Air Quality Monthly Report

March, 2014

Department of Environment
Ministry of Environment, Forest and Climate Change
Bangladesh

Content

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, Narayangonj, 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^3 (9 ppm)	8 hours(a)
	40 mg/m^3 (35 ppm)	1 hour(a)
Pb	0.5 µg/m^3	Annual
NO_x	100 µg/m^3 (0.053 ppm)	Annual
PM10	50 µg/m^3	Annual (b)
	150 µg/m^3	24 hours (c)
PM2.5	15 µg/m^3	Annual
	65 µg/m^3	24 hours
O_3	235 µg/m^3 (0.12 ppm)	1 hour (d)
	157 µg/m^3 (0.08 ppm)	8 hours
SO_2	80 µg/m^3 (0.03 ppm)	Annual
	365 µg/m^3 (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 ug/m^3
(c) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m^3 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 programmeis 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 inTable 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.

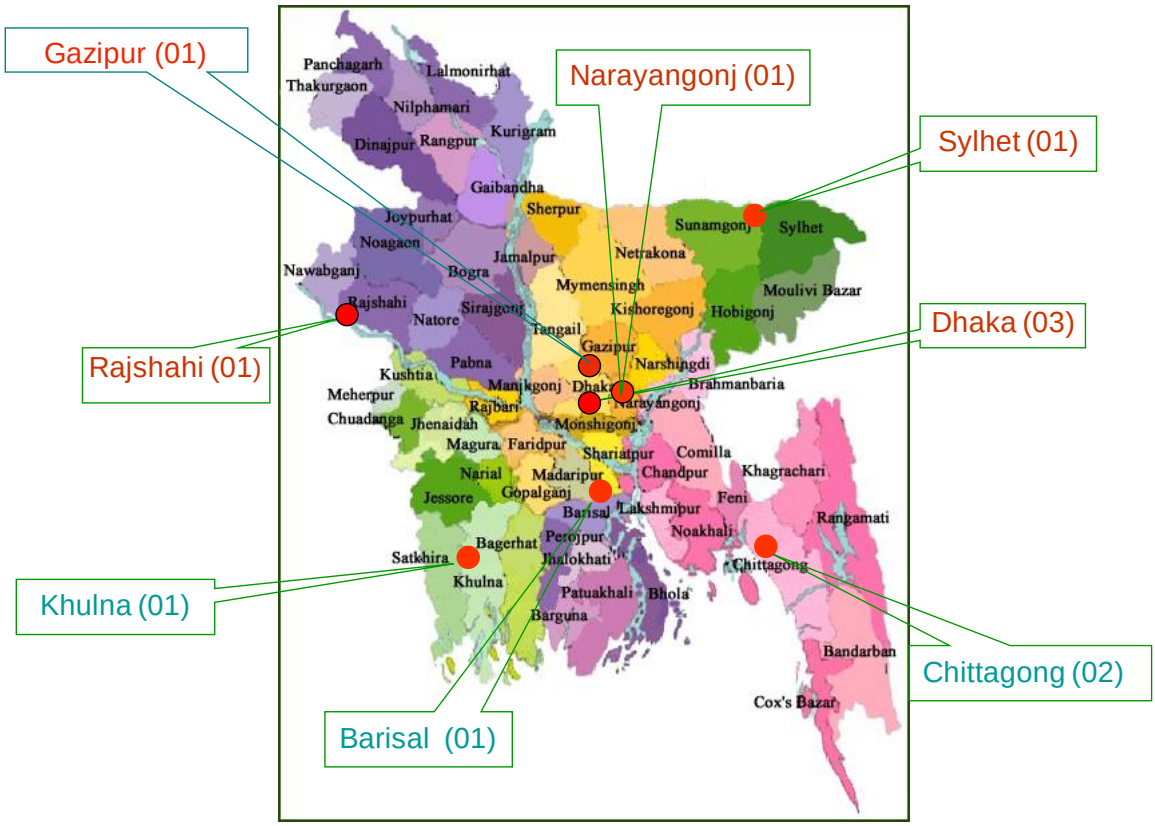


Figure 1: CAMS Location in Bangladesh

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 AIRQuis system established under BAPMAN project. The data are stored in AIRQuis 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 measurements on air quality parameters during March 2014 at 11 CAMS operated under 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 NOx 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 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 the CAMS in operation. In case of data capture rate below 75% for a particular averaging time are not reported. Data from Khulna CAMS could not be included in the report because data were not available in the central data station due to failure of the virtual private networking. Only the PM and some met data were available from Narayanganj CAMS due to power problems. BARC, Farmgate CAMS keeps shut down due to Air conditioning system failure since 20 March, 2014, so data capture rate is poor. Beside, few more analyzers at different CAMS were under maintenance and eventually the data capture rate for those parameters found low and in some cases no data were available.

