

**Government of the People's Republic of Bangladesh**

**Ministry of Environment and Forests**

**Monthly Air Quality Monitoring Report  
Reporting Month: November, 2014**

**Clean Air and Sustainable Environment Project**  
(নির্মলবায়ু এবং টেকসই পরিবেশ প্রকল্প)

**December, 2014**

**Department of Environment**

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## 1. Introduction

Air quality management plans based on knowledge of sources, appropriate air quality standards, accurate air quality data, and effective incentives; and enforcement policies is therefore needed to be adopted.

At this backdrop, real-time measurements of ambient level pollutants were made at 8 major cities (Namely, Dhaka, Narayanganj, Gazipur, Chittagong, Rajshahi, Khulna, Barisal and Sylhet) of Bangladesh. The data generated will be used to define the nature and severity of pollution in the cities; identify pollution trends in the country; and develop air models and emission inventories.

The program encompasses operation of the sampling and monitoring network, and quality assurance activities to ensure the quality of the data collected and disseminated by the CASE project.

CASE project monitors the criteria pollutants such as carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, PM10 and PM2.5. Monitoring is performed to demonstrate attainment or non-attainment of national ambient air quality standards to assess the trends of air pollution levels.

The main purpose of this report is to present, analyze and make available of these data to the general public, stakeholders, researchers and policy makers to develop effective air pollution abatement strategies. This report summarizes the air quality data collected at the different CAMS in operation under the Department of Environment (DoE) air quality monitoring network.

The basis for discussion of air quality has been the data collected from the Air Quality monitoring Network stations under DoE. The data have been quality controlled and the air pollution levels have been compared to the Bangladesh Ambient Air Quality Standard as adopted in 2005. Table 1 represents the current and approved air quality standards for Bangladesh.

Table 1: National Ambient Air Quality Standards for Bangladesh

Pollutant	Objective	Average
CO	10 mg/m <sup>3</sup> (9 ppm)	8 hours(a)
	40 mg/m <sup>3</sup> (35 ppm)	1 hour(a)
Pb	0.5 µg/m <sup>3</sup>	Annual
NO <sub>x</sub>	100 µg/m <sup>3</sup> (0.053 ppm)	Annual
PM10	50 µg/m <sup>3</sup>	Annual (b)
	150 µg/m <sup>3</sup>	24 hours (c)
PM2.5	15 µg/m <sup>3</sup>	Annual
	65 µg/m <sup>3</sup>	24 hours
O <sub>3</sub>	235 µg/m <sup>3</sup> (0.12 ppm)	1 hour (d)
	157 µg/m <sup>3</sup> (0.08 ppm)	8 hours
SO <sub>2</sub>	80 µg/m <sup>3</sup> (0.03 ppm)	Annual
	365 µg/m <sup>3</sup> (0.14 ppm)	24 hours (a)

Notes:

- (a) Not to be exceeded more than once per year
- (b) The objective is attained when the annual arithmetic mean is less than or equal to 50 µg/m<sup>3</sup>
- (c) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m<sup>3</sup> is equal to or less than 1
- (d) The objective is attained when the expected number of days per calendar year with the maximum hourly average of 0.12 ppm is equal to or less than 1 (Source: AQMP, DOE).

## 2. Monitoring Network

The main objective of the Bangladesh AQM network is to provide reliable information to the authorities and to the public about the air quality in most populous cities of Bangladesh.

As a part of the air quality monitoring strategy, several objectives can be achieved, including:

- Establish source/receptor relationships;
- Identify which are the pollutants of concern and their current status;
- Show how widespread air pollution problems are and indicate the general extent of the public exposure;
- Provide benchmarks against which trends in overall air quality can be compared and devise performance indicators for assessing the impact of an air quality management plan or strategy;
- Provide a data base for evaluation of effects; of urban, land use management, and transportation planning; of development and evaluation of abatement strategies; and of development and validation of atmospheric processes and models.

Another objective in the monitoring and management programme is to provide input data for modeling. These data will serve as a background for performing air quality planning and abatement studies. Model results may also serve as input to other studies such as health related investigations and exposure assessments.

The ambient air quality monitoring network Bangladesh consists of eleven (11) fixed Continuous Air Monitoring Stations (CAMS). The locations of the 11 CAMS are shown in Figure 1. Brief description of the monitoring stations and the list of measured parameters recorded at each station are provided in Table 2.

Table 2: Description of Monitoring Network:

City	ID	Location	Lat/Lon	Monitoring capacity
Dhaka	CAMS-1	SangshadBhaban, Sher-e-Bangla Nagar	23.76N 90.39E	PM10, PM2.5, CO, SO2, NOX, O3, and HC concentrations with meteorological parameters.
	CAMS-2	Firmgate	23.76N 90.39E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters.
	CAMS-3	Darus-Salam	23.78N 90.36E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Gazipur	CAMS-4	Gazipur	23.99N 90.42E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Narayangonj	CAMS-5	Narayangonj	23.63N 90.51E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Chittagong	CAMS-6	TV station, Khulshi	22.36N 91.80E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters.
	CAMS-7	Agrabad	22.32N 91.81E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Khulna	CAMS-8	Baira	22.48N 89.53E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological parameters
Rajshahi	CAMS-9	Sopura	24.38N 88.61E	PM10, PM2.5, CO, SO2, NOX, O3, and HC with meteorological

City	ID	Location	Lat/Lon	Monitoring capacity
				parameters.
Sylhet	CAMS-10	Red Crecent Campus	24.89N 91.87E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.
Barisal	CAMS-11	DFO office campus	22.71N 90.36E	PM10, PM2.5, CO, SO2, NOX and O3 with meteorological parameters.

