A SEMINAR PAPER ON

Air Pollutants and Their Impacts on Human Health in Dhaka City

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Abstract

The main air pollutants in Dhaka City is particulate matter. Which occur due to emissions from brick kilns, motor vehicle. This study assessed the present scenario of pollutants level in Dhaka City.Samples are collected from Sangsad Bhaban, BARC Farmgate as well as Darussalam Mirpur Area of Dhaka City. The harmful pollutants like**,** PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3 and CO all are present in the three locations of the City. The average concentrations are 271.5, 101.3, 30, 24, 12 microgram/m^3 and1.88 ppm respectively. Consequently, all pollutants are in considerable level in comparison with the Bangladesh air quality standards. But the particulate matter (PM_{10} and $PM_{2.5}$) exceed the Bangladesh air quality standards and those prescribed under the World Health Organization air quality guidelines at an alarming level. Therefore, the contribution of particulate matter occurring many hazardous diseases like vomiting respiratory tract illness different types cancer coronary diseases and so on is increasing day by day. Brick kilns located in different zones in Dhaka is the highest emitter of that pollutant during the dry season. Whereas motor vehicle is considered as the second highest source of air pollution for all the year round. The health impact of air pollutants was overviewed with respect to pollutants type.

ABSTRACT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Dhaka is the capital and the largest city of Bangladesh that comprises five adjacent municipal areas, Savar, Narayanganj, Gazipur, Keraniganj, and Tongi as well as the Dhaka City Corporation (DCC) It is surrounded by nine rivers (Padma, Jamuna, Meghna, Old Brahmaputra, Dhaleshwari, Shitalakshya, Brahmaputra, Buriganga and Arial Khan). The area of this city is 1,353 km^2, of which DCC occupies 276 $km^{2.}$ The city is situated between 23° 42' and 23° 54' north latitude and 90° 20' and 90° 28' east longitude. It has developed with uncontrolled growth and few regulatory restraints. It is considered as one of the densely populated megacities in the world, with about 18 million inhabitants within a 300-km^2 area. Therefore, results in heavy traffic congestion with a mix of frequently buses, trucks, smoky cars, taxis bicycle and rickshaws. All those transport struggle for coexistence on the roadways. Along with those, industrial growth was also rose to 7.5 % in the Fiscal Year 2011(Bangladesh Bank 2011). Therefore, emission of different hazardous substances like particulate matter ($PM_{2.5}$, PM_{10}), some gases such as ozone(O_3), oxides of sulfur (SO_x), nitrogen (NO_x) and carbon (CO), some heavy metal (lead, cadmium mercury) at elevated level deteriorate the air quality of Dhaka city. At present, the air quality of Dhaka has been ranked as a 3rd most polluted City in the world (WHO, 2018). This poor air quality entails a massive cost amounting to 134 billion taka (US$ 1.59 billion) a year in the capital alone in terms of lost human health and life (Mahmud, 2011). Polluted air also acts as 17.6% risk factor for most of the death and disability in Bangladesh.

Air pollutants are the chemical components, are responsible for remain in the air in such amount that is detrimental to human health, vegetation as well as the environment, or responsible for air pollution. Air pollution is a condition of the air, that endangers the welfare of persons, interferes with the normal enjoyment of life or property, endangers the health of animal life or causes damage to plant life or property (Government of Alberta, 2006). Air Quality is measured by the amount of particulate matter, some gaseous substances as well as heavy metal (lead, cadmium mercury) are present in the air. Thousands of pollutants are responsible for air pollution. Among them, $PM_{2.5}$, PM_{10}, NO_x, SO_2 CO, O_3 are the most health hazardous. Vehicles are one of the principal contributors to air pollution. (Begum et.al. 2011) Some pollutants such as soot particles, oxides of nitrogen and sulfur are emitted directly into the air by the combustion of fossil fuels for domestic cooking (Bonzini et al. 2010). Motorized road traffic, power generation, industrial sources, and residential heating are the key source of primary air pollutants. Whereas, primary pollutants react or interact with the atmosphere, form secondary pollutants mainly ozone (O_3) and Particulate matter PM (Schwarze et al. 2006). The resuspension of soil and road dust by wind or moving vehicles, as well as construction work and industrial emissions, are the major emitter for $PM_{10.}$ Textile and dying, tanneries, pulp and paper, cement, metal, fertilizer, and chemical factories, in particular, emit particulate matter (PM) (Mahmood 2011). Those are also responsible for the emission of sulfur oxides, nitrogen oxides, carbon monoxide and ammonia (Mahmood 2011). Fine particles are derived primarily from direct emissions from combustion processes such as gasoline and diesel fuel, burning of wood, coal for power generation, and industrial purpose (Schwarze et al. 2006) Ultrafine particles are fresh and emit from combustion-related sources such as vehicle exhaust and atmospheric photochemical reactions and are recognized as important markers of exposure to traffic exhaust along main roads (Franchini et al. 2015). Both fine and ultrafine particles have the worst effects on health as they can reach the deepest portions of the airways or even reach the bloodstream directly (Franchini et al. 2011; Franchini et al. 2007). Air pollution is now a matter of Concern all over the world due to its harmful impact on health. Each year, more than 5.5 million people around the world die prematurely from illnesses caused by breathing polluted air (WHO,2012). Those illnesses include lung cancer, heart disease, stroke, acute respiratory infections, and chronic obstructive pulmonary diseases such as bronchitis and emphysema (GBD 2013 Collaborators 2015). Nitrogen dioxide causes respiratory infection Carbon monoxide reduces delivery of oxygen into the human body, creates a severe headache and decreases visual perception and manual dexterity. (Saiful 2014) Among all fine particulate matter (PM2.5) is more destructive because it is responsible for cardiovascular disease, heart disease, pulmonary infection, lung infection and ultimately death prematurely. On the basis of polluted air quality with the presence of Particulate matter Dhaka is ranked as 45^{th} among the 3000 cities of 103 countries (WHO, 2016)

Objectives

1. To review the current status of air pollutants in Dhaka City with emphasis on the major or key pollutant.
2. To understand the human health impacts of air Pollutants.