Inspection of the data shows that there were some occurrences of non-compliance with respect to the BNAAQS for both PM10 as well as PM2.5 levels at some of the stations where data were available. NOx concentrations in majority of the station were also observed non-attainment. It is observed that the monthly average concentration level of PM2.5 and PM10 measured at different CAMS were found around 90-140 µg/m3 and 144-296µg/m^3 respectively during the month of March 2014. It is also seen that the concentration level of PM2.5 exceeded the BNAAQS for 22 days at Sangsad Bhaban CAMS, 11 days at Darussalam &18 days at Sylhet CAMS, 29 days at Gazipur CAMS,15 days at Narayonganj CAMS & 16 days at Barishal CAMS and 19 days at CDA, Agrabad and 18 days at Tv station Chittagong,27 days at Rajshahi CAMS respectively. On the other hand PM10 exceeded 16 days at Sangsad CAMS, 16 days at Darussalam CAMS, & 19 days at Narayonganj CAMS, 11 days at Barishal CAMS, 26 days at Gazipur CAMS, 11 days at Sylhet CAMS, 25 days at Rajshahi CAMS, 16 days at TV station Chittagong & 12 days at Agrabad, Chittagong respectively. From the time series plot of both PM10 and PM2.5, it is seen there are only a few episodes of low PM concentrations. 24-hours average PM levels in all cities monitored are decreasing compared to previous month because dry seasons in over and wind speed is increasing. Lower wind speed and occurrences of inversion reduces dispersion of particulate matter and thus increases the PM pollution levels in winter season. It is also observed that all the gaseous pollutants except NOx in few CAMS did not exceed the BNAAQS. In case of NO_x concentrations, there was non-attainment for 18 days at BARC CAMS, 13 days at Darussalam CAMS, 18 days at Gazipur (Dhaka) CAMS, 26 days at Rajshahi CAMS respectively. NOx values did not exceed the BNAAQS values in Sylhet and Barisal CAMS.

In general PM pollution levels in the cities monitored during the reporting month found lower 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 beginning, which is reflected in the data monitored in all CAMS during month of March-2014. It is observed that average wind speed and precipitation compared to previous month has a increasing tendency, which increases the rate of dispersion of the pollutants and this might be a reason for observed lower PM concentration.

Wind frequency distributions, also called Wind roses for only Agrabad, Chittagong, Sylhet, Sangsad, Narayonganj, Darussalam and Barisal CAMS under the monitoring network are presented in ANNEX. From the wind rose patterns, it is observed that the predominant wind direction during the month March 2014 were mainly from north-west direction.

4. Summary and conclusion

Data obtained from CAMS operated under DoE air quality monitoring network during March, 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_{10} and $PM_{2,5}$ are the most critical pollutants and 24-hour average for both PM10 and PM2.5 concentrations were found decreasing tendency of non compliance with the BNAAQS during the month of March, 2014. 50% days of attainment in respect of BNAAQS were observed in the period. It is observed that the average concentration

level of PM2.5 and PM10 were around around 90-140 µg/m3 and 144-296µg/m^3 respectively during the month of March 2014.

- The gaseous pollutants except NOx measured at different CAMS did not exceeded limit values of the BNAAQS. In case of NOx non-compliance observed in BARC, Darussalam, Rajshahi, Gazipur CAMS. Maximum 24 hours NOx concentration at these stations found to be higher than annual average BNAAQS limit values (53 ppb) especially in BARC CAMS where observed 24-hours average was 168 ppb and max 243 ppb. This is a road side monitoring station and higher traffic congestion may be cause for high NOx concentration.
- Due to increased average wind speed and precipitation during March 2014, dispersion and wash out of pollutants increasing and thus the pollution concentration levels showed lower than previous month.