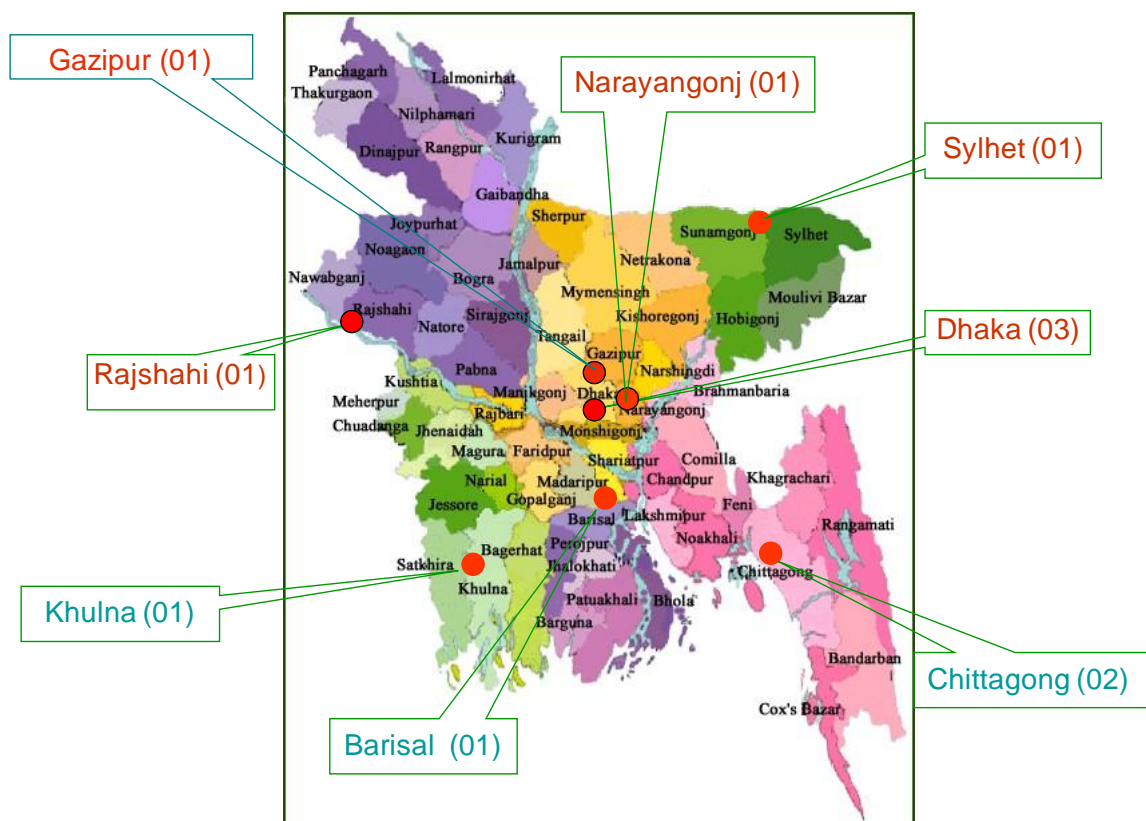


Figure 1: CAMS Location in Bangladesh

Monitoring data from network stations are transferred to a central data centre at the Department of Environment office in Dhaka and simultaneously transferred to Air Quality Management System based on NILU AIRQus system established under BAPMAN project. The data are stored in AIRQus database for quality check, control, evaluation, validation, statistical analysis. Quality controlled data are then stored in the final database for further analysis, reporting, presentations and future use.

### 3. Monthly Air Quality

The data presented in this report are based on monitoring of air quality parameters during November 2014 at 11 CAMS operated under CASE-DoE monitoring network. Table-3 summarizes the basic statistics of the data along with the data capture rate and the number of days for which specific pollutant exceeded the Bangladesh National Ambient Air Quality Standard (BNAAQs). Since NO<sub>x</sub> have only annual standard, so for this pollutant daily 24-hours average concentration levels were compared with the annual average. During data quality control some data, which are outliers (beyond 3<sup>rd</sup> and 97<sup>th</sup> percentile) and inconsistent data, were flagged as invalid and those were not included in the analysis. Time series plots based on the data generated in the CAMS are also given in Annexes.

In general the data availability (valid data) found to be over 80% except few parameters in some CAMS in operation. During the reporting several analyzers were not operational due to routine preventive/corrective maintenance. In case of data capture rate for specific pollutant below 75% for a particular averaging time are not reported. Data from Khulna CAMS and BARC CAMS could not be included in the report because data were not available in the central data station due to malfunctioning of data acquisition system at the station.