CHAPTER 2

MATERIALS AND METHODS

As this seminar paper is exclusively a review paper, there is no need to follow some specific methods to prepare it. All the relevant data and information about the topic were collected and used from secondary sources. The information from different books, journals, booklets, proceeding, newsletters, souvenir, consultancy report that are available in the libraries of BSMRAU, BRRI were compiled chronologically to complete it successfully. Maximum necessary supports were taken from internet searching. Finally, this seminar paper was also prepared with the consultation of my respective major professor and honorable seminar course instructors.

CHAPTER 3

REVIEW OF FINDINGS

3.1 The Air Quality Index(AQI)

The Air Quality Index(AQI) is an index that is used for reporting daily air quality. It describes us how clean or polluted air of a location is and what associated health effects might be a concern for the people of this location. The AQI focuses on health effects that people of a country may experience within a few hours or days after breathing polluted air. Based on the exposure to all types of pollutants (PM, CO, O_3, SO_2, and NO_2) with the AQI based on the worst exposure concentration for any of these pollutants it is measured. This system was first developed by the United States Environmental Protection Agency (US EPA) and has now been adapted to the standards applied in a number of other countries.

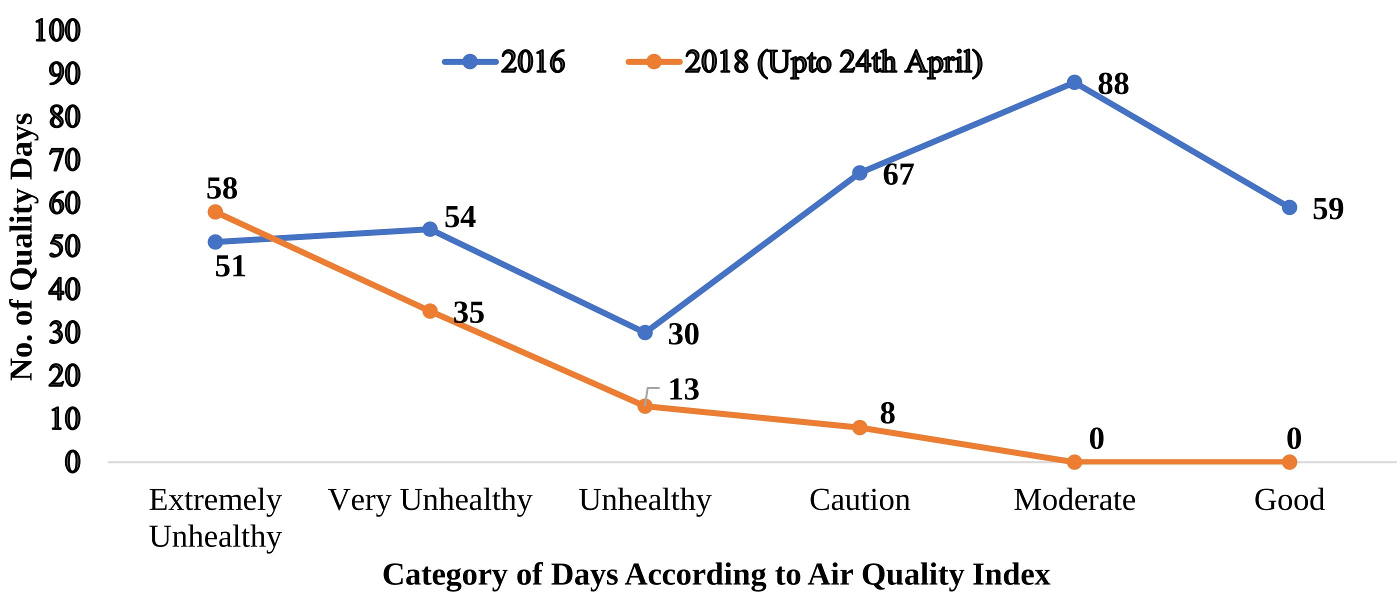
Table-1: Bangladesh Air Quality Index values and Observable Health implication

Air quality index (AQI) Range	Category	Health Implications
0-50	Good	A level that will not impact patients suffering from diseases related.
51-100	Moderate	A level that may have a meager impact on patients in case of chronic exposure.
101-150	Caution	A level that may have harmful impacts on patients and members of sensitive groups specially children and old age people.
151-200	Unhealthy	A level that may have harmful impacts on patients and members of sensitive groups (children, aged or weak people) and also cause the general public unpleasant feelings.
201-300	Very Unhealthy	A level that may have a serious impact on patients and members of sensitive groups in case of acute exposure.
301-500	Extremely Unhealthy	A level that may need to take emergency measures for patients and members of sensitive groups and have harmful impacts on the general public.

Source: USEPA, 2005

Table-1 represents the quality or category range of air which is good healthy or unhealthy. Here Green color represents the air quality is good for health whereas light yellow is moderate for health. On the other hand, yellow gives the caution sign and orange color spells out the air is unhealthy for the human. Red and Violet are the sign of very unhealthy and extremely unhealthy category of air. The moderate category is the health threat and it is clearly not recognizing the likely effects on susceptible populations including children and the elderly. The rest of three categories (unhealthy, very unhealthy, and extremely unhealthy) are adequately informative of

Figure 1: Number of Quality Day in Dhaka City from 2016 and 2018



Source: Anonymous, 2018

the risks for all aged people. Figure 1 depicts that in 2016 good air quality prevails only 59 days and 88 days were good but in year, 2018 (From January to April) no good or moderate category days were found. Among the 4 months of 2018, 58 days were extremely unhealthy. This data clearly spells out that people of Dhaka City are in extremely unhealthy condition. Day by day this city is losing its inhabitability due to bad air quality.

3.2 Spatial Distribution of ambient air pollutants concentration in Dhaka City (2010-2017)

Pollutants are everywhere all over the world. Therefore, air pollution is a burning issue nowadays. Since 1996-97, air pollution of Dhaka city became the severest when lead in the air was reported higher than in the atmosphere of any other place of the world. In 21st century Dhaka City also kept its trend of air pollution where presence of particulate matter (PM_{10}) was one of the most destructive levels.

