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Status of Air Quality and Survey of Particulate Matter Pollution in Pabna City, Bangladesh

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ABSTRACT: *Particulate matter (PM) is the most significant air pollutant associated with death and disease compared to other measured criteria pollutants. In this paper, the study have been performed to know about the particulate pollution and its effect in human life in Pabna, a city of Bangladesh. This particulate matter ($PM_{2.5}$ and PM_{10}) concentrations in the air of Pabna city have been investigated at five selected locations in Pabna city. Investigation was done by "Handheld Laser Particle Counter" device. From this study it is found that in Pabna the air pollution problem is severe and it crosses the AQI standard. This paper also recommends the possible ways to improve the air pollution problem in Pabna, Bangladesh.*

Keywords: *Air pollution, Motor transport, Particulate matter, PM_{10}, $PM_{2.5}$.*

I. INTRODUCTION

In parallel with the advancement of technology, industrial revolution has imported new problems. Air pollution is one of such problems and has been severely affecting the urban as well as rural area environmental quality in the globe. Particulate matter pollution is a major concern in the large cities of Bangladesh. The main contributors of air pollution are motor vehicles, brick kilns, diesel generators and industries. In recent years much research interest has been shown on atmospheric particles as they influence on climate change and cause adverse health effects [4]. The pollutant species in Bangladesh with respect to transportation systems are carbon monoxide (CO), hydrocarbons (HC), photochemical oxidants e.g., ozone (O3), nitrogen oxides (NOx), suspended particulate matter (SPM), sulfur dioxide (SO_2), and lead (Pb). Air quality monitoring data is limited in Bangladesh, however, periodic surveys by the Department of Environment (DOE), indicate that the ambient levels of SPM, SO_2 and airborne lead are higher than the Bangladesh air quality guidelines. The pollutants emitting from automobiles are obvious contributor to the pollution problem in Bangladesh; however, no emissions inventory detailing sources of pollution in national level is currently available.

Pabna, is a populated and rapidly developing cities in Bangladesh. The rapid growth of population along with unplanned land use development and inefficient traffic management system caused tremendous pressure on existing road network in Pabna city. Air pollution caused by transportation is being growing a serious environmental problem in Pabna city. It occurs due to the use of low lead gasoline without proper catalytic converters, high sulfur in diesel, large number of high polluting vehicles (nosimon/korimon), impure fuel, inefficient land use, and overall poor traffic management. The heterogeneous flows of traffic and having poor maintenance four stroke engine vehicles, which emit greater proportion of black smoke, are the major issues of concern. Moreover, gasoline pilfered from official vehicles finds its way into the informal market for sale to the auto-rickshaw and auto-tempo drivers. Such pilfered gasoline is often mixed with kerosene and when used in two stroke engines becomes a potential agent for pollutant emission.

The objective of this work is to investigate the occurrences and characteristics of the suspended particulate matters (TSP, PM_{10} and $PM_{2.5}$) at the five main points of the Pabna city, Bangladesh. This work could be used as an incentive to perform other studies in order to develop strategies that would control and diminish the air pollution problems in this region. It is also anticipated that the study would help to develop future control strategies towards creating a pollution free environment in Pabna, Bangladesh.

II. AMBIENT AIR QUALITY STANDARDS

An Air Quality Index (AQI) is a communication to describe ambient air quality relative to the relevant national air quality standards. It helps to warn sensitive populations that they should take appropriate measures to reduce their exposure to the ambient air and to inform the general public that there are serious problems with air quality that need to be addressed as a societal responsibility to the whole population. Different countries affix different colors and assign different values to the same descriptor of potential risk.

Table 1: Ambient air quality standards in Bangladesh and their comparison with WHO and US standards [6]

Pollutant	Averaging time	Bangladesh Standard (□g/m³)	WHO standard (□g/m³)	US Standard (□g/m³)
$PM_{2.5}$	24 hr	65	25	15.4
	Annual	15	10	-
PM_{10}	24 hr	150	-	54
	Annual	50	20	-
Ozone (O_3)	8 hr	157 (0.08 ppm)	100	25
	1 hr	235 (0.12 ppm)	-	-
Carbon Monoxide (CO)	8 hr	10,000 (9 ppm)	10,000	3.8
	1 hr	40,000 (35 ppm)	30,000	-
Sulfur Dioxide (SO_2)	1 hr	80 (0.03 ppm)	-	13.4
	24 hr	365 (0.14 ppm)	20	-
NO_2	1 hr	100 (0.053 ppm)	-	28.2