Inspection of the available data shows that there were number of occurrences of non-compliance for PM<sub>10</sub> & PM<sub>2.5</sub> levels at majority of monitoring stations during the month of November 2014. It is observed that the 24 hr average concentration level of PM<sub>2.5</sub> exceeded BNAQS for 28 days at Darus-Salam, Mirpur, 21 days at Barisal and 16 days at Narayanganj during the month of November 2014. Such non-attainment occurred for 21 days in Sangshad Bhaban, 28 days at Gazipur, also for 20 days in Agrabad, Chittagong, 22 days in TV Station, Chittagong and 15 days at Sylhet CAMS. Data capture rate of PM<sub>2.5</sub> at Narayanganj CAMS is low for the reporting month. For PM<sub>10</sub> non-attainment with respect to BNAQS occurred for 19 days in Sangsad, 24 days in Darus Salam, 27 days at Gazipur, 25 days at Narayanganj CAMS and 18 days at Rajshahi, 19 days in Agrabad, Chittagong and 15 days in Barisal & TV station Chittagong and 08 days in Sylhet CAMS during the reporting month. The monthly average concentration level of PM<sub>2.5</sub> and PM<sub>10</sub> measured at different CAMS were found 69-208 µg/m<sup>3</sup> and 135-352 µg/m<sup>3</sup> respectively during the month of November 2014. From the time series plot of both PM<sub>10</sub> and PM<sub>2.5</sub>, it is seen there are most of the episodes of high PM concentrations. 24-hours average PM levels in all cities monitored are found higher compared to the previous month because rainy season is towards its end. It is also observed that all the gaseous pollutants except NO<sub>x</sub> measured at different CAMS did not exceed the BNAQS during the month of November 2014. NO<sub>x</sub> concentrations exceed the BNAQS 20 days in Darussalam, 21 days in Narayanganj CAMS, 01 day in Gazipur CAMS and 04 days in Agrabad CAMS in this month.

In general PM pollution levels in the cities monitored during the reporting month found slightly higher compared to previous month in respect of public health. Usually in the dry seasons the pollution level reached highest peak and gradually decreases during wet season, which is reflected in the data monitored in all CAMS during the month of November-2014. It is observed that average wind speed and precipitation compared to previous month has a decreasing tendency, which decreases the rate of dispersion of the pollutants and this might be a reason for observed higher PM concentration.

Wind frequency distributions, also called Wind roses for few CAMS (wind data available for those stations) under the monitoring network are presented in ANNEX. From the wind rose patterns, it is observed that the predominant wind direction during the month November 2014 were mainly from north-east direction with few exceptions.

Daily air quality index (AQI) values were calculated based on the available air quality data and summary of the AQI by categories are presented in annex Table 5. Summary data shows majority of the days AQI values were in unhealthy, very unhealthy or extremely unhealthy categories.

#### 4. Summary and conclusion

Data obtained from CAMS operated under DoE air quality monitoring network during November 2014 have been analyzed and reported. Data availability was over 70-80% for all the criteria pollutant monitored at different CAMS with few exceptions. Air quality data for some pollutants were not reported because either the analyzer was not functional or the data capture rate was too low. From the analysis of the data following conclusion can be drawn:

- PM<sub>10</sub> and PM<sub>2.5</sub> are the most critical pollutants. 24-hour average for both PM<sub>10</sub> and PM<sub>2.5</sub> concentrations were found non-compliance at majority of the station with the BNAQS during the month of November, 2014. It is observed that the average concentration level of PM<sub>2.5</sub> and PM<sub>10</sub> were around 69-208 µg/m<sup>3</sup> and 135-352 µg/m<sup>3</sup> respectively during the month of November 2014.
- The gaseous pollutants except NO<sub>x</sub> measured at different CAMS did not exceed limit values of the BNAQS. NO<sub>x</sub> concentrations exceeded the BNAQS 20 days in Darussalam, 21 days in Narayanganj CAMS, 01 day in Gazipur CAMS and 04 days in Agrabad CAMS in this month.
- Due to decreasing average wind speed and precipitation during November 2014, dispersion and wash out of pollutants decreasing and thus the pollution concentration levels showed higher than previous month.
- Monthly summary of calculated AQI values based on data from different CAMS showed that during this month most of day's air quality was either unhealthy or very unhealthy and extremely unhealthy and most frequent responsible pollutant was PM<sub>2.5</sub>.

During the reporting month a number of analyzers especially SO<sub>2</sub> & NO<sub>x</sub> did not produce data and they are under maintenance process.

Table 3: Summary Air Quality and Meteorological data measured during November 2014 at different CAMS operated under DoE

Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC) <sup>a</sup>	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayong anj)	CAMS-6 TV-St (Chittagong) <sup>a</sup>	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna) <sup>a</sup>	CAMS-10 (Rajshahi) <sup>a</sup>	CAMS-11 (Barisal)
SO <sub>2</sub> -24 hr	ppb	140	Average	DNA*	DNA <sup>1</sup>	2.39	3.06	6.26	DNA*	5.82	4.29	DNA <sup>1</sup>	DNA*	DNA*
			Max	DNA*	DNA <sup>1</sup>	5.07	10.6	15.9	DNA*	16.3	12.4	DNA <sup>1</sup>	DNA*	DNA*
			Min	DNA*	DNA <sup>1</sup>	0.40	0.64	0.60	DNA*	2.17	1.18	DNA <sup>1</sup>	DNA*	DNA*
			Excedance(Days)	DNA*	DNA <sup>1</sup>	0	0	0	DNA*	0	0	DNA <sup>1</sup>	DNA*	DNA*
			Data capture(%)	DNA*	DNA <sup>1</sup>	95	56	86	DNA*	82	65	DNA <sup>1</sup>	DNA*	DNA*
NO <sub>2</sub> -24 hr	ppb	53 (Annual)	Average	DNA*	DNA <sup>1</sup>	76.7	34.8	65.7	DNA*	34.0	33.2	DNA <sup>1</sup>	DNA*	DNA*
			Max	DNA*	DNA <sup>1</sup>	148	63.8	101	DNA*	77.9	51.3	DNA <sup>1</sup>	DNA*	DNA*
			Min	DNA*	DNA <sup>1</sup>	7.86	16.1	22.1	DNA*	10.7	19.0	DNA <sup>1</sup>	DNA*	DNA*
			Excedance(Days)	DNA*	DNA <sup>1</sup>	20	1	21	DNA*	4	0	DNA <sup>1</sup>	DNA*	DNA*
			Data capture(%)	DNA*	DNA <sup>1</sup>	88	73	92	DNA*	92	90	DNA <sup>1</sup>	DNA*	DNA*
CO- 1 hr	ppm	35	Average	1.59	DNA <sup>1</sup>	2.27	1.76	1.88	1.40	1.05	1.48	DNA <sup>1</sup>	DNA*	1.41
			Max	2.9	DNA <sup>1</sup>	5.46	5.6	4.85	3.11	4.88	10.7	DNA <sup>1</sup>	DNA*	5.84
			Min	0.34	DNA <sup>1</sup>	0.67	0.36	0.43	0.05	0.16	0.43	DNA <sup>1</sup>	DNA*	0.36
			Excedance(Hour)	0	DNA <sup>1</sup>	0	0	0	0	0	0	DNA <sup>1</sup>	DNA*	0
			Data capture(%)	92	DNA <sup>1</sup>	95	94	93	79	93	90	DNA <sup>1</sup>	DNA*	84
CO-8hr	ppm	9	Average	1.59	DNA <sup>1</sup>	2.26	1.76	1.87	1.41	1.05	1.44	DNA <sup>1</sup>	DNA*	1.40
			Max	2.76	DNA <sup>1</sup>	4.52	3.86	3.73	2.52	3.66	4.44	DNA <sup>1</sup>	DNA*	4.72
			Min	0.64	DNA <sup>1</sup>	0.81	0.58	0.45	0.40	0.28	0.48	DNA <sup>1</sup>	DNA*	0.41
			Excedance(Hour)	0	DNA <sup>1</sup>	0	0	0	0	0	0	DNA <sup>1</sup>	DNA*	0
			Data capture(%)	92	DNA <sup>1</sup>	94	93	93	78	93	89	DNA <sup>1</sup>	DNA*	81
O <sub>3</sub> -1hr	ppb	120	Average	DNA*	DNA <sup>1</sup>	DNA*	4.22	4.65	11.8	15.1	8.23	3.83	8.88	8.86
			Max	DNA*	DNA <sup>1</sup>	DNA*	24.7	67.0	44.2	68.2	40.5	39.3	40.7	44.4
			Min	DNA*	DNA <sup>1</sup>	DNA*	0.84	0.05	8.87	0.05	0.05	0.77	0.05	0.09
			Excedance(Hour)	DNA*	DNA <sup>1</sup>	DNA*	0	0	0	0	0	0	0	0
			Data capture(%)	DNA*	DNA <sup>1</sup>	DNA*	94	84	80	88	90	58	93	83
O <sub>3</sub> -8hr	ppb	80	Average	DNA*	DNA <sup>1</sup>	DNA*	4.16	4.60	11.7	15.5	8.31	3.84	9.05	9.01
			Max	DNA*	DNA <sup>1</sup>	DNA*	22.0	35.5	36.9	55.9	29.0	30.8	28.7	30.3
			Min	DNA*	DNA <sup>1</sup>	DNA*	0.91	0.08	8.87	0.24	0.36	1.03	0.19	0.23
			Excedance(Hour)	DNA*	DNA <sup>1</sup>	DNA*	0	0	0	0	0	0	0	0
			Data capture(%)	DNA*	DNA <sup>1</sup>	DNA*	94	78	78	83	89	57	90	80

CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbishment CAMS, PM= Particulate Matter  
DNA= Data Not Available, 1= Poor data capture rate due to station Data Logger not in operation, \*=DNA due to malfunction of the analyzer/sensor or poor data capture rate

Table 3: Summary Air Quality and Meteorological data measured during November 2014 at different CAMS operated under DoE (Cont'd)

