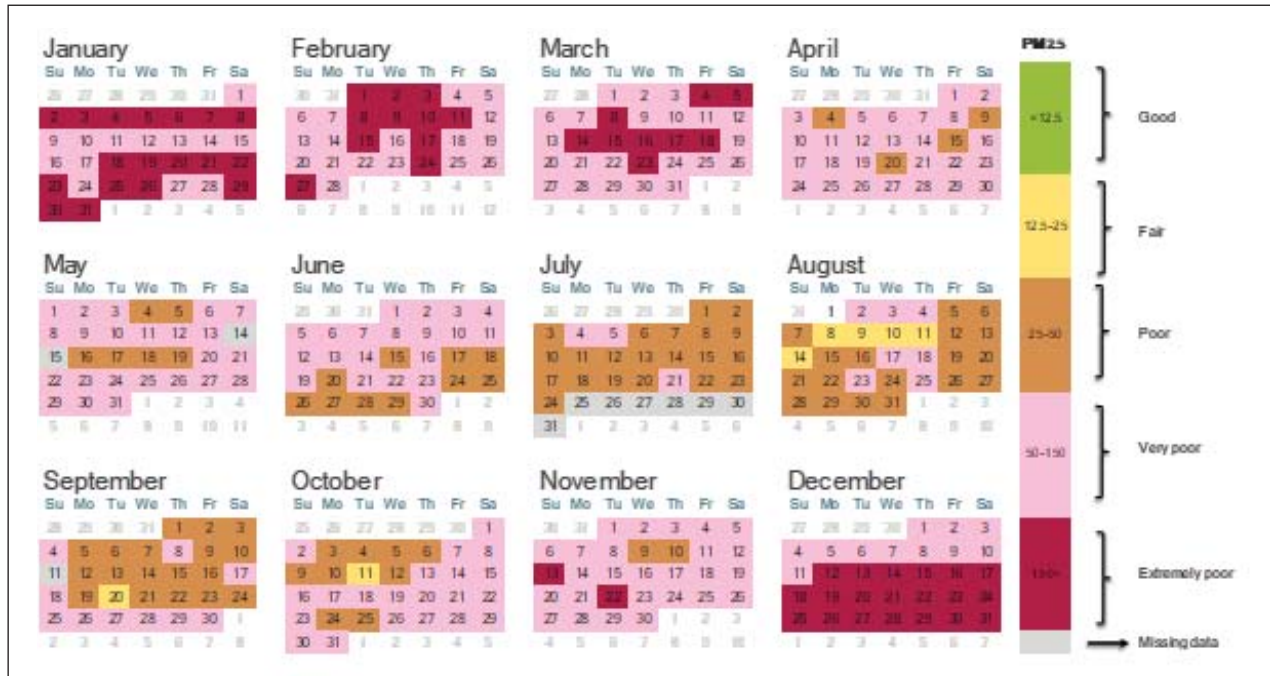
Figure 3 shows the PM2.5 concentration in Dhaka's air in 2022. To meet national air quality guidelines, the daily average PM2.5 level must be below 12.5 $\mu\text{g}/\text{m}^3$ for 'good' air quality (EPA, 2022). Thus, Dhaka had no good air days in 2022 (Figure 3). In Dhaka, air quality is mostly 'very poor' with PM2.5 concentrations ranging from 50-150 $\mu\text{g}/\text{m}^3$.

The PM2.5 concentration in Bangladesh's air is high and expected to rise. According to a 2020 research, Bangladesh's population-weighted PM2.5 concentration is projected to rise to 72 $\mu\text{g}/\text{m}^3$ by 2030 from 52 $\mu\text{g}/\text{m}^3$ in 2010 (Kuylenstierna, et al., 2020). However, the population weighted PM2.5 concentration of Bangladesh had already surpassed the predicted value for 2030 with a value of approximately 78 $\mu\text{g}/\text{m}^3$ in 2020 (AQLI, 2022).