2.1 Particulate Matter:

It is widely accepted that particulate matter is the major pollutant of concern internationally and in Bangladesh (ADB 2006, UNEP 2012). A particulate matter is defined as a solid or liquid particle suspended in a gas which is usually air. Particulate matter is the term tern for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets [10]. Particulate matter is primarily formed from chemical reactions in the atmosphere and through fuel combustion with insufficient oxygen e.g, motor vehicles, power generation, industrial facilities, residential fire places, wood stoves and agricultural burning.

Table 2: Classification of particulates according to their aerodynamic diameter [14]

Size Range	Diameter
PM_{10} (Thoracic Fraction)	Less or Equal than 10µm
$PM_{2.5}$ (Respirable Fraction)	Less or Equal than 2.5µm
PM_1	Less or Equal than 1µm
Ultrafine	Less or Equal than 0.1µm
PM_{10}- $PM_{2.5}$ (Coarse Fraction)	2.5 -10µm

Some particles are directly come from a variety of sources such as cars, trucks, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Other particulates may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight water vapor.

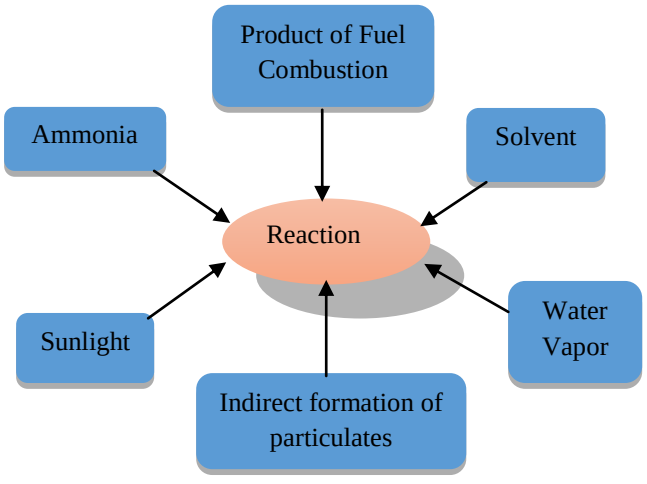

Fig. 1: Formation of particulates [10]

2.2 Impact of Air Pollution (Particulate Pollution):

Particulate pollution has great effects in our daily life [1]. Its effects are given below:

1. It effects on climatic change by changing the way radiation is transmitted through the atmosphere
2. Particular matter blocks through alveoli, leading to cancer, Alzheimer's and permanent declines in lung capacity and causes premature death.
3. Inhaling the particulate matter is the prime cause of asthma.
4. Sulfur particles produces sulfuric acid, which causes the acid rain, which makes the lakes and streams acidic, damaging the sensitive forests and farm crops and affect the diversity of ecosystem.
5. Soot, a type of PM, stains and damages stone and other materials, including culturally important objectives such as monuments and status.
6. PM is the major cause of reduced visibility (haze) in parts of many national parks. The haze is formed by pollution particles in the air.

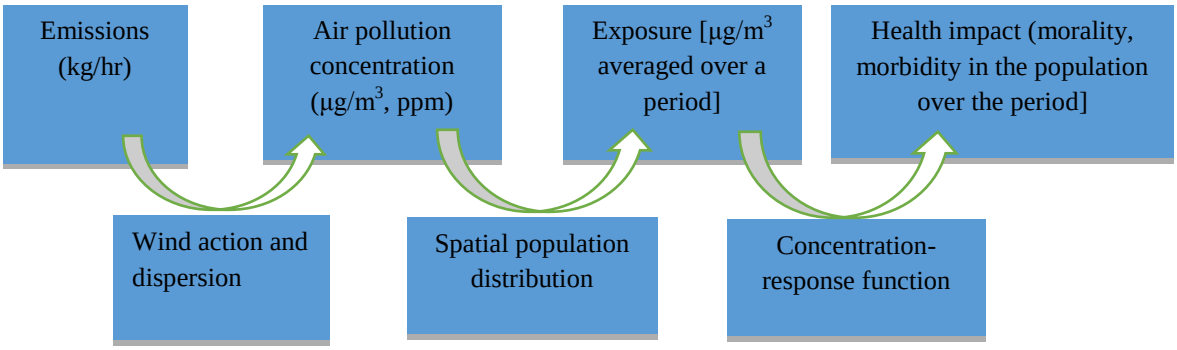

Fig. 2: Relationship between emissions, air pollution, concentrations, exposure and health impacts.