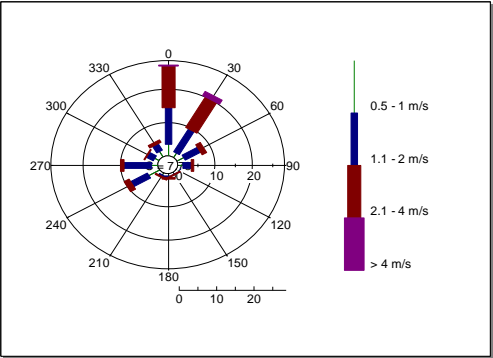
Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC) <sup>a</sup>	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayong anj)	CAMS-6 TV-St (Chittagong) <sup>a</sup>	CAMS-7 Agrabad- (Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna) <sup>a</sup>	CAMS-10 (Rajshahi) <sup>a</sup>	CAMS-11 (Barisal)
PM <sub>2.5</sub> -24hr	µg /m <sup>3</sup>	65	Average	131	DNA*	171	163	208	267	133	68.5	DNA*	DNA*	144
			Max	221	DNA*	282	294	312	371	182	118	DNA*	DNA*	239
			Min	41.4	DNA*	60.3	56.9	108	94.8	63.0	24.9	DNA*	DNA*	83.9
			Excedance(Days)	21	DNA*	28	28	16	22	20	15	DNA*	DNA*	21
			Data capture(%)	86	DNA*	92	92	66	79	75	86	DNA*	DNA*	78
PM <sub>10</sub> -24hr	µg /m <sup>3</sup>	150	Average	195	DNA*	286	292	352	195	210	135	DNA*	256	224
			Max	334	DNA*	485	433	590	324	355	211	DNA*	484	336
			Min	75.1	DNA*	116	110	134	86.6	94.0	72.9	DNA*	110	152
			Excedance(Days)	19	DNA*	24	27	25	15	19	8	DNA*	18	15
			Data capture(%)	94	DNA*	88	90	89	80	91	83	DNA*	89	63
Solar rad. 1hr	watt/m <sup>2</sup>	NA	Average	119	DNA*	143	158	90.0	DNA*	162	169	DNA*	DNA*	157
			Max	642	DNA*	704	769	827	DNA*	774	759	DNA*	DNA*	755
			Min	6.81	DNA*	7.57	7.76	0.05	DNA*	7.44	6.93	DNA*	DNA*	7.86
			Data capture(%)	94	DNA*	96	94	78	DNA*	94	91	DNA*	DNA*	85
Relative Humidity 1hr	(%)	NA	Average	67.6	DNA*	64.9	74.7	66.7	DNA*	66.2	69.2	DNA*	DNA*	74.1
			Max	94.3	DNA*	95.7	95.9	96.5	DNA*	89.8	96.5	DNA*	DNA*	98.4
			Min	28.3	DNA*	30.1	32.5	28.7	DNA*	32.8	36.8	DNA*	DNA*	30.7
			Data capture(%)	94	DNA*	96	94	93	DNA*	94	91	DNA*	DNA*	85
Ambient Temp. 1hr	(°c)	NA	Average	21.9	DNA*	25.7	23.6	23.8	18.3	25.1	24.4	DNA*	DNA*	25.3
			Max	31.1	DNA*	34.0	33.9	44.9	28.4	32.7	33.3	DNA*	DNA*	35.1
			Min	13.8	DNA*	18.0	15.7	16.1	5.04	17.8	16.7	DNA*	DNA*	16.7
			Data capture(%)	94	DNA*	96	94	92	80	94	91	DNA*	DNA*	85
Rainfall 1hr	(m.m.)	NA	Average	0.65	0.34	0.03	0.03	0.61	DNA*	0.10	0.02	DNA*	DNA*	0.08
			Max	3.46	1.50	0.16	0.27	2.89	DNA*	38.2	0.03	DNA*	DNA*	0.89
			Min	0.02	0.03	0.02	0.02	0.02	DNA*	0.02	0.02	DNA*	DNA*	0.02
			Data capture(%)	93	14	51	40	11	DNA*	70	29	DNA*	DNA*	3

CAMs= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbishment CAMs, PM= Particulate Matter

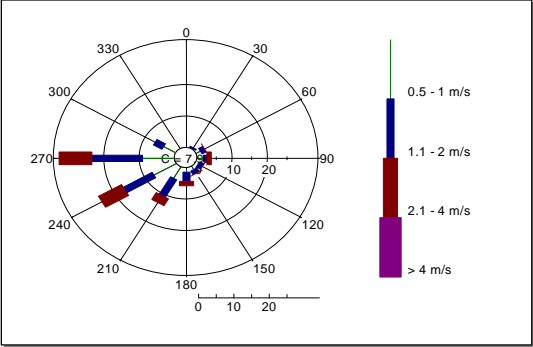
DNA= Data Not Available, 1= Poor data capture rate due to station Data Logger not in operation, \*=DNA due to malfunction of the analyzer/sensor or poor data capture rate

Figure 2: Wind frequency distributions (wind roses) from different CAMS monitored for November 2014 (cont'd).