PM2.5 levels significantly worsen Dhaka's AQI. Figure 4 shows that AQI in Dhaka reached 250 in December 2022, indicating 'very unhealthy' air quality. January, February, and March experienced 'poor' air quality. The lowest AQI scores were 107 and 105 in July and August. Monsoon rains may have halted brick kiln manufacturing resulting in improved air quality. An AQI of 101-150 is 'unhealthy for sensitive groups'. Hence, even the lowest AQI in Dhaka threatens vulnerable populations. No AQI in Dhaka city reached 'moderate' in 2022, indicating acceptable air quality for people. Air pollution in Dhaka is high year-round, however air quality varies.

Analysis of more than 10 years of hourly data of 17 air quality monitoring stations across Bangladesh shows that, on average, six stations had PM 2.5 concentrations above 100 $\mu\text{g}/\text{m}^3$ or twenty times the WHO standard, and eleven stations had PM 2.5 concentrations above 50 $\mu\text{g}/\text{m}^3$ or ten times the WHO standard (Figure 5). Thus,

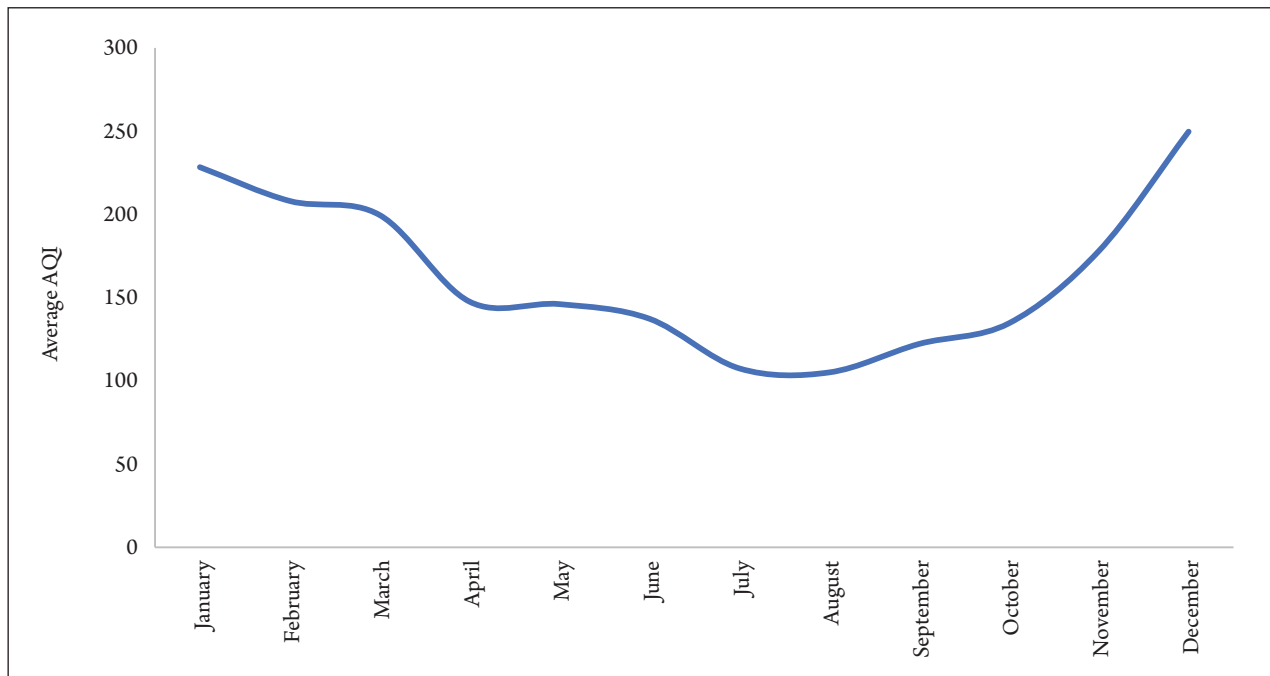
Figure 3: No Good Air Days – A PM 2.5 Calendar for Dhaka in 2022



Source: Authors' illustration using data from U.S. Embassy Bangladesh Air Quality (AirNow, 2022); (EPA, 2022).