At present manual data quality checks and screening are performed for analyzing the air quality data, further strict quality assurance program that will be developed for this program which eventually will improve the data quality. During the reporting month a number of analyzers did not produced data and need maintenance. Necessary action for maintenance of the analyzers will be taken.

ANNEX

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

Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC)[a]	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayonganj)	CAMS-6 TV-St (Chittagong)[a]	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna)[a]	CAMS-10 (Rajshahi)[a]	CAMS-11 (Barisal)
SO_2 -24 hr	ppb	140	Average	13.9	20.8	8.39	10.1	DNA**	8.34	7.53	5.44	DNA[1]	4.38	21.5
			Max	35.6	39.3	22.9	21.8	DNA**	13.6	11.6	9.76	DNA[1]	7.73	24.5
			Min	0.54	10.8	1.51	3.99	DNA**	3.33	3.13	2.79	DNA[1]	0.41	3.24
			Excedance(Days)	0	0	0	0	DNA**	0	0	0	DNA[1]	0	0
			Data capture(%)	67	62	96	95	DNA**	93	92	83	DNA[1]	73	81
NO_2 -24 hr	ppb	53 (Annual)	Average	DNA*	168	54.0	62.5	DNA**	DNA*	DNA*	23.9	DNA[1]	69.7	10.9
			Max	DNA*	243	118	88.0	DNA**	DNA*	DNA*	44.5	DNA[1]	121	22.8
			Min	DNA*	60.6	12.7	13.6	DNA**	DNA*	DNA*	13.9	DNA[1]	38.8	2.48
			Excedance(Days)	DNA*	18	13	18	DNA**	DNA*	DNA*	0	DNA[1]	26	0
			Data capture(%)	DNA*	60	90	86	DNA**	DNA*	DNA*	83	DNA[1]	90	88
CO- 1 hr	ppm	35	Average	DNA*	DNA**	2.22	1.87	DNA**	1.08	2.06	2.62	DNA[1]	0.51	1.07
			Max	DNA*	DNA**	9.79	8.79	DNA**	11.2	4.20	7.56	DNA[1]	0.95	8.91
			Min	DNA*	DNA**	0.51	0.29	DNA**	0.05	1.07	1.10	DNA[1]	0.14	0.40
			Excedance(Hour)	DNA*	DNA**	0	0	DNA**	0	0	0	DNA[1]	0	0
			Data capture(%)	DNA*	DNA**	97	96	DNA**	90	92	84	DNA[1]	85	88
CO-8hr	ppm	9	Average	DNA*	DNA**	2.20	1.86	DNA**	1.10	2.06	2.60	DNA[1]	0.51	1.06
			Max	DNA*	DNA**	6.97	3.28	DNA**	6.59	3.46	5.49	DNA[1]	0.63	4.85
			Min	DNA*	DNA**	0.65	0.46	DNA**	0.32	1.60	1.54	DNA[1]	0.37	0.44
			Excedance(Hour)	DNA*	DNA**	0	0	DNA**	0	0	0	DNA[1]	0	0
			Data capture(%)	DNA*	DNA**	99	98	DNA**	95	97	92	DNA[1]	92	91
O_3-1hr	ppb	120	Average	6.94	DNA*	13.4	DNA*	DNA**	20.7	16.4	14.7	DNA[1]	20.4	16.7
			Max	43.9	DNA*	65.3	DNA*	DNA**	55.0	55.3	50.5	DNA[1]	62.4	78.4
			Min	1.56	DNA*	0.92	DNA*	DNA**	8.81	0.05	1.16	DNA[1]	0.05	3.68
			Excedance(Hour)	0	DNA*	0	DNA*	DNA**	0	0	0	DNA[1]	0	0
			Data capture(%)	87	DNA*	98	DNA*	DNA**	95	88	83	DNA[1]	91	94
O_3-8hr	ppb	80	Average	7.01	DNA*	13.5	DNA*	DNA**	20.7	16.2	14.9	DNA[1]	20.4	16.7
			Max	38.6	DNA*	56.1	DNA*	DNA**	45.7	50.2	45.6	DNA[1]	53.2	58.2
			Min	1.68	DNA*	1.03	DNA*	DNA**	9.39	0.15	1.32	DNA[1]	0.23	4.07
			Excedance(Hour)	0	DNA*	0	DNA*	DNA**	0	0	0	DNA[1]	0	0
			Data capture(%)	89	DNA*	99	DNA*	DNA**	96	97	92	DNA[1]	99	96

CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbisment CAMS, PM= Particulate Matter
DNA= Data Not Available, 1= DNA due to station not within monitoring network, *=DNA due to malfunction of the analyzer/sensor, **=DNA due to poor data capture rate

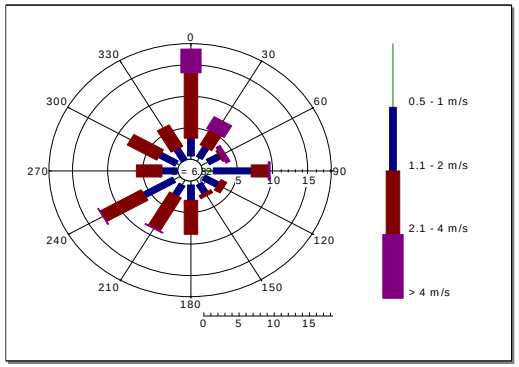
Table 3: Summary Air Quality and Meteorological data measured during March 2014 at different CAMS operated under DoE (Cont'd)

Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC)[a]	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayonganj)	CAMS-6 TV-St (Chittagong)[a]	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna)[a]	CAMS-10 (Rajshahi)[a]	CAMS-11 (Barisal)
$PM_{2.5}$ -24hr	µg /m^3	65	Average	99.1	DNA[2]	91.2	113	115	140	106	90.1	DNA[1]	90.8	92.6
			Max	209	DNA[2]	146	161	185	245	167	137	DNA[1]	175	153
			Min	54.5	DNA[2]	68.7	74.9	41.6	75.8	52.3	43.5	DNA[1]	43.4	44.1
			Excedance(Days)	22	DNA[2]	11	29	15	18	19	18	DNA[1]	27	16
			Data capture(%)	81	DNA[2]	68	89	55	61	70	85	DNA[1]	93	77
PM_{10} -24hr	µg /m^3	150	Average	189	DNA[2]	241	219	215	170	174	160	DNA[1]	296	144
			Max	348	DNA[2]	484	345	400	281	268	236	DNA[1]	445	239
			Min	108	DNA[2]	133	117	101	89.7	91.5	90.4	DNA[1]	164	59.6
			Excedance(Days)	16	DNA[2]	16	26	19	16	12	11	DNA[1]	25	11
			Data capture(%)	81	DNA[2]	73	88	78	95	69	78	DNA[1]	84	91
Solar rad. 1hr	watt/m^2	NA	Average	165	DNA*	231	222	158	DNA*	215	193	DNA[1]	DNA*	212
			Max	789	DNA*	992	896	604	DNA*	863	871	DNA[1]	DNA*	894
			Min	5.61	DNA*	6.60	7.08	0.76	DNA*	7.31	5.88	DNA[1]	DNA*	7.25
			Data capture(%)	92	DNA*	98	97	12	DNA*	95	90	DNA[1]	DNA*	94
Relative Humidity 1hr	(%)	NA	Average	53.9	DNA*	54.3	60.7	DNA*	DNA*	60.6	63.9	DNA[1]	68.0	63.4
			Max	89.7	DNA*	91.7	95.5	DNA*	DNA*	92.3	95.1	DNA[1]	99.6	95.3
			Min	16.9	DNA*	21.9	22.2	DNA*	DNA*	21.5	24.6	DNA[1]	21.8	20.5
			Data capture(%)	92	DNA*	98	97	DNA*	DNA*	94	90	DNA[1]	94	94
Ambient Temp. 1hr	(°c)	NA	Average	24.8	DNA*	DNA*	27.4	DNA*	DNA*	25.9	25.8	DNA[1]	25.2	29.5
			Max	44.7	DNA*	DNA*	41.3	DNA*	DNA*	32.8	35.7	DNA[1]	38.2	41.7
			Min	15.4	DNA*	DNA*	15.5	DNA*	DNA*	19.4	16.6	DNA[1]	16.7	19.7
			Data capture(%)	92	DNA*	DNA*	97	DNA*	DNA*	94	90	DNA[1]	94	94
Rainfall 1hr	(m.m.)	NA	Average	1.74	1.05	0.05	0.04	0.03	0.10	0.03	0.05	DNA[1]	0.02	0.11
			Max	5.10	4.44	0.42	2.41	0.04	0.30	1.03	2.70	DNA[1]	0.02	5.40
			Min	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	DNA[1]	0.02	0.02
			Data capture(%)	91	43	81	72	1	93	63	57	DNA[1]	0	15

