AIR POLLUTION IN CHITTAGONG CITY

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ABSTRACT
To maintain a peaceful and sound life as well as good health, knowledge about air pollution and its related aspects have become an essential part for human beings. Hence, the concentration of air pollutants in a few location of Chittagong city and the trends of air quality throughout the year for the change of meteorological parameter were investigated with the help of Department of Environment, Bangladesh Meteorological Department and Continuous Air Monitoring Stations (CAMS) of Chittagong city. It has been observed that the concentration of SPM exceeds both the national and international standards. From all the analysis it is clear that the air pollution in Chittagong city is lower considerably in the month April to September. The average Air Quality Index (AQI) value from the year 2013 to 2015 is increasing gradually which is the indication of increasing air pollution in Chittagong city. Therefore, it is suggested that Government of Bangladesh should take proper steps to control the air pollution of Chittagong city.

Keywords*:* Air pollution; Air Quality Index; Standard particulate matter; $PM_{2.5}$; PM_{10}

INTRODUCTION

Clean air is essential to maintain the gentle balance of life on this planet, not just for humans, but wildlife, vegetation, water and soil. But at the same time polluted air, may develop more serious respiratory problems for human beings and also damage our living environment including plants and animals. Air pollution, especially in the large cities of Dhaka and Chittagong, is a major environmental hazard in Bangladesh. There are two major sources of air pollution in Bangladesh, vehicular emissions, and industrial emissions (M. S. Islam. 2014). These are mainly concentrated in the cities. Other than those there are many brick-making kilns operated seasonally, mainly in dry season all over Bangladesh. More or less all of these kilns use coal and wood as their prime sources of energy resulting in the emission of particulate matter, oxides of sulfur, and volatile organic compounds.

Chittagong city is situated on the right bank of the river Karnaphuly. There are various sources of air pollution in Chittagong city, among them unfit vehicles and industries are notable. The numbers of mostly reconditioned vehicles are increasing in every year. One third of these vehicles do not have any fitness certificate. Due to port facility, this city is attractive for the investors to build up industry. A number of 'Export Processing Zones (EPZ)' has been established by the local and foreign investors (BBS, 2010). Most of the industries are not following the environmental rules and regulations. Along with this many urban areas and shopping and recreational facilities are present within the boundary of the study area considered where human exposure to air pollution caused by vehicular induced turbulence. Though green landscape around Chittagong city and monsoon heavy rainfall helps to reduce the intensity of air pollution, a significant change in land uses and human intervention aggravate the degradation of air quality (Rouf et al., 2012).

The influence of poor ambient air quality on human health, agricultural production and damage to materials has been well documented in developing and developed countries. The children, elderly people or the people with heart or lung diseases when breathe polluted air may build up more serious respiratory problems. An estimated 15,000 premature deaths, as well as several million cases of pulmonary, respiratory and neurological illness are attributed to poor air quality in Dhaka, according to the Air Quality Management Project (AQMP), funded by the government and the World Bank (IRIN, 2009). The yearly economic loss associated with these health problems could range from a low estimate

of $60 million to a high estimate of $270 million, equivalent to 1.7to 7.5% of the city's gross product (Rahman, S.M. 2010).

AIM & OBJECTIVES OF THE STUDY

The main objective of this study is to know the present air pollution condition of Chittagong city. However the individual objectives are listed as determination of the concentration of various pollutants like SOx, NOx and SPM, determination of the Air Quality Index (AQI) value, variation of Air Quality with meteorological parameters & comparison of all the parameters with standards.

METHODOLOGY

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects. (https://www3.epa.gov/airnow/aqi_brochure_02_14.pdf) The AQI category and health effect statement according to United State Environmental Protection Agency (USEPA) are described in Table 1.