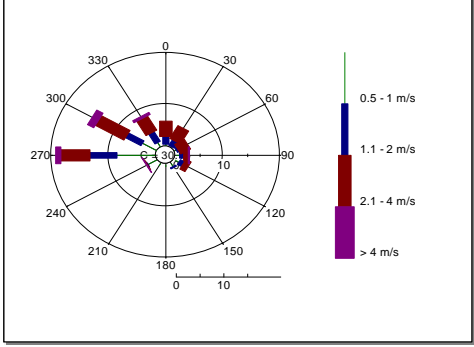
**Wind Rose of Agrabad, Chittagong CAMS**



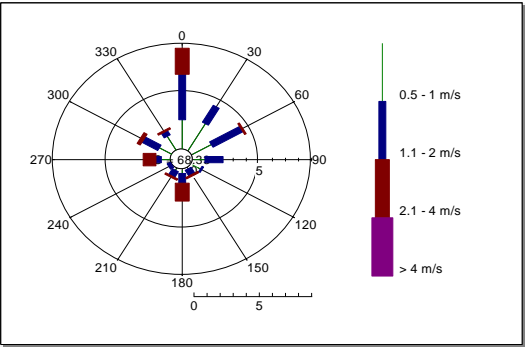
**Wind Rose of Darussalam CAMS**



**Wind Rose of Gazipur CAMS**



**Wind Rose of Narayanganj CAMS**



**Wind Rose of Sylhet CAMS**

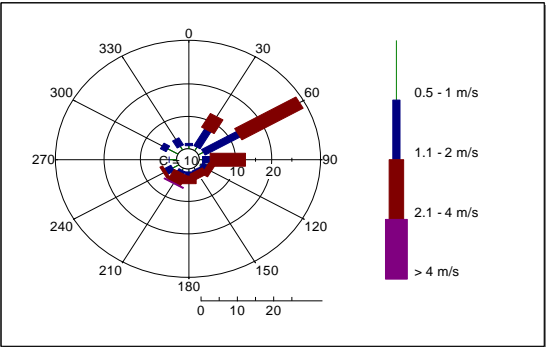


FIGURE 3: TIME SERIES OF ALL PARAMETERS (SO<sub>2</sub>, NO<sub>x</sub> AND O<sub>3</sub>) MEASURED IN ALL CAMS DURING NOVEMBER 2014