Table-2: Ambient Air Quality of different location in Dhaka City in the year of 2010

Pollutants Conc\Location	Mohakhali	Farmgate	Mogbazar	Sonargaon	Science Lab	Bangladesh Standard value
CO(µg/m3) 8-hour average	2519	7730	5726	3435	5726	10000 (8-hour average)
PM_{10} (µg/m3) 24-hour average	547.66	289.92	383.53	161.93	167.64	150 (24-hour average)
NO_x (µg/m3) 4-hour average	376	752	339	75	113	100 (Annual)
SO_2 (µg/m3) 24- hour average	Trace	Trace	Trace	Trace	Trace	365 (24-hour average)

Source: Ahmmed et. al. 2010

From the Table-2 it is clear that in 2010 the concentration level of CO was within the limit of Bangladesh Standards by the Department of Environment (DoE) of the Government of Bangladesh (GoB) (US EPA, 2005). In case of SO_2, the same result was observed. But the concentrations of NOx in the ambient air exceed the standard values set by the Department of Environment, GoB. But, it may be mentioned here that the standard value of NOx set by the DoE was annual average and the results shown in Table 2, were 4 hours average. Particulate matter was also exceeded its standard level among all the 6 locations in Dhaka City at an alarming rate. Table -2 clearly spells out that the Mohakhali Location contained the highest concentration of PM_{10} as well as NO_x comparing all the 6 locations.

With the 5 years (2013-2017) monitoring of BARC farmgate location, it is observed that only NO_X crossed its standard limit of National Ambient Air Quality Standard with alarming rate (Table-3). This area is basically a traffic hotspot and thus the NO_x concentration was higher than other monitoring stations. With the increase of vehicular fleet and other industrial activities, the NO_x

concentration was increased in the year of 2013-2015. Whereas in 2017 concentration of NO_x decreased slightly but still it exceeded its NAAQS. In case of Particulate matter, only $PM_{2.5}$ was showing the increasing trend from 2013-2017 year. Among all, it was reached its peak in the year

Table-3: Ambient Air pollutants at BARC, Farmgate, Dhaka

Concentration of pollutants	2013	2014	2015	2017	NAAQS
PM_{10}(µg/m^3) 24-hour average	123	94.4	152	65.5	150
$PM_{2.5}$(µg/m^3) 24-hour average	65.7	130	78.3	77	65
SO_2 24-hour(ppb)	7.74	6.44	6.63	16	140
NO_x(ppb) 24-hour	104	153	143	80	53 (Annual)
CO (ppm) 8-hour average	1.11	1.90	2.75	1.8	9
O_3(ppb) 8-hour average	15.9	6.97	6.67	6.6	80

NAAQS=National Air Quality Standard Source: Anonymous, 2017

of 2014. All other pollutants were well below its standards values for Bangladesh (Table -3). By observing all pollutants level at BARC, Farmgate station except NO_x and $PM_{2.5}$ all ambient concentrations were in the satisfactory level. Therefore, it is expected that all the pollutants concentration would be low in future. However, due to heavy traffic, proper monitoring is to be needed systematically near those places for better judgment on the exposure levels of all pollutants levels in the city.

Sangsad Bhaban is an urban/semi-residential area, it was observed that the temporal coverage of the air quality data on criteria pollutants was fairly good except $PM_{2.5}$ (Table-4)

Table-4: Ambient Air pollutants at Sangsad Bhaban, Dhaka

Concentration of pollutants	2013	2014	2015	2017	NAAQS
PM_{10}(µg/m^3) 24-hour average	148	139	131	65.4	150
$PM_{2.5}$(µg/m^3) 24-hour average	81.6	72.6	78	61.83	65
SO_2 (ppb) 24-hour)	5.05	4.93	---	---	140
NO_x(ppb) 8-hour average	33	33.5	32.7	---	53 (Annual)
CO(ppm) 8-hour average	1.06	1.15	0.67	1.55	9
O_3(ppb)	4.61	2.54	0.84	---	80

NAAQS=National Air Quality Standard Source: Anonymous, 2017

The data on SO_2 was not monitored due to mechanical error in the year of 2017 and 2015. Data on NO_x and O_3 was also missing for the same reason in 2017. Though the ambient concentration of $PM_{2.5}$ crossed its standard value of Bangladesh, it maintained the decreasing trend from 2013 to 2017 year (Table-4). PM10 was also observed decreasing day by day. Exposure of CO is due to exposure levels to the general population. The measured CO concentration was very low that is below air quality standard level here, but it is close to traffic hotspots the level of CO is slightly higher in 2017 than the previous year.

Table-5: Comparison between National Air Quality Standard and Ambient Air pollutants at Darussalam, Mirpur-1 Dhaka

Concentration of pollutants	2013	2014	2015	2017	NAAQS
PM_{10}(μg/m^3) 24-hour average	156	160	162	160	150
$PM_{2.5}$(μg/m^3) 24-hour average	90.2	96.8	88.4	83.8	65
SO_2 24-hour(ppb)	10.3	9.95	7.89	12.05	140
NO_x(ppb) 24-hour	49.4	45.4	45.4	31.34	53 (Annual)
CO (ppm) 8-hour average	2.26	2.67	1.96	2.6	9
O_3(ppb) 8-hour average	6.44	5.75	12	7.7	80

NAAQS=National Air Quality Standard

Source: Anonymous, 2017

In this location, $PM_{2.5}$ did not exceed only the standard air quality level but also reached its pick level in the year of 2014. The concentration was 96.8 μg/m^3. The concentration of PM_{10} was also found above the National Air Quality Standard of Bangladesh. The amount of Particulate matter was increased significantly within 5 years a reflection of the growing challenge of pollution in Dhaka City. (Table-5). The other pollutants like Carbon monoxide, Ozone, sulfur dioxide, nitrogen oxide remain below standard level. However, during 2013-2015 the concentration level of SO_2 was near to its standard value but it decreased slightly by the year of 2017. Therefore, proper inspection is mandatory to inhibit the increase of these pollutants in future.