The index for a pollutant is calculated using the mathematical expression:-

$$Ip = [(I_{Hi} - I_{Lo})/ (BP_{Hi} - BP_{Lo})]*(C_p - BP_{Lo}) + I_{Lo}$$

Where, I_p = the index value for pollutant P;

C_p = the truncated concentration of pollutant P;

BP_{Hi} = the breakpoint that is $\geq C_p$;

BP_{Lo} = the breakpoint that is $\leq C_p$;

I_{Hi} = the AQI value corresponding to BP_{Hi};

I_{Lo} = the AQI value corresponding to BP_{Lo};

Table1. Effects of Air Pollutants According to AQI (USEPA)

AQI Values	Description	Color code	Health Effects Statement
0-50	Good	Green	None
51-100	Moderate	Yellow	Unhealthy sensitive people should consider reducing prolonged or heavy exertion
101-150	Unhealthy for Sensitive group	Orange	Increased likelihood of respiratory symptoms in sensitive individuals
151-200	Unhealthy	Red	Increased aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly
201-300	Very Unhealthy	Purple	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant increase in respiratory effects in general population.
>300	Extremely Unhealthy	Maroon	Serious aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; serious risk of respiratory effects in general population.

RESULTS AND DISCUSSIONS

The average AQI of the year 2013, 2014 and 2015 is 127, 132 and 133 respectively. This is the indication of increasing air pollution in Chittagong city. Fig.1 to Fig. 3 represents the daily AQI trend from 2013 to 2015. In almost 90 percent cases the responsible pollutants for AQI calculation is $PM_{2.5}$.