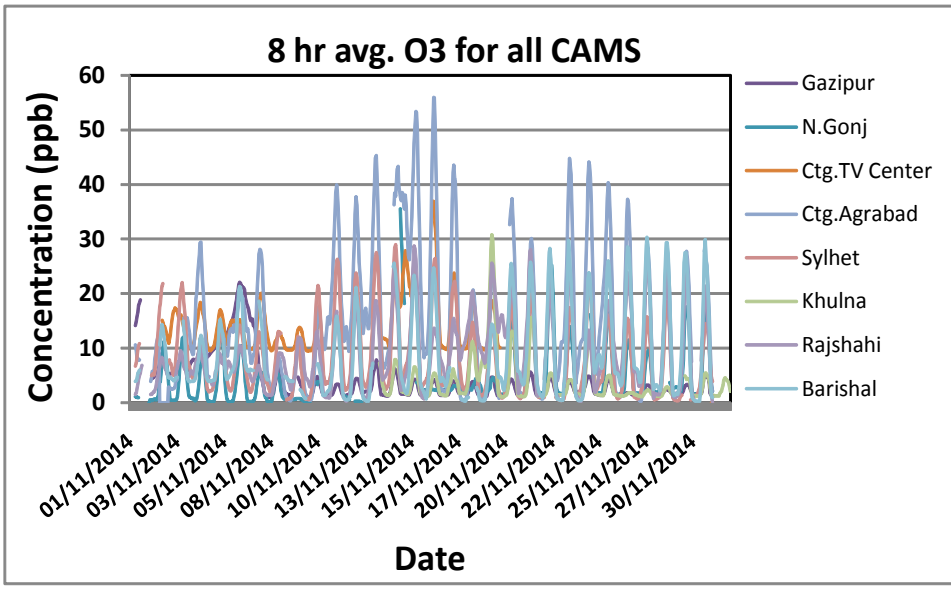
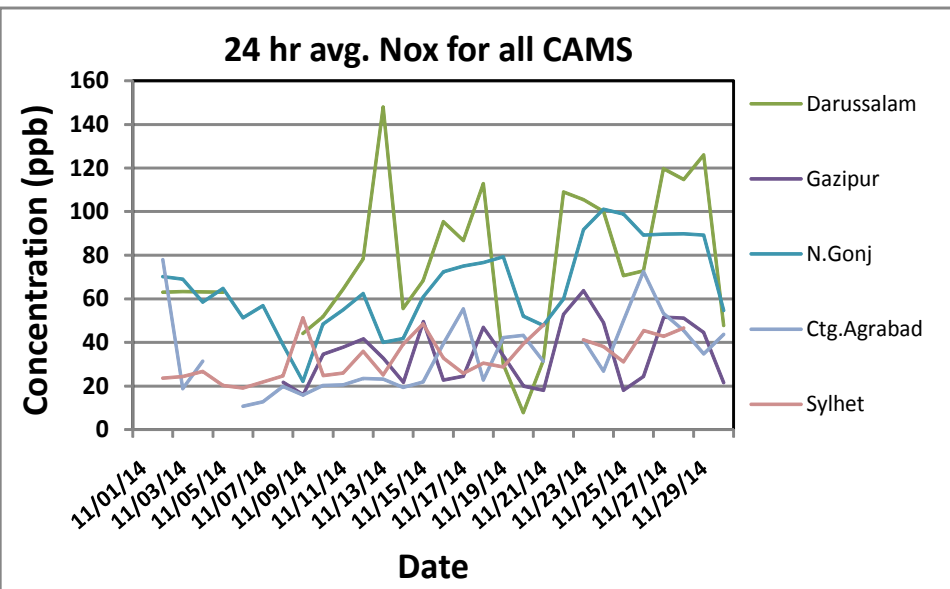
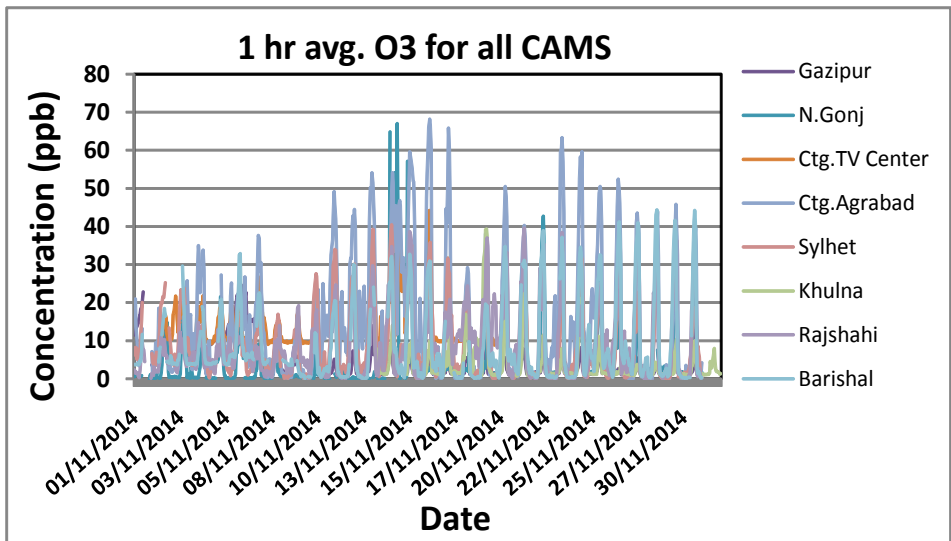
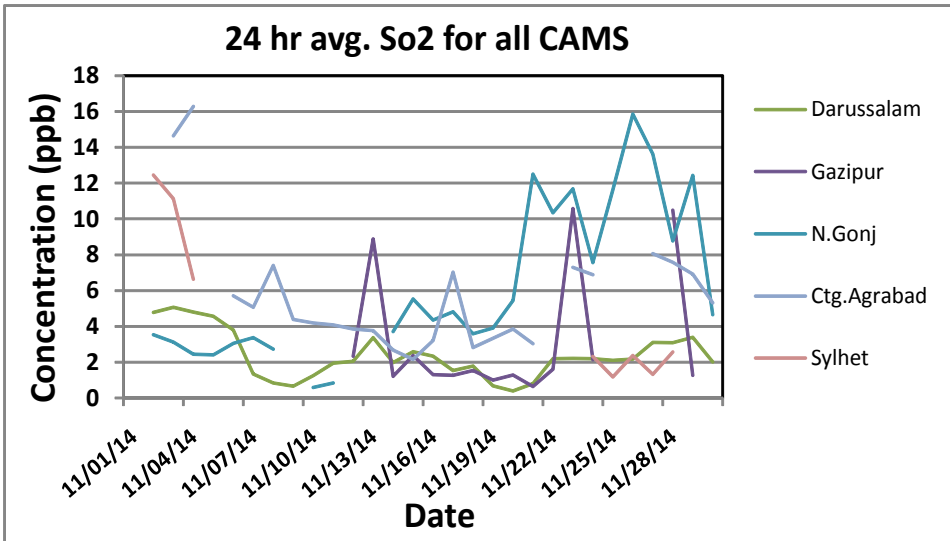