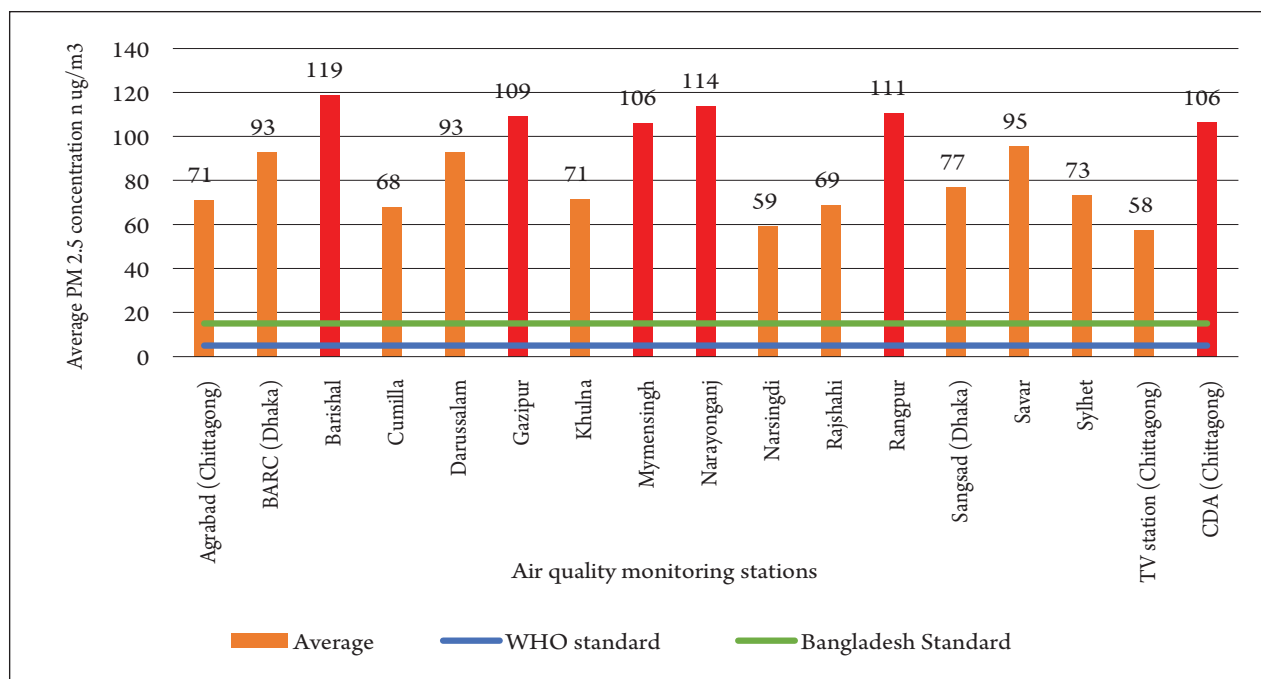
Note: According to daily National Ambient Air Quality Standard (EPA, 2021) <https://www.epa.gov/for-community/environmental-information/air-quality/pm25-particles-in-the-air>

Figure 4: Monthly Fluctuations in AQI in Dhaka City, 2022



Source: Authors' illustration using data from U.S. Embassy Bangladesh Air Quality (AirNow, 2022).

Figure 5: Average PM2.5 Concentration Across Bangladesh, 1 November 2012 - 1 January 2023 (in ug/m3)



Source: Authors' illustration based on data from the Department of Environment (DoE), Ministry of Environment, Forest, and Climate Change, Government of People's Republic of Bangladesh.

across Bangladesh, air quality is mostly 'very poor', with PM2.5 concentrations ranging from 50-150 $\mu\text{g}/\text{m}^3$.