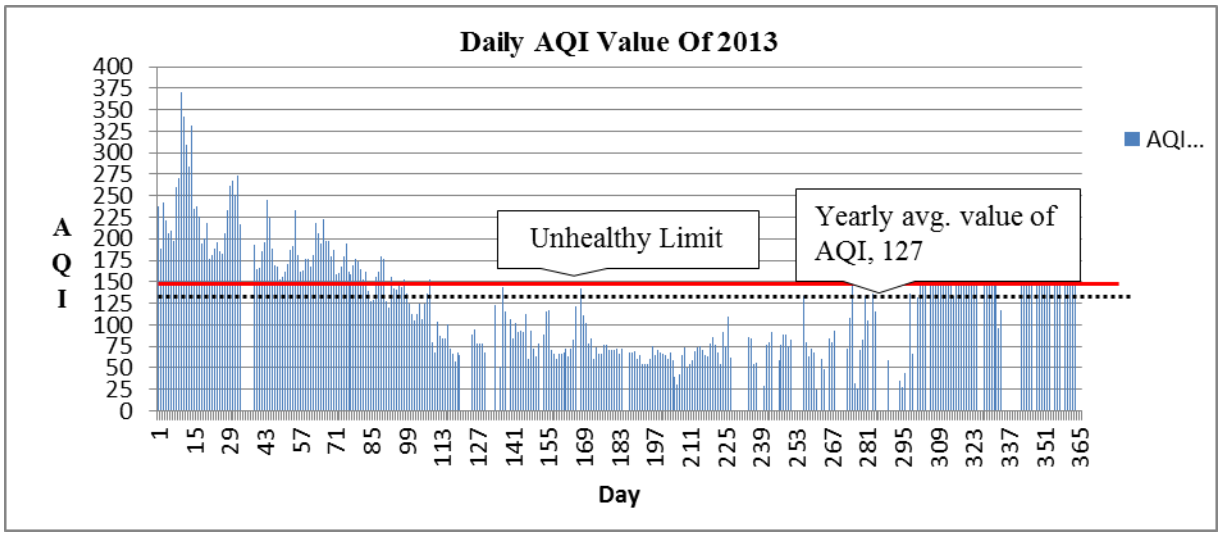

Fig 1: Daily AQI for the year 2013

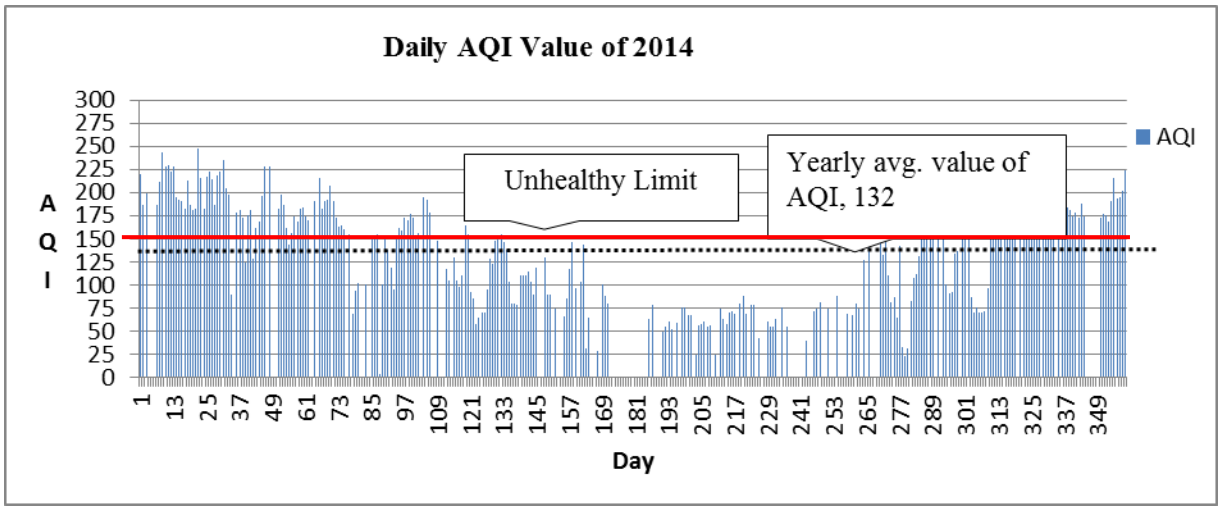

Fig 2: Daily AQI for the year 2013

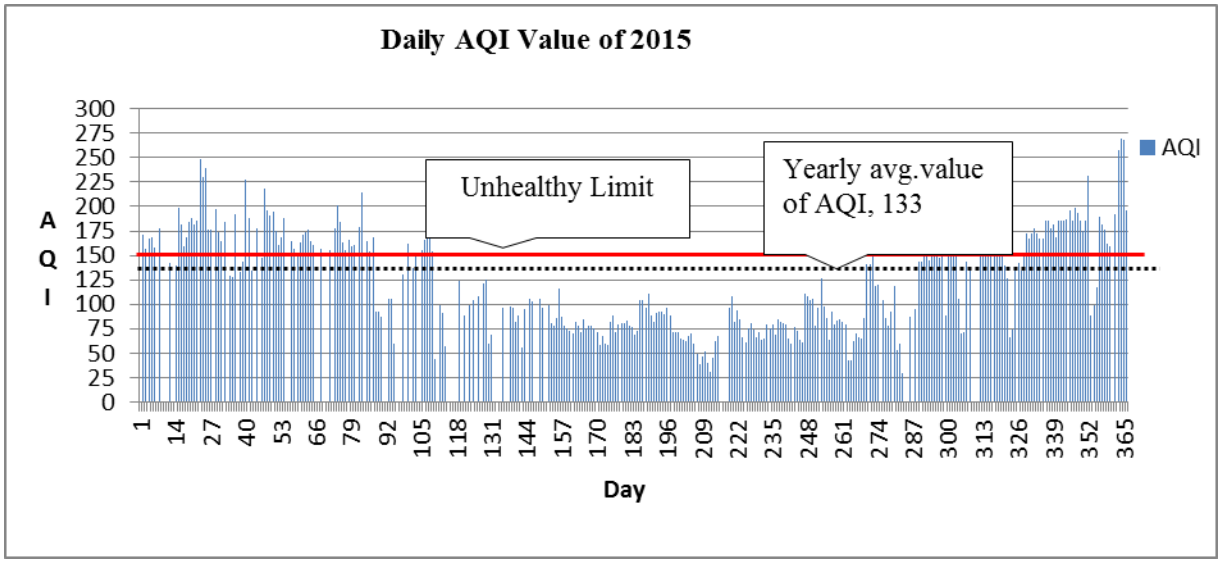

Fig 3: Daily AQI for the year 2013

The pollutants concentration largely depends on meteorological parameters. When the rainfall and wind speed is high specially in monsoon period the concentration of PM2.5 decreases. The time series plot of PM2.5 and metrological parameter presented in Fig 4 to Fig. 6, shows temporal (daily) variation of PM2.5 concentration with the change of intensity of