Figure 4: TIME SERIES OF ALL PARAMETERS (CO, PM10 AND PM2.5) MEASURED IN CAMS DURING NOVEMBER, 2014

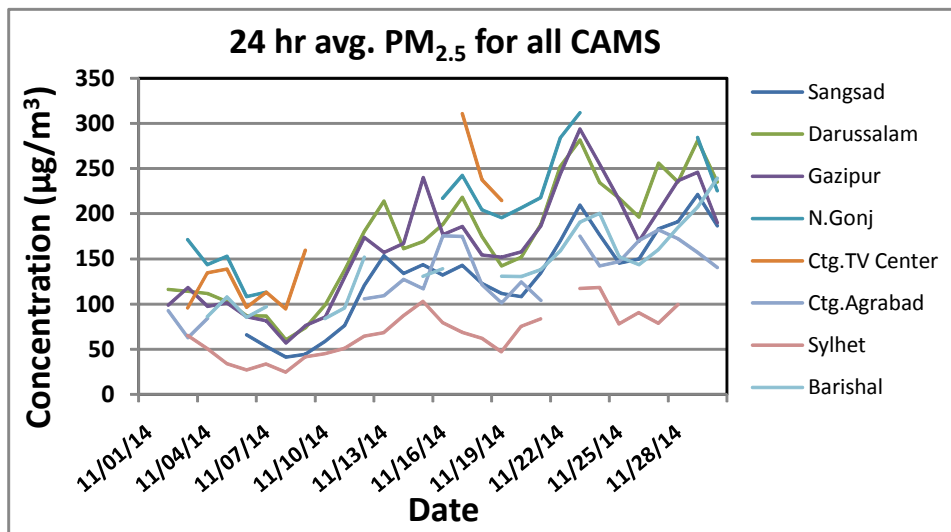
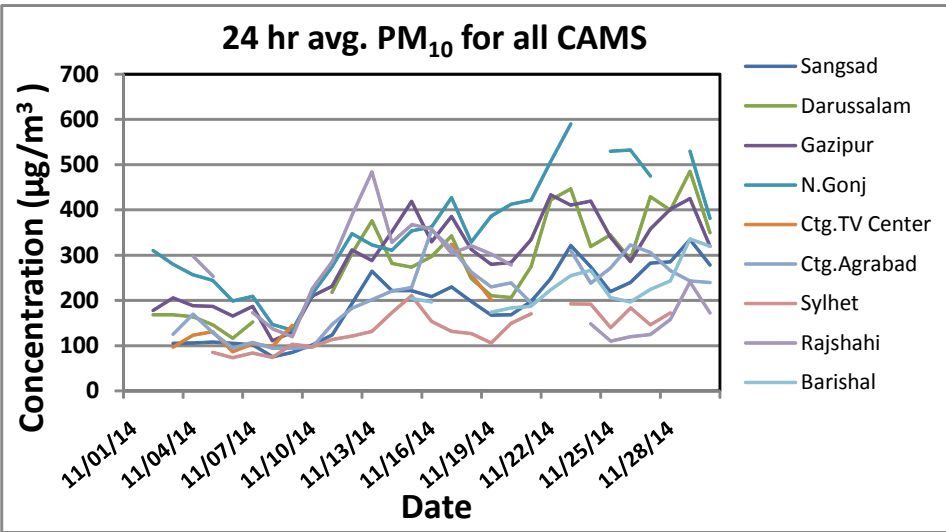
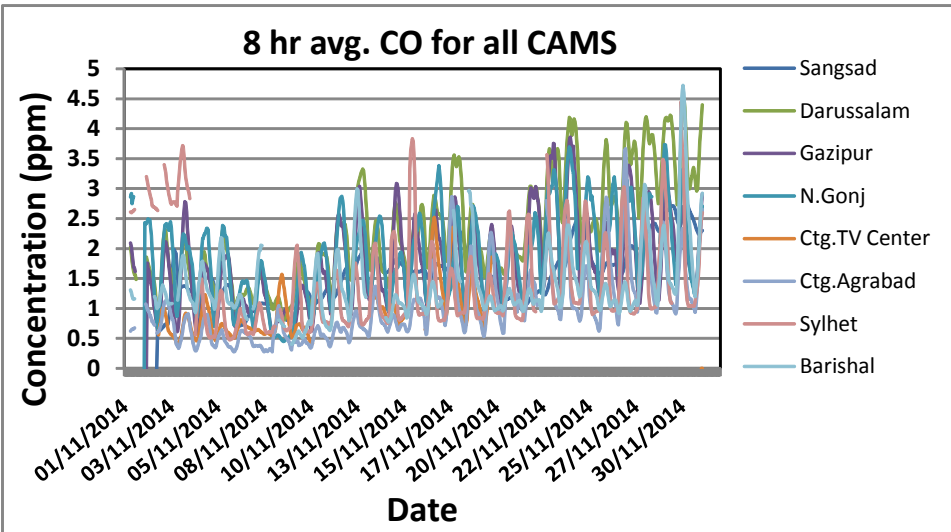
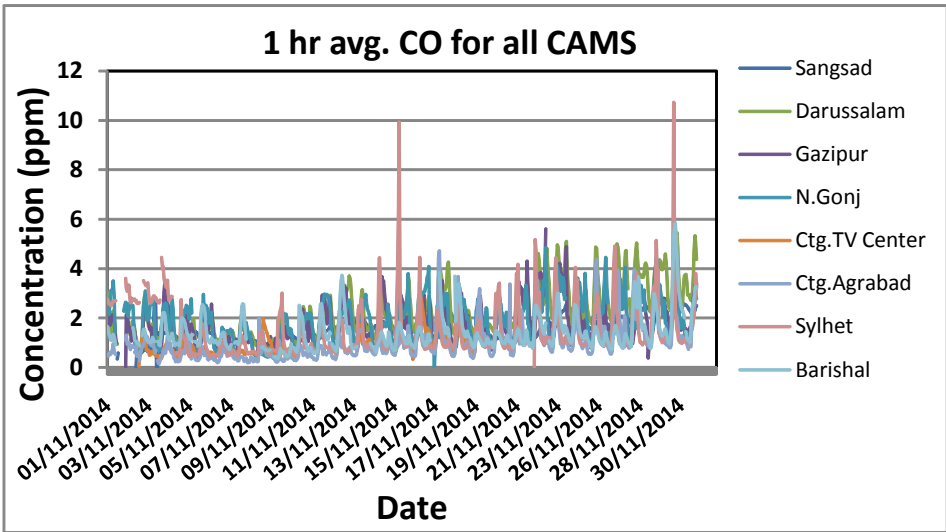


Figure 5: Monthly Summary of AQI for month of November, 2014