3. Key drivers of air pollution: vehicular emission, brick kilns and climate change

3.1 Vehicular emission

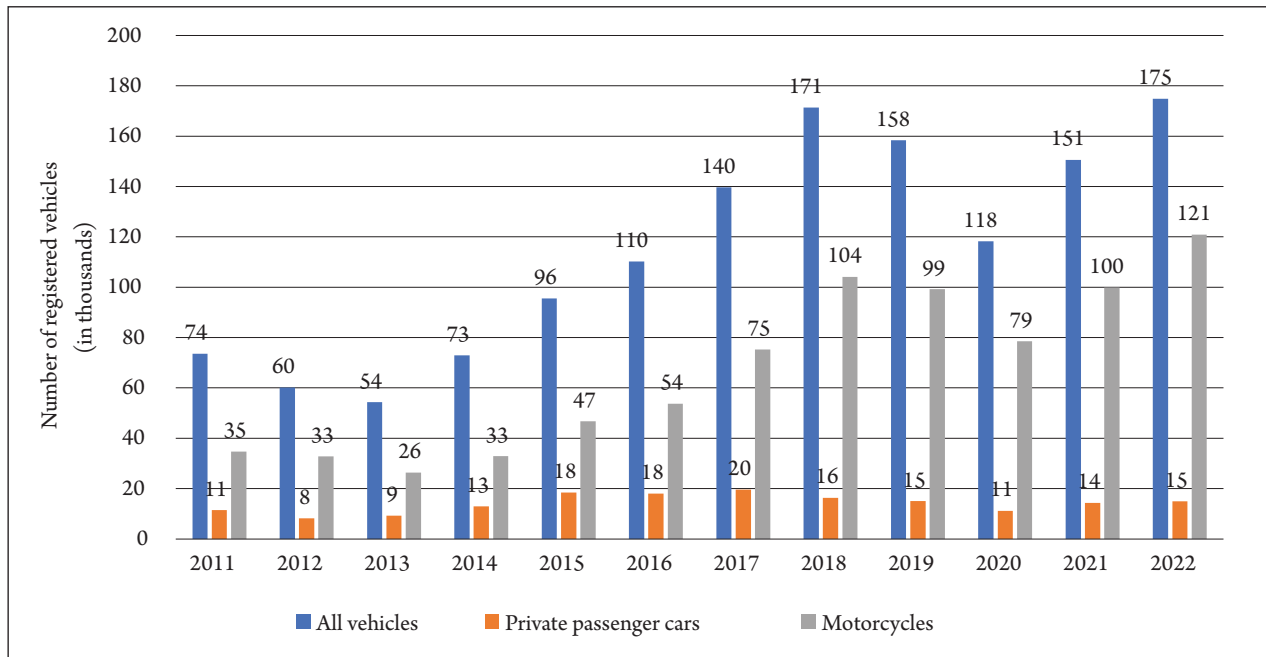
Vehicular emission is a major source of air pollution in Bangladesh, especially in Dhaka city which alone accounts for 40 per cent of the country's registered vehicles (Department of Environment, 2019). A study by the Norwegian Institute for Air Research (NILU) under the Clean Air and Sustainable Environment (CASE) project found vehicular emission to be associated with about 10.4 per cent of fine particles in Dhaka's air (Department of Environment, 2019).

From Figure 6 it can be observed that the number of registered vehicles in Dhaka metropolitan area has increased drastically over the years. There were 1,995,458 registered vehicles in Dhaka as of April 2023, of which 52 per cent were motorcycles, and 17 per cent were private cars (Bangladesh Road Transport Authority, 2023). This rise in automobiles is primarily due to more motorcyclists on Dhaka's roadways. As Pathao, a ridesharing service, gained popularity in 2016, Dhaka saw more motorcyclists. The number of registered motorcycles in Dhaka has increased by 138 per cent approximately from 2016 to April 2023 (Bangladesh Road Transport Authority, 2023), and this might have played a role in increasing air pollution in Dhaka.

According to a World Bank report, cities with considerable construction activities and traffic had the most air pollution (Raza, Mahmud, & Rabie, 2022).

Figure 6: Year-wise Number of Registered Vehicles in Dhaka Metropolitan Area, 2011-2022

(in thousands)



Source: Authors' illustration using data from Bangladesh Road Transport Authority (Bangladesh Road Transport Authority, 2023).

The Department of Environment of Bangladesh (DoE) and the World Bank tested roadside car and motorbike emissions under the CASE project. This programme classified all diesel automobiles as Dhaka's worst polluters. It was also discovered that 78 per cent of motorcycles and 77 per cent of diesel vehicles failed to satisfy their respective air pollution limit values set by the government. (Department of Environment, 2019). To lessen air pollution in Dhaka, vehicle emissions must be reduced.