metrological parameter over the sampling period. During monsoon period when rainfall and wind speed is high the concentration of $PM_{2.5}$ dwindles gradually. The middle portion of figure shows the lower concentration of $PM_{2.5}$. Here only the variation of $PM_{2.5}$ concentration with the change of meteorological parameters shows, because from study we found that in almost all the cases $PM_{2.5}$ is the responsible pollutants for AQI.

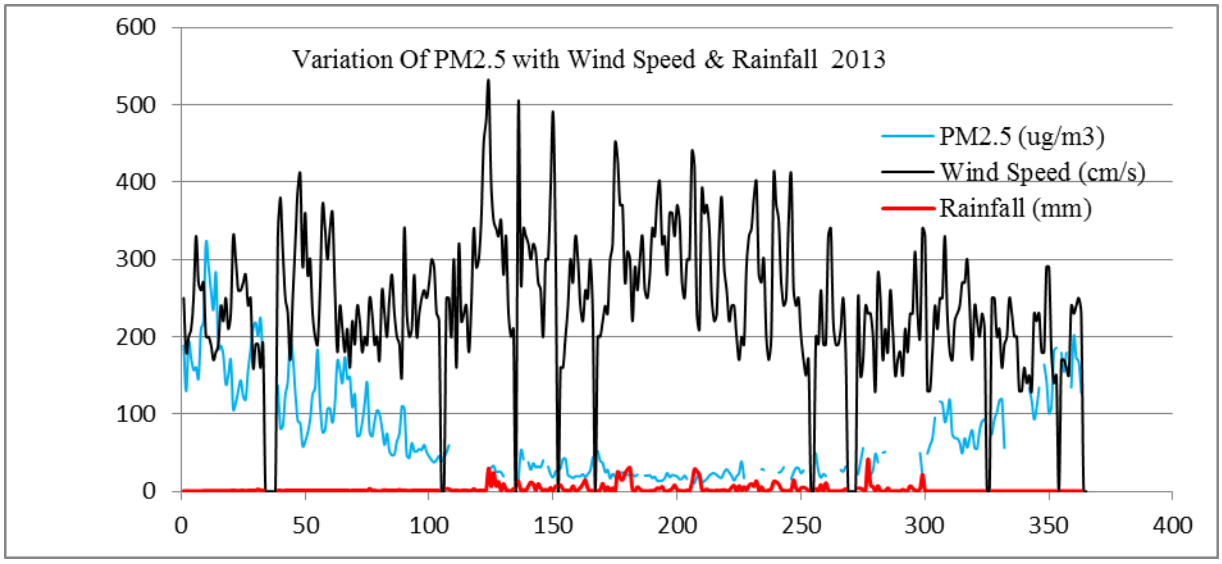

Fig. 4: Temporal (daily) variation of PM2.5 concentration with variable wind speed & rainfall in 2013