Generally, by comparing Table-3, Table-4 and Table-5 it was observed that the temporal coverage of the air quality data on criteria pollutants is fairly good except few cases. With the assessment of the data among the three tables, it can be concluded that yearly average PM concentration levels in both fractions ($PM_{2.5}$ and PM_{10}) in all monitoring sites were high and usually exceeded the Bangladesh National Ambient Air Quality Standards (BNAAQS). The maximum value of the PM concentration levels reaches as high as 2/3fold compared to the 24 hours BNAAQS values (150 µg/m3 for PM10 and 65 µg/m3 for PM2.5). Thus, PM was recognized as the most important pollutant of concern for Bangladesh. In the table-2 same scenario was found about PM level in 2010 at Mohakhali, Farmgate, Mogbazar, Science lab as well as Sonargaon. Therefore, exposure of PM concentration is a burning issue for Dhaka City from 2010 to till now.

Table-6: Average concentration of $PM_{2.5}$ in three locations of Dhaka City (2013-2017)

Year	Darussalam Mirpur	Sangsad Bhaban Agargaon	BARC Farmgate
2013	90.2	81.6	85.7
2014	96.8	72.6	130
2015	88.4	78	78.3
2017	83.8	61.83	77

Source: Anonymous, 2017

It is clear from the Table-6 that the ambient 24-hour average $PM_{2.5}$ of Darussalam, Mirpur from 2013 to 2017 was significantly higher than Sangsad Bhaban and BARC Farmgate area. Because of larger emission sources (higher motorization rate, larger population) are found here. On the other hand, a massive surge in the number of brick kilns situated near this area. About 60% of $PM_{2.5}$ comes from brick kilns in Dhaka City. It was also seen from literatures that the PM concentrations in winter to some extent influenced by the transboundary movement of air pollution. Therefore, emission of $PM_{2.5}$ from Brick kiln also pollutes the air of nearby locations like Gabtoli, Darussalam road and so on.

Table-7 spells out the ambient 24-hour average $PM_{2.5}$ of Darussalam, Mirpur from 2013 to 2017 was significantly higher than Sangsad Bhaban and BARC Farmgate area. Because of larger emission sources (higher motorization rate, larger population) are found here.

Table-7: Average concentration of PM_{10} in three locations of Dhaka City (2013-2017)

Year	Sangsad Bhaban	BARC Farmgate	Darussalam Mirpur
2013	148	123	156
2014	159	94.4	160
2015	131	155	162
2017	65.4	65.5	150

Source: Anonymous, 2017

This is because of larger emission sources (higher motorization rate, larger population) are found here. On the other hand, a massive surge in the number of brick kilns situated near this area. It was also seen from literatures that the PM concentrations in winter to some extent influenced by transboundary movement of air pollution. Therefore, emission of PM_{10} from Brick kiln also pollutes the air of nearby locations like, Gabtoli, Darussalam road and so on. Heavy motor vehicles are also the effective cause for increasing level of PM_{10} in this location. During night time very high concentrations of the fine particulate matters were observed in this location presumably due to the emissions from tracks and Lorries running only at night. These tracks and Lorries are not allowed during daytime in Dhaka city. However, the total average $PM_{2.5}$ mass concentration was about eight times higher than WHO and about 3.0 times higher than DoE, Bangladesh guideline values for 24-hours.

3.3 Air pollutants level in 2018 in Dhaka City

In March 2018 the average emission of air pollutants at BARC, Farmgate, Sangsad Bhaban as well as Darussalam Road, Mirpur are presented in Figure 2 in association with Standard Air Quality in Bangladesh.

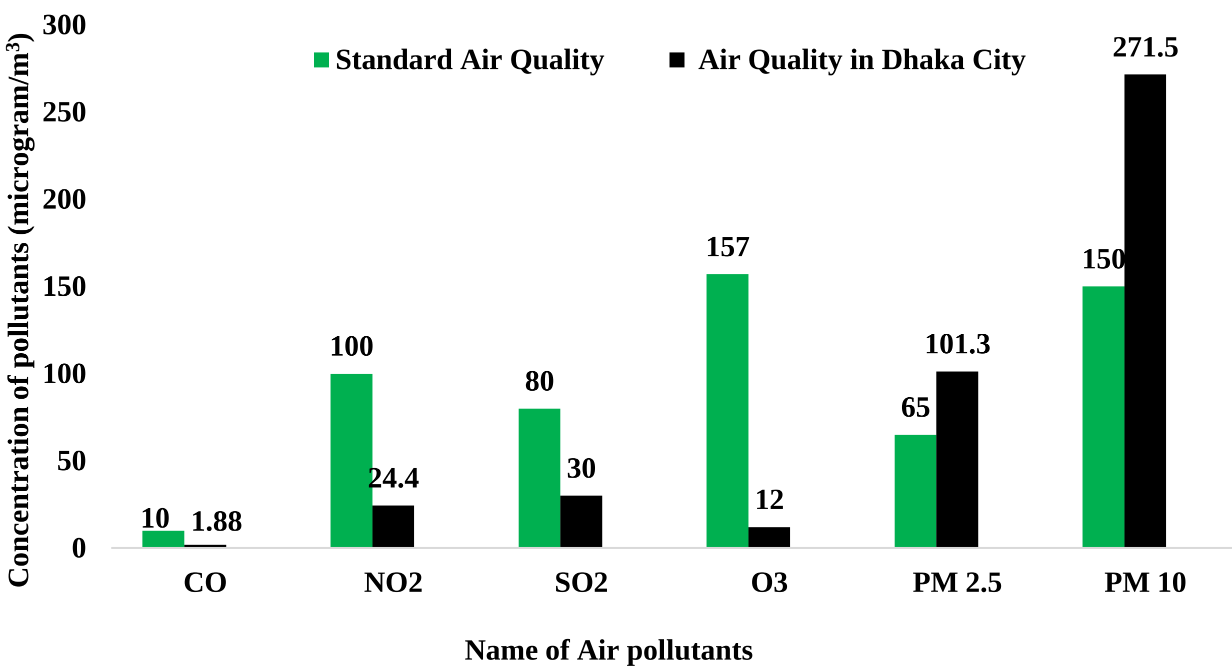


Figure 2: Average ambient air pollutants of 3 locations in March 2018

Source: Anonymous, 2018

In this figure 2, Black column stands for air pollutants level in Dhaka City and Green column represents Standard air Quality level of Bangladesh. Concentration was measured in microgram/m^3 except CO. unit of CO is ppm. This is because Standard value of CO is very low in Microgram/m^3. The same situation has happened with coarse and fine particle matter as it has been seen in Table 3. Table 4 as well as Table 5. That means both two particles crossed the standard limit with an alarming concentration and rest of all pollutants remain well below the Air Quality Standard for 24- hour averaging periods

3.5 Seasonal Variation of PM $_{2.5}$ in Dhaka City

Figure 3 shows the monthly variation level of PM_{10} and $PM_{2.5}$ emission in 2017.