3.2 Brick kilns

Brick kilns are a significant contributor to PM in the air, and brick manufacturing is the fastest-growing industry in Bangladesh (Guttikunda, Begum, & Zia, 2014). There were 8,000 brick kilns in Bangladesh as of 2018, and around 90 per cent of them were considered to be Fixed Chimney Kilns (FCK) which are the most harmful to the environment (MoEFCC, 2019). DoE reports 2,052 brick kilns in Dhaka division, 1,728 of which are functioning (MoEFCC, 2019). Dhaka had

487 brick kilns in 2019, followed by Gazipur and Narayanganj. About 58 per cent of fine particles in Bangladesh's air originate from brick kilns (Chowdhury, 2022). Bricks are made on dry soil after monsoon season and throughout winter till monsoon season. Thus, monsoon PM levels are lower. There are several types of brick kilns, including FCK, zigzag kiln, improved zigzag kiln (IZK) and hybrid hoffman kiln (HHK). FCK produces the most PM and has the lowest construction cost. HHKs are expensive yet energy-efficient. Bangladesh's most convenient brick kilns are DoE-approved IZKs (Chowdhury, 2022). IZKs are better than FCKs and regular zigzag kilns in terms of energy consumption.

The brick kiln industry accounts for 1 per cent of Bangladesh's GDP and is a significant energy consumer (MoEFCC, 2019). The government needs tighter monitoring to enforce brick kiln restrictions. Brick kilns must have DoE permits and Environment Clearance Certificates to operate in the nation under the Brick Manufacturing and Brick Kiln Establishment (Control

(Amendment) Act 2019 (MoEFCC, 2019). These clearing certifications should be based on sustainable brick manufacturing practises. Unfortunately, there are numerous illegal brick kilns in the nation owing to a lack of monitoring and enforcement.

3.3 Climate change

Air pollution and climate change are intertwined in a vicious cycle where one is deteriorating the other continuously. Air quality is influenced by climate change through complex interactions in the atmosphere. Bangladesh is currently witnessing unpredictable variations in weather patterns alongside a persistent increase in both temperature and precipitation levels due to climate change (World Bank, 2021). The mean of monthly rainfall during the peak monsoon from June to August has declined significantly (World Bank, 2021), leading to more days of poor air quality in Dhaka city.

Air pollution alters the energy balance between the atmosphere and Earth's surface, producing temperature fluctuations and global warming (Mustafina & Ali, 2022). According to experts, the recent heat wave in Bangladesh was a consequence of air pollution, since dust particles and polluted gases absorb heat, and the highly polluted dust particles and gaseous substances contribute to heat flow leading to a hotter atmosphere (Majumder, 2023). Moreover, due to intense heat throughout the day, large amounts of water vapour evaporate from water bodies and rivers. Later the excess water vapour in the air forms a foggy atmosphere, which is called 'low cloud'. Although, low cloud lowers the temperature, it blocks sunlight from reaching Earth's surface (Ocko, 2016). Thus, it makes the air seem foggy and creates hazards for travelling on the roads.

Bangladesh is one of the top ten most vulnerable countries to climate change (Mustafina & Ali, 2022). Although its current contribution to global greenhouse gas (GHG) emissions is only 0.4 per cent, it is likely to increase exponentially considering its fast economic

growth and industrialisation (World Bank, 2022c). Thus, Bangladesh must reduce air pollution to counter climate change.

4. New evidence on health and economic impacts

4.1 Health impacts analysis

Breathing poor quality air has adverse impacts for the wellbeing of the people of Bangladesh. Globally, air pollution is responsible for 6.4 million deaths per year (WHO, 2023). Air pollution affects the economy because employees lose productive years to disability, illness, and early death, and need more healthcare. Air pollution was the second largest cause of deaths and disabilities in Bangladesh in 2019 (Chen, 2022). Air pollution is responsible for two million premature deaths in South Asia (World Bank, 2022a). The most vulnerable to PM2.5 are children and the elderly. Air pollution causes lung infections in children because their respiratory systems are still developing. Over the last 20 years, air pollution-related mortality from most causes have stayed steady, although respiratory infections, tuberculosis, and maternal and neonatal illnesses have dropped. Due to the rise in air pollution-related cardiovascular disorders, the number of people dying from these causes has nearly doubled, from 56,500 in 2000 to over 100,000 in 2019 (Global Burden of Disease, 2019).