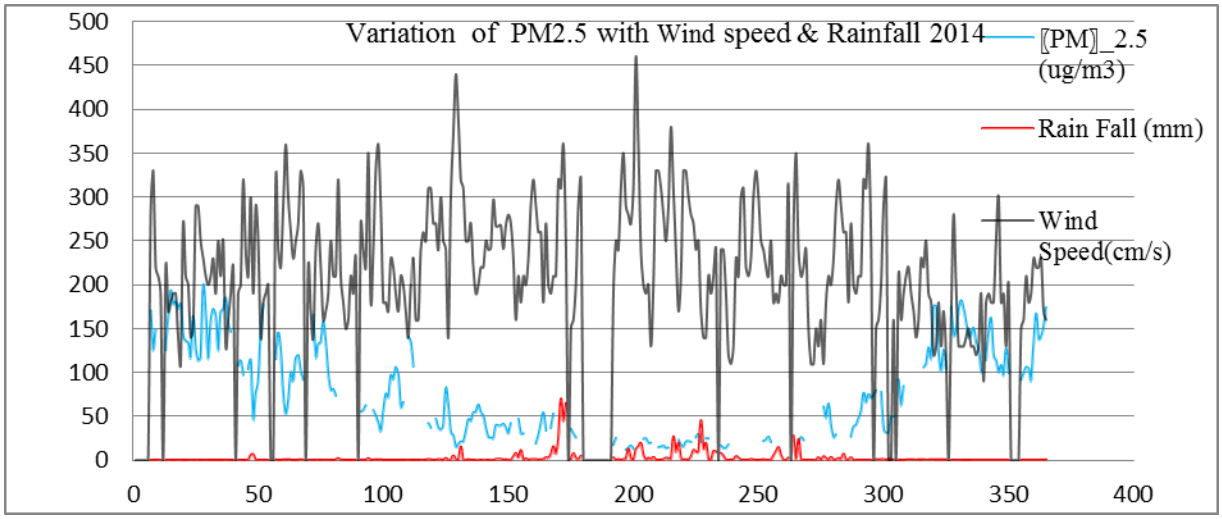

Fig. 5: Temporal (daily) variation of PM2.5 concentration with variable wind speed & rainfall in 2014

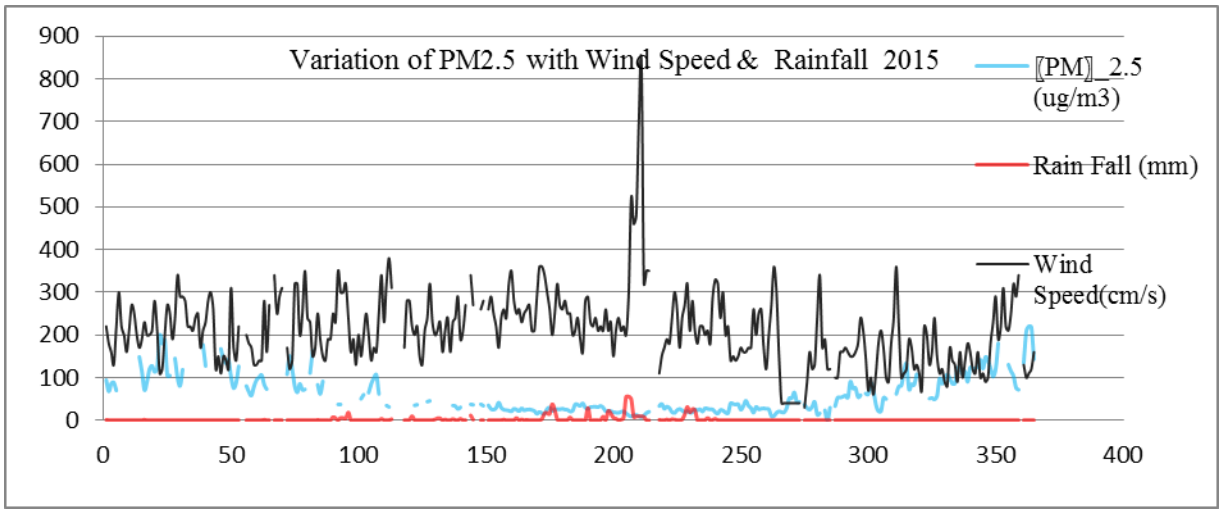

Fig.6: Temporal (daily) variation of PM2.5 concentration with variable wind speed & rainfall in 2015

Table 2 shows the concentration of various pollutants at some specific location of Chittagong city. The concentration of SPM exceeds both the national and international standards.