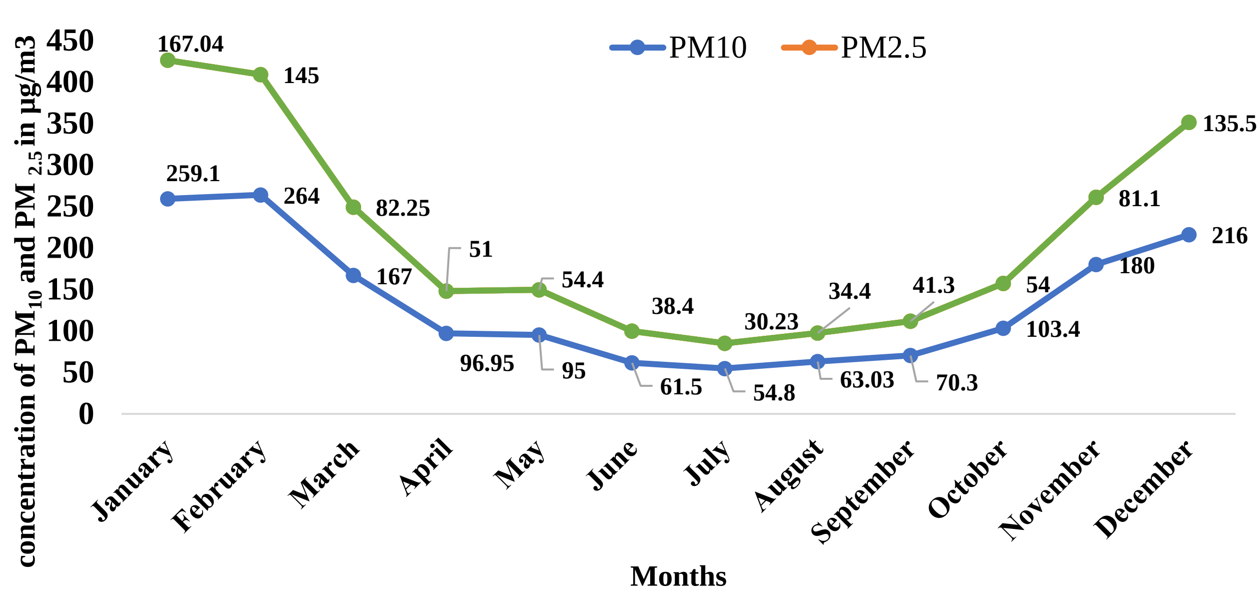


Figure 3: Seasonal Variation of PM10 and PM2.5 in 2017

Source: Anonymous, 2018

Here green line represents $PM_{2.5}$ and blue line indicates the PM_{10}. This line graph clearly spells out that the emission of both two particulate matter is increased in the dry season that means it starts to increase from the month of November and reaches its peak level in the month January and February.

During the wet season, heavy rainfall occurs across the country. In this time rivers, canals, wetlands, low-lying areas around Dhaka city are inundated. During this time the wind speed is higher than the dry season. Pollutants, especially the particulate matter of 2 sizes, are washed away from the air by the rain. Thus, the amount of $PM_{2.5}$ as well as$PM_{10}$is less than dry season.

On the other hand, dryland conditions, low relative humidity and prevailing cloud free skies during the winter season are highly conducive for generation of transboundary aerosols together with local urban activities. The scanty rainfall and presence of clean sky reduces the atmospheric scavenging processes thereby a high level of aerosol loading occur. These aerosols would comprise coarse aerosols arising from mechanical processes in association (Swapan et al. 2001) with urban activities as well as the finer aerosols produced from precursors and those two lifted up by turbulence. The coarse aerosols are short-lived, while the fine aerosols have longer residence time. Therefore, both PM_{10} and $PM_{2.5}$ remain high during winter season. Moreover, temperature inversions in the morning and in the evening occur frequently during winter season and these inversion layers reduce the air volume available to dilute pollutants. Thus, the presence of an inversion layer in a city leads to an increased concentration of the pollutants even if the emissions remain unchanged. Thus, PM_{10} and $PM_{2.5}$ concentration start increasing during the winter season. (Flossmann et. al.2008)

3.6 Source of Particulate matter in Dhaka City

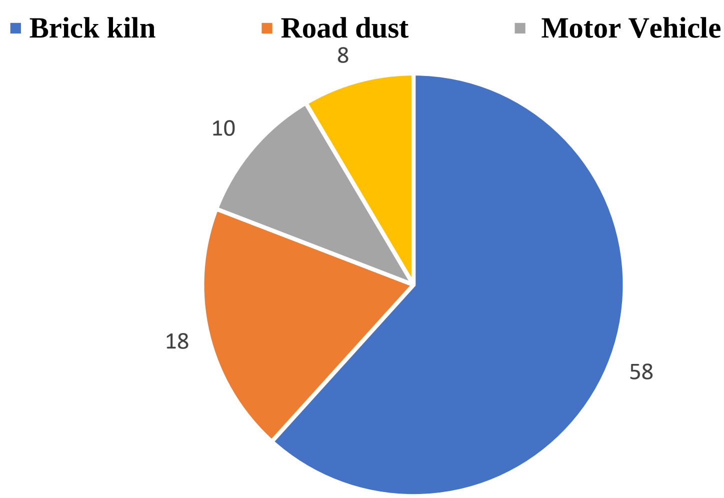


Figure 4 : Source of Particulate matter in Dhaka

Source: Anonymous ,2018

From this Figure, 4.it is clear to all that brick kiln emit a huge concentration of particulate matter in Dhaka city. More than half of the total air pollution through particulate matter comes from brick Kiln and motor vehicle contribute a few concentration of particulate matter. The concentration is only 18% Therefore measure should be taken to inhibit the illegal orthodox brick field construction.