III. METHODOLOGY

Particulate matter sampling was performed by using the device "Handheld Laser Particle Counter" to collect the data from five different locations. To bring accuracy in our measurement and for comfort handling of the particle counter "Repeat Mode" is found suitable for our work. Thus, we have selected the "Repeat Mode" and collected the data for our work. By setting the sampling time, frequency and interval of each measurement, this unit automatically measures as specified and stops after the measurements. Interval is the time between the beginning of first measurement and next. In this method, particle size can be set. The device was placed in the selected locations for collecting PM from morning to evening (9:00 a.m. to 5:00 p.m. local time). In our work, we have tried to find out the particulate matter (PM) having aerodynamic diameter of 0.3, 0.5, 1, 3, 5 μm and the vehicles passing through those points per 30 minutes to determine in which area the particulate matter is higher when the vehicle passing rate is high.

3.1 Sampling Sites and Sampling of $PM_{2.5}$ and PM_{10}:

Data collection was done in five locations. Description of the sampling locations in Pabna, Bangladesh.

Table 3: Description of selected location

Location	Status of Site
Main Bus terminal	Commercial area with heavy traffic
Gachpara	Industrial area with heavy traffic
Ononto Mor	Semi urban area with medium traffic
Library Bazar	Mainly residential with low traffic
Traffic Mor	Commercial area with medium traffic

During collecting the data, it is drastically found that the transportation system of Pabna city is very poor. There is no parking spot, 3wheeler stand; also the roads are very narrow. Sometimes the vehicles population is so high that there creates traffic Jam in Main bus terminal and traffic mor. To get maximum amount of particulate in the selected area, all the data has been taken when the road is busy, like office opening time and closing time and also where the sunlight intensity is less.

Table 4: Combined chart of all locations showing the amount of different types of particulate.

Place	Particulate				
	0.3µm Count/m^3	0.5µm Count/m^3	1µm Count/m^3	3µm Count/m^3	5µm Count/m^3
Library Bazar	107669	58116	1424	290	58
Gachpara Crossing	580343	52416	1198	191	56
Traffic Mor	501856	51041	953	159	44
Ononto Mor	255411	53010	1079	106	37
Main Bus Terminal	748091	49458	2197	686	120

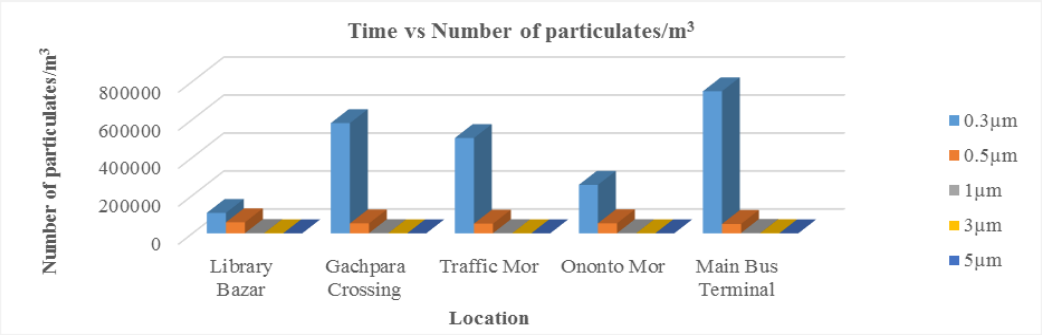

Fig. 3: Combined chart of all locations showing the amount of different types of particulate.

3.2 Traffic Volume at the Sampling Site:

A traffic survey was conducted by manual counting of vehicles at the five locations on selected days during the study period to understand correlation between PM concentrations and traffic volume. The data was taken per 30 minutes. It was observed that the Buses were the main motorized vehicles plying along Main Bus Terminal and most of them are of Diesel driven. Besides this many old minibus, bus, motor cycle, truck and covered vans were also run through the roadways. It was found that heavy-duty diesel trucks and covered vans operated 7 times more frequently at night than during the day.