Table 2. Concentration of SO_x, NO_x, and SPM at three locations of Chittagong

Location	Date	SO_x(µg/m^3)	NO_x(µg/m^3)	SPM (µg/m^3)
Agrabad, Ctg.	20/05/15	64	40	520
New Market, Ctg.	10/06/15	56	32	410
A.K. Khan gate, Pahartali, Ctg.	05/08/15	….	….	250
Standard as per ECR 2005 in Bangladesh		Below 100	Below 80	Below 200

CONCLUDING REMARKS

Air pollution is an increasing threat to modern civilization. Due to the people's tendency to being modern and civilized urbanization and industrialization increases rapidly and a large variety of vehicles also increases. This large variety of vehicles causes large concentration of emission, which causes air pollution.

It has been found that the concentration of Standard Particulate Matter (SPM) in Agrabad, New Market and A.K. Khan Gate, Pahartali, Chittagong are 510,420 and 250μg/m^3, respectively, which was significantly higher than the standard value. From all the analysis it is clear that the air pollution in Chittagong city is lower during the month April to September due to rainfall and wind speed. The average Air Quality Index (AQI) value of year 2013, 2014 and 2015 are 127, 132 and 133 respectively, which means the average yearly air pollution condition in Chittagong city is unhealthy for sensitive group, according to USEPA. Almost all the cases the responsible pollutants for AQI value is $PM_{2.5}$. Therefore, it is suggested that if the generation of anthropogenic particulate matter can control, the air pollution in Chittagong city will be predominantly reduced.

REFERENCES

Begum BA, Kamal M, Salam A, Salam MA and Biswas SK (2011). Assessment of particulate air pollution at Kalbagan and Shisumela area along the Mirpur Road.Bangladesh J. Sci. Ind. Res. 46(3):343-352.

Brandon C (1997). Economic valuation of air and water pollution in Bangladesh. Workshop Discussion Draft, the World Bank.

DoE, *The Environment Conservation Rules 1997 (Revised in 2005)* (2005), Department of Environment, Ministry of Environment and Forest, Government of Bangladesh, Dhaka, Bangladesh.

http://www.case-moef.gov

https://www3.epa.gov/airnow/aqi_brochure_02_14.pdf

IRIN [online]. "Bangladesh: Air Pollution Choking Dhaka", available: http://www.irinnews.org/Report.aspx?ReportId=83772, accessed July 2009.Karim, M. M. Traffic pollution in Bangladesh & Metropolitan Dhaka a Preliminary Investigation, 2009.

M. Khaliquzzaman, S. A. Tarafdar, S. K. Biswas, A. Islam, and A. H. Khan. Nature and the extent of airborne particulate matter pollution in Urban and Rural areas of Bangladesh during 1993-98. Technical report AECD/AFDCH/9-50,1999.

M. S. Islam. (2014). Air Pollution in Dhaka City: A Burning Issue. Journal of Science Foundation, July 2014, Vol. 12, No.2

Rahman, S.M. 2010. Air Quality Assessment and the Health Effects of Air Pollution in Dhaka City through Impact-Pathway Model, M. Sc. Engg. Thesis, Department of Civil Engineering, Bangladesh University of Engineering & Technology, Dhaka.

Rouf MA, Nasiruddin M, Hossain AMS and MS Islam. (2011). Trend of ambient air quality in Chittagong City. Bangladesh J. Sci. Ind. Res. 47(3), 287-296, 2012