3.7 Health effects of various air pollutants

Air pollution is not just a problem in cities. More than 2.8 billion people around the world continue to burn solid fuels such as wood, charcoal, coal, and dung in their homes for cooking and heating (Chafe et al. 2014)

3.7.1 Sulfur dioxide (SO_2)

SO_2 is a colorless gas has a sharp odor. It is produced from the burning of fossil fuels (coal and oil) and the smelting of mineral ores that contain sulfur.

SO_2 causes irritation of the eyes. The respiratory system and the functions of the lungs can be affected also. (Li et al. 2015) Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract (Padula et al. 2013). Some studies conclude that a proportion of people with asthma experience changes in pulmonary function and respiratory symptoms after periods of exposure to SO_2 as short as 10 minutes (Gonzalez et al. 2013). Hospital admissions for cardiac disease and mortality increase on days with higher SO_2 levels. SO_2 combines with water and forms sulfuric acid; which is the main component of acid rain that is a cause of deforestation. SO_2 is one of the main industrial-based pollutants may have age-specific effects on the development of Crohn's disease especially adults employed in driving occupation (Li et al. 2009) and ulcerative colitis, respectively (Kaplan et al. 2010). Increasing concentrations of SO_2 may also be considered as a risk factor for maternal depressive symptoms (Lin et al.2017) The increasing levels of SO_2 and PM_{10} may induce acute development of maternal emotional stress (Lin et al.2017).

3.7.2 Ozone (O_3)

Excessive ozone in the air can have a marked effect on human health. O_3 in association with other Indoor PM emissions make excuse for respiratory diseases (acute and chronic), lung malfunctioning, asthma, premature birth (Zaidi et al., 2011; Yamamoto et al., 2014) Ozone exposure may have an effect on cardiac development (Kannan et al. 2007). In Europe, it is currently one of the air pollutants of most concern. Several European studies have reported that the daily mortality rises by 0.3% and that for heart diseases by 0.4%, per 10 µg/m^3 increase in ozone exposure (EEA, 2016) From other study of Hongkong it was observed that exposure of O_3 increased hospital admission for asthma in children

3.7.3 Nitrogen oxide (NO_2)

It is an air pollutant having several correlated activities. anthropogenic emissions of NO_2 are through the combustion processes (heating, power generation, and engines in vehicles and ships). Therefore, the major source of NO_2 in ambient air is road traffic (Nishimura et. al. 2013). NO_x is not so health hazardous but it helps in the production of nitrate aerosols, which form an important fraction of $PM_{2.5}$ and, in the presence of ultraviolet light, of ozone. At a short-term exposure of standard level (200 µg/m^3), it shows toxicity which causes significant inflammation of the airways. Epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO_2 (Mccreanor et. al. 2007). Growth reduction of lung is also linked to NO_2 at concentrations currently measured (or observed) in cities of Europe and North America. An estimated 70 000 deaths occur from exposure to NO_2 whereas in Denmark it is estimated that 3000 premature deaths occur annually from exposure to PM & NO_2 (Anonymous, 2016) From another study of Hongkong it was observed that Each 10 µg/m3 increase in NO2 corresponded to an adjusted OR of 1.25 (95% CI 1.16 to 1.36) for diagnosed asthma in six to 13 years-old Chinese children (Liu et al.2014).

3.7.4 Particulate matter ($PM_{2.5}$ and PM_{10})

Particulate matter Specially $PM_{2.5}$ is not only a health hazardous pollutant of Dhaka City or Bangladesh it is a detrimental pollutant all over the world. Due to short-term PM exposure the percentage of relative risk increase for all-cause mortality has been estimated to range from 0.4% to 1.5% per 20 µg/m3 increase in coarser PM_{10} and from 0.6% to 1.2% per 10 µg/m3 increase in finer $PM_{2.5}$ (Stieb et al. 2002), including more than 60 million Medicare beneficiaries from 2000 through 2012, observed that, for every increase of 10 µg/m3 in $PM_{2.5}$, there was an associated 7.3% increase in all-cause mortality. Long-term exposure to particulate matter is also responsible for weakening of immune system of children, females and elderly people because they are considered as prone group (Gurley et al., 2012) with the increasing incidence of cardiovascular, respiratory and all-cause mortality (Jerrett et al. 2009; Levy et al.2005; Bell et al.2004). Furthermore, it is the largest and most directly connected to the risks of mortality which causes cancer, cardiovascular and respiratory disease. This is now one of the largest global health risks, with a disease burden comparable to that from tobacco smoking (WHO, 2014; WHO, 2015).