There is a direct relationship between poor air quality and poor human health (WHO, 2023b). If WHO's air quality guideline of PM2.5 in the air is exceeded by 1 per cent, the probability of experiencing breathing problems increases by 12.8 per cent for an individual (Raza, Mahmud, & Rabie, 2022). Air pollution also poses a threat to mental health, as the World Bank reported that depression is commonly found among the residents around the areas with persistent traffic and major construction (Raza, Mahmud, & Rabie, 2022). Additionally, there is a 20 per cent higher possibility of

being depressed with a 1 per cent increase in exposure to PM_{2.5} above WHO's guideline for an individual (Raza, Mahmud, & Rabie, 2022).

Moreover, outdoor air pollution also causes indoor air pollution which makes women and children suffer the most (Leung, 2015). Household air pollution contributes to a higher percentage of deaths related to conditions such as ischaemic heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease (COPD) (Ministry of Health and Family Welfare, 2022). Studies show that air pollution causes adverse health effects on pregnancy outcomes including preterm births (PTB) and low birth weight (LBW). According to health experts, pregnant women are at serious risk, especially in their second trimester due to ambient air pollution. (Nahian, et al., 2023).

Air pollution causes early deaths, shortened lifespans, and various impairments. In 2019, more than 44 per cent of lower respiratory tract infections among children under 5-year-old was caused due to air pollution. (Global Burden of Disease, 2019). Lower respiratory tract infections cause more than 20 per cent of deaths in Bangladesh, indicating an alarming situation.

Assuming the WHO standard as the baseline, AQLI found that a 10 µg/m³ rise in PM_{2.5} reduces life expectancy by 0.98 years for an individual (AQLI, 2022). PM_{2.5} concentration is related to a reduction in life expectancy. Every 10 µg/m³ increase in PM_{2.5} concentration above 5 µg/m³, the WHO standard, reduces life expectancy by 0.98 years (AQLI, 2023). This relationship was established by AQLI using evidence from a study on the China's Huai River Policy (Ebenstein, Fan, Greenstone, He, & Zhou, 2017). According to AQLI estimations, in 2020 life expectancy decreased by 7 years relative to the WHO standard in Bangladesh. If it is assumed that the PM_{2.5} concentration follows the same rate of change as previously predicted (Kuylenstierna, et al., 2020), then

it can be estimated that by 2030 the PM_{2.5} concentration in Bangladesh's air will reach approximately 88 µg/m³ from about 78 µg/m³ in 2020, and thus the reduction in life expectancy will be 8 years as per the WHO standard.

The number of years Bangladeshis live with air-pollution related disabilities has more than doubled to over 592,000 since 2000 (Global Burden of Disease, 2019). The public health impact of such exposure to air pollution is significant. Disabilities and chronic illnesses lower quality of life and cost individuals, the state, and businesses in medical expenses and lost productivity of people who could be working and contributing to economic growth and the tax base.

4.2 Economic impacts analysis

Air pollution not only harms our health and environment but also hurts Bangladesh's economy. Air pollution reduces agricultural output, retail footfall, and educational achievement, in addition to affecting worker health and productivity. Air pollution's economic impact includes direct costs like medical bills, agricultural production losses, and indirect costs like lost workplace productivity and sick days. PM_{2.5} pollution is predicted to cost USD 8.1 trillion in health costs, or 6.1 per cent of world GDP in 2019 (World Bank, 2022b). PM 2.5 is the most harmful air pollutant which has caused approximately 14,000 deaths since 1 January 2021 in Dhaka and cost Dhaka's economy approximately USD 1.7 billion to date. (Greenpeace Southeast Asia, 2023). This is the equivalent of USD 167 or BDT 18,036 per person, assuming that 1 USD equal to BDT 108 as of 7 June 2023, and the population of Dhaka was 10.2 million as of 2022 (BBS, 2022). Air pollution also raises environmental cleaning costs, reduces consumer spending, and causes early death. Air pollution may also impair educational achievement and wages throughout adulthood. (Barker, 1995) (Currie & Vogl, 2013). A study in India shows that lowering air pollution to a safe level can possibly reduce health

expenditures by 10 per cent (Gupta, 2008). In developing countries when air quality improves by 20 percent, there could be an increase of 1.3 working hours (Hanna & Oliva, 2016).