In the local roads, most of the vehicles are of 2-stroke petrol, diesel or shallow engine (Nasimon), CNG 3wheelers, Motorcycle, Car. It is seen that at day time approximately 1200 numbers of different types of vehicles (mostly diesel driven bus, truck, van, pickup etc) ply per hour through Dhaka-Pabna road, the heavy traffic area.

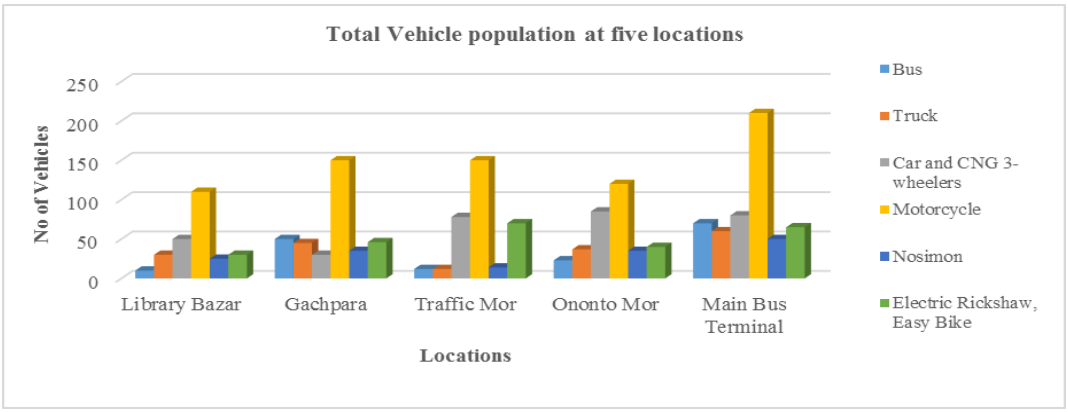

Fig. 4: Average vehicle population in the five places per 30 min.

IV. RESULT

From the collected data, it can be observed that the particulate pollution per cubic meter is greater in those areas where the vehicles passing rate per 30 minutes is high. So we can say that, the amount of particulate pollution is proportional to the number of vehicles in those points. From our work, the following results can be drawn:

1. The top most polluted point is Main Bus Terminal.
2. The second most polluted area is Traffic mor.
3. The third most polluted area is the Gachpara Crossing.
4. The fourth most polluted area is Ononto mor,
5. The fifth most polluted area is the Library bazar.

V. MEASURES TO CONTROL AIR POLLUTION

It is not possible to eliminate the particulate pollution completely. Because it is produced naturally and produced in the time when all types vehicles runs using diesel and petrol. The dynamic development of motor transport is connected with the necessity to reduce its negative impact on natural environment. Pabna Pouroshova should have should have to take some earlier steps to make the city clean. Also the people need to concern about the air pollution, which can reduce the amount of particulate pollution in our daily life. There are some steps to control air pollution can take, are:

1. Using good quality of fuel in vehicle.
2. Proper maintenance of vehicle.
3. Using good lubricants.
4. Using good quality of catalytic converter to reduce the amount of particle remains in the exhaust gases.
5. Arranging pre-ecological technologies in a technical infrastructure of motor transport.
6. Prohibited the using of local fuel (collected from different source)
7. Tree Plantation.
8. Removing the old vehicles, as well as 2-stroke vehicles from the road.

VI. CONCLUSION

The Particulate matter concentration of $PM_{2.5}$ and PM_{10} in the air of Pabna have been collected and compared. Main bus terminal is found as the highly concentrated area for $PM_{2.5}$ and PM_{10}. The other locations are also having high $PM_{2.5}$ and PM_{10}. It is found that the concentrations of $PM_{2.5}$ and PM_{10} in Pabna is higher than the ambient air quality standards in Bangladesh. Brick kiln emission and long range transports are the particulate matter sources those increase the particulate matter in Pabna. So initiatives have to be taken to control the PM emission from brick kilns, motor transport which will give positive impact on the air quality of Pabna. Therefore, it is high time to develop an air pollution abatement strategy to protect people from the hazardous effects arising from elevated atmospheric trace metal levels by the systematic study of air pollution.

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