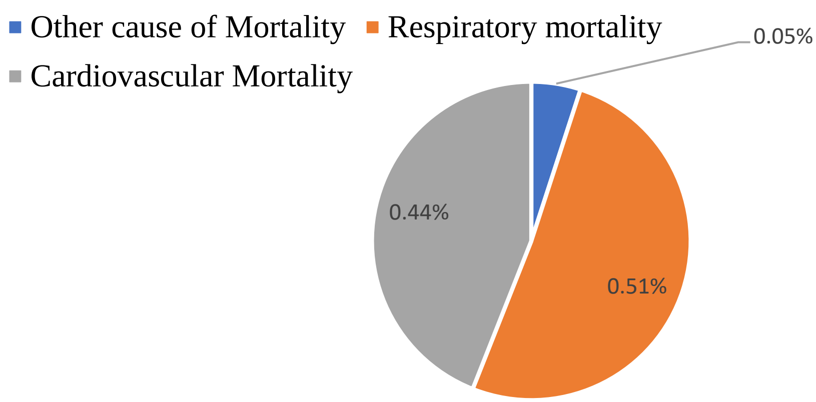


Figure 5: Mortality% due to PM2.5 Exposure

Source: WHO, 2012

Figure 5 shows every 10 microgram/m^3 increase in Particulate matter 2.5 with a 0.38% increase in total mortality, a 0.51% increase in respiratory mortality, and a 0.44% increase in cardiovascular mortality (WHO, 2012). Large amount of epidemiological and toxicological studies in developed countries related with elevated particulate concentration (especially $PM_{2.5}$) with an increased risk of premature mortality. Various studies (e.g. USEPA 2007) also shows that among the criteria air pollutants, $PM_{2.5}$ has the most detrimental impact on health. Recently, air pollution (indoor and outdoor) is listed as the world's largest single environmental health risk with the ever-increasing association to the incidences cardiovascular diseases and cancer (WHO, 2014; Baklanov et al., 2016). PM_{10} may induce acute development of maternal emotional stress. (Lin et al.2017)

CHAPTER 4

CONCLUTIONS

The data capture rate and the data quality were at a satisfactory level during the reporting except for few locations. In general, gaseous pollutants mainly, CO, SO_2, NO_x, O_3 appear does not exceeding the BNAAQS whereas particulate pollutants in both fractions (PM2.5 and PM10) are usually show exceeding trend especially during winter season when participation rate as well as, wind speed are very low. While during the rainy season (from May to October) both PM_{10} and $PM_{2.5}$ concentration remain below or near to the standard values because of scavenging of particulate matter by rainfall. Thus, particulate matter looks like most important pollutants that need attention to reduce it for improving the air quality.

All the air pollutants are health hazardous for instance, short-term (10 minutes) exposure to SO_2 to human, causes aggravation of asthma and chronic bronchitis. On the other hand, 10 $\mu g/m^3$ exposure of ozone is responsible for 0.4%, increase of heart diseases. CO, SO_2, NO_x, O_3, all the four elements are carcinogenic either directly or indirectly. Those pollutants are also responsible for the lung infection, pulmonary infection and sometimes increase death rate. However, Particulate matter 2.5 itself increase 0.38% of total mortality, where 0.51% increase in respiratory mortality, and 0.44% increase in cardiovascular mortality. Due to very small diameter in size particulate matter can easily penetrate into the cell or easily enter into the blood level and act as a silent killer. Therefore, it is found more detrimental to the human being. Along with its harmful health impact emission rate of this pollutant is also very high. This scenario is present not only Dhaka city but also all over the world. Particulate matter specially $PM_{2.5}$is one of the largest health hazardous issue in the world.

REFERENCES

Ahmmed, K. M. Tanvir and Begum, (2010) Air Pollution Aspects of Dhaka City, International Conference on Environmental Aspects of Bangladesh (ICEAB10), Japan, 129-133.

Anonymous, 2016. Air Quality Status and Trends: 2013-2015. Department of Environment. Ministry of Environment and Forests, 3-48. Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: April, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: December, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: February, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: January, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: June, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2017. Monthly Air Quality Monitoring Report: March, 2017. Department of Environment. Ministry of Environment and Forests, Retrieved on: www.case.doe.gov.bd

Anonymous, 2018. Monthly Air Quality Monitoring Report: March, 2018. Department of Environment. Ministry of Environment and Forests, 1-9. Retrieved on: www.case.doe.gov.bd

Baklanov, A., Molina, L.T., Gauss, M. (2016). Megacities, air quality and climate. Atmospheric Environment 126, 235-249.

Bangladesh Bank. (2011). Major economic indicators; Monthly update. Dhaka: Bangladesh Bank.

Begum, B.A., Hossain, A., Saroar, G., Biswas, S.K., Nasiruddin, M., Nahar, N., Chowdury, Z., Hopke, P.K., 2011. Sources of carbonaceous materials in the airborne particulate matter of Dhaka. Asian Journal of Atmospheric Environment (AJAE) 5, 237-246.

Bell, M. L., McDermott, A., Zeger S. L., Samet, J.M., Dominici F. (2004). Ozone and short-term mortality in 95 US urban communities, 1987–2000. JAMA 292(19), 2372–2378.

Bonzini, M., Tripodi, A., Artoni, A., Tarantini, L., Marinelli, B., Bertazzi, P.A. Apostoli, P., Baccarelli, A. (2010). Effects of inhalable particulate matter on blood coagulation. J. Thromb. Haemost 8, 662–668.

Chafe, Z. A., Brauer, M., Klimont, Z., Van Dingenen, R., Mehta, S., Rao, S., Riahi, K., Dentener, F., Smith, K. R., (2014). Household Cooking with Solid Fuels Contributes to Ambient $PM_{2.5}$ Air Pollution and the Burden of Disease. Environmental Health Perspectives 122(12), 1314–1320

EEA, European Environment Agency (2016). Air quality in Europe — 2016 report, Luxembourg Publications Office of the European Union. Retrieved on: www.eea.europa.eu

EPA (U.S. Environmental Protection Agency) 2007. Integrated Science Assessment for Particulate Matter Retrieved on: www.cfpub.epa .gov

Flossmann, F.I., Hall, W. D., and Pruppacher, H. R, (2008). A theoretical study of the wet removal of atmospheric pollutants: PartI. The redistribution of aerosol particles captured through nucleation and impaction scavenging by growing cloud drops, Journal of Atmospheric Science 42, 583-606.

Franchini, M., Mannucci, P.M. (2007). Short-term effects of air pollution on cardiovascular diseases: Outcomes and mechanisms. J. Thromb. Haemost 5, 2169–2174.

Franchini, M.; Mannucci, P.M. (2011). Thrombogenicity and cardiovascular effects of ambient air pollution. Blood 118, 2405–2412.

Franchini, M., Mannucci, P.M. (2015). Impact on human health of climate changes. European Journal International Medicine 26, 1–5.