There are costs of air pollution mitigation, but in most cases the benefits outweigh the costs. A cost-benefit analysis found that for Bangladesh the benefit-to-cost ratio in 2030, based on changes in morbidity, was 3.67 when in compliance with the WHO Interim Target 1 (World Bank, 2022a). This shows that there are far more benefits to reducing air pollution than costs in the case of Bangladesh. Some of the benefits include reduced medical expense and reduced work absenteeism.

5. Successful policies implemented by China

Although China is considered to be the largest emitter of GHGs in the world, the air quality in Bangladesh is worse than in China (World Bank, 2022a). Since 2008, China has effectively addressed air pollution while preparing for the Olympics. China now has the best air quality monitoring coverage in the world (IQAir, 2022). The government of China imposed strict laws regarding vehicle ownership, polluting industries, emission standards, and established air quality monitoring stations to keep track of air quality and reduce air pollution in the country.

Some of these policies implemented by China include:

Implementing a lottery system on vehicle license plates: In 2011, Beijing was the first city to institute a city-wide lottery system on motor vehicle license plates (Yang, Liu, Ping, & Liu, 2014). The random assignment of number plates to customers was meant to limit the number of plates issued each month. This method discouraged fossil fuel automobile purchases. Due to this lottery scheme, car sales plummeted (Yang, Liu, Ping, & Liu, 2014). Before the lottery method, Beijing's

the number of motor vehicle increased by 365 per cent from 2001 to 2010. After the lottery method was implemented, the increase in the number of motor vehicles slowed to 25 per cent from 2011 to 2021 (CEIC, 2021).

Implementing emission standards: The Chinese government also reduced fossil fuel use. China adopted clean fossil fuel requirements in 2008 to reduce air pollution before the 2008 Olympics. Retailers in China had to offer Euro IV-standard petrol and diesel under the new regulations. From July 2023, China applied the China VI standard, which integrated European and U.S. best practices (Yang, He, Shao, Cui, & Mao, 2021); (Reuters, 2023).

Shutting down industries causing heavy environmental pollution: China shut down 15 polluting enterprises that were unable to operate sustainably. These included paper-making, leather-making, bleaching and dyeing, insecticide, oil refining, gold dressing, electroplating, sulphur, arsenic, mercury, lead, zinc, asbestos, and radioactive product manufacture (Xie, 2020). Additionally, China also promoted clean and efficient production technologies.

Monitoring air quality routinely: One of the major measures taken by the government of China was tracking air quality and publishing the data weekly. The government installed 114 new air quality monitoring stations in China (IQAir, 2022). To monitor air quality the government assigned the Environmental Protection Bureau (EPB) in Beijing to coordinate, plan and make yearly amendments to Air Quality Monitoring (AQM).

Using renewable energy: Beijing powered all 2022 Olympics sites using renewable energy sources. Despite winter and a major international event, Beijing's PM2.5 levels were falling. Energy efficiency and clean energy are also promoted in China's 13th Five-Year Plan (2016–2020) to reduce air pollution.

6. Concluding remarks

The air quality in Bangladesh is expected to deteriorate further in the future without any policy intervention. Air pollution causes significant costs to citizens' quality of life and the economy at large. Looking at the neighbouring countries, it is evident that air quality can be improved. However, such improvement requires commitment and consistency in action. Although there are several policies in place by the government to reduce air pollution in Bangladesh, there is little implementation. Currently, transitioning industries towards more sustainable practices is crucial. Implementing stricter policies in public-private partnerships is important for effectively curbing air pollution. Public and private partnership can be encouraged in terms of installing a greater number of air quality monitoring stations, tracking air quality, raising public awareness, and investing in the development and adoption of clean technologies. Having the best air

quality monitoring coverage was one of the most effective policies by China to reduce air pollution. The government of Bangladesh can also encourage both domestic and foreign investments in energy and resource efficiency in order to reduce air pollution.

Through the implementation of comprehensive policies targeting air pollution and emissions, Bangladesh has the potential to significantly decrease air pollution-related fatalities by 50 per cent or potentially save nearly 1 million lives by the year 2030 (World Bank, 2022c). Taking decisive action to combat air pollution in Bangladesh is not only a matter of public health, but also an opportunity to create a cleaner and more sustainable environment for future generations. By prioritising the implementation of effective policies, investing in clean technologies, and fostering international collaboration, Bangladesh can pave the way for a brighter and healthier future.

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