GBD 2013 Collaborators, (2015) Global, Regional, and National Comparative Risk Assessment of Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks in Countries, 1990–2013: A Systematic Analysis for the Global Burden of Disease Study 2013, The Lancet 396 (10010), 2287–2323

Gonzalez, Barcala, F.J., Pertega, S., Garnelo, L. et al. (2013). Truck traffic related air pollution associated with asthma symptoms in young boys: a cross sectional study. Public Health 127,275–281.

Government of Alberta (2006). Environment. Web site. Retrieved on: www.gov.ab.ca.

Gurley, E.S., Salje, H., Homaira, N., Ram, P.K., Haque, R., Jr, P.W., Bresee, J., Moss, W.J., Luby, S.P., Breysse, P. (2012). Seasonal concentrations and determinants of indoor particulate matter in a low-income community in Dhaka, Bangladesh. Environmental Research 121, 11-16.

Jerrett, M., Burnett, R. T., Pope, A. C., Ito, K. Thurston, G., Krewski, D., Shi, Y., Calle, E., Thun, M. (2009). Long-term ozone exposure and mortality. N Engl J Med 360(11), 1085–1095. doi:10.1056/NEJMoa0803894

Kannan, S., Misra, D. P., Dvonch, J. T. & Krishnakumar, A. (2007). Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework for exploring potential. Ciencia & saude coletiva 12, 1591–1602

Kaplan, G. G, Hubbard, J., Korzenik, J., Sands, B. E. et al. (2010) e Inflammatory Bowel Diseases and Ambient Air Pollution: A Novel Association. American Journal of Gastroenterology 105, 2412–2419.

Levy, J.I., Chemerynski, S.M., Sarnat, J.A. (2005). Ozone exposure and mortality: An empirical Bayesmeta regression analysis. Epidemiology 16(4), 458–468. doi:10.1097/01.ede.0000165820.08301.b3

Li, M., Zhang, Q., Kurokawa, J., Woo, J.-H., He, K. B., Lu, Z., Ohara, T., Song, Y., Streets, D. G., Carmichael, G. R.' Cheng, Y. F., Hong, C. P., Huo, H., Jiang, X. J., Kang, S. C., Liu, F., Su, H., Zheng, B. (2015). A Mosaic Asian Anthropogenic Emission Inventory for the MICS-Asia and the HTAP Projects. Atmospheric Chemistry Physics Discussion 428, 34813–34869.

Li, X., Sundquist, J., Sundquist, K. (2009). Educational level and occupation as risk factors for inflammatory bowel diseases: a nationwide study based on hospitalizations in Sweden. Inflammatory Bowel Diseases 15:608–615.

Lin, Y., Zhou L., Xu J. et al. (2017). The impacts of air pollution on maternal stress during pregnancy: Scientific Reports 7, 40956 doi:10.1038/srep40956

Liu, F., Zhao, Y., Liu, Y.Q., Liu, Y.; Sun, J., Huang, M.M., Liu, Y., Dong, G.H. (2014). Asthma and asthma related symptoms in 23326 Chinese children in relation to indoor and outdoor environmental factors: The Seven Northeastern Cities (SNEC) study. Science of Total Environment 497–498, 10–17.

Mahmood, S. A. I. (2011). Air pollution kills 15,000 Bangladeshis each year: The role of public administration and governments integrity Journal of Public Administration and Policy 3(4), 129-140.

Mahmud, I. (2011). Air pollution cost TK 124 billion a year in Dhaka city. Bangladesh Independent News. Retrieved on: www.bdinn.com.

McCreanor, J., Culligan, P., Nieuwenhuijsen, M.J. et al. (2007). Respiratory effects of exposure to diesel traffic in persons with asthma. National Engl Journal of Medicine 357, 2348–2358

Nishimura, K., Galender, J.M., Roth, L.A. et al. (2013). Early life air pollution and asthma risk in minority children. American Journal of Respiration Critical Care Medicine 188,309–318.

Padula, A. M. et al. (2013). The association of ambient air pollution and traffic exposures with selected congenital anomalies in the San Joaquin Valley of California. American Journal of Epidemiology 177, 1074–1085

Saiful, M.I. (2014). Air Pollution in Dhaka City: A Burning Issue. Journal of Science Foundation 12(2), 20-21

Schwarze, P.E., Ovreik, J., Lag, M., Refsnes, M., Nafstad, P., Hetland, R.B., Dybing, E. (2006). Particulate matter properties and health effects. Consistency of epidemiological and toxicological studies. Human Experiment Toxicology 25, 559–579

Stieb, D.M., Judek S., Burnett, R.T. (2002). Meta-Analysis of time-series studies of air pollution and mortality: Effects of gases and particles and the influence of cause of death, age, and season. Journal of Air Waste Management Association 52, 470–484.

Swapan, K., Biswas, Solaiman, A., Tarafdar, Islam, A. and Khaliquzzaman M. (2001). Impact on Unleaded Gasoline Introduction on the concentration of Lead in Dhaka Air, Dhaka: AECD.

USEPA. 2005. National Ambient Air Quality Standards (NAAQS)

WHO (World Health Organization). 2016. Review of Evidence on Health Aspects of Air Pollution: Final Technical Report. Retrieved on: www.euro.who.int

WHO, (2014). 7 million premature deaths annually linked to air pollution. Air Quality & Climate Change. World Health Organization, Geneva.

WHO. 2014. 7 million deaths annually linked to air pollution. Cent. European Journal of Public Health, 22, 53–59.

WHO. 2015. Mortality from ambient air pollution for 2012 Retrieved on: www.who.int

WHO. Mortality from household air pollution for 2012. Geneva2014 2015, Retrieved on, www.who.int

WHO, (2018). World Report 2018, Annual review of human rights around the globe, Retrieved on: www.hrw.org

Yamamoto, S., Phalkey, R., Malik, A., (2014). A systematic review of air pollution as a risk factor for cardiovascular disease in South Asia: Limited evidence from India and Pakistan. International journal of hygiene and environmental health 217, 133-144.

Zaidi, S.M., Moin, O., Khan, J.A. (2011). Second-hand smoke in indoor hospitality venues in Pakistan. 1080 International Journal of Tuberculosis & Lung Disease 15, 972-977.