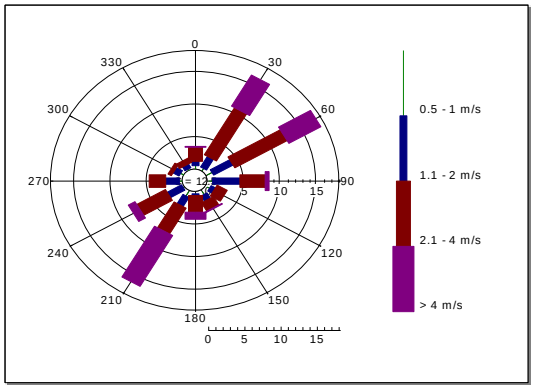
CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbisment CAMS, PM= Particulate Matter, DNA= Data Not Available
1= DNA due to station not within monitoring network, 2= DNA due to filter paper not setting *=DNA due to malfunction of the analyzer/sensor, **=DNA due to poor data capture rate

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

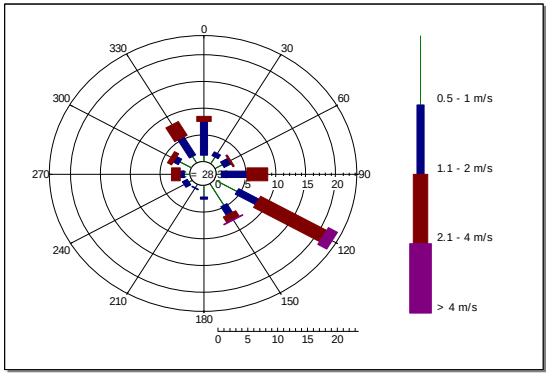
Wind Rose of Agrabad, Chittagong CAMS



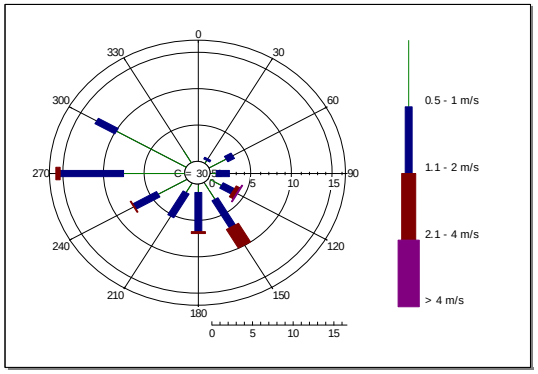
Wind Rose of Sylhet CAMS



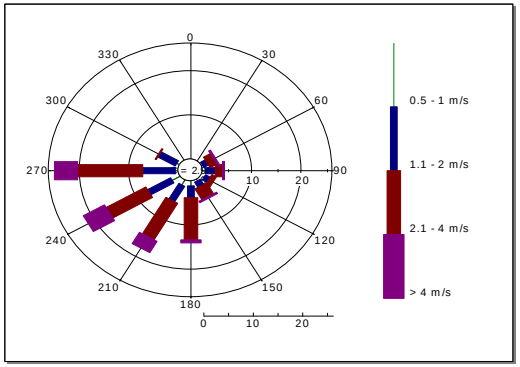
Wind Rose of Sangsad CAMS



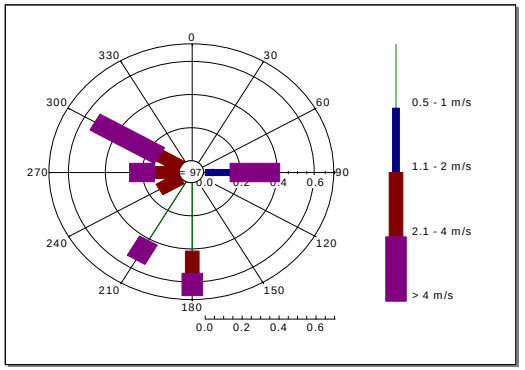
Wind Rose of Barisal CAMS



Wind Rose of Darussalam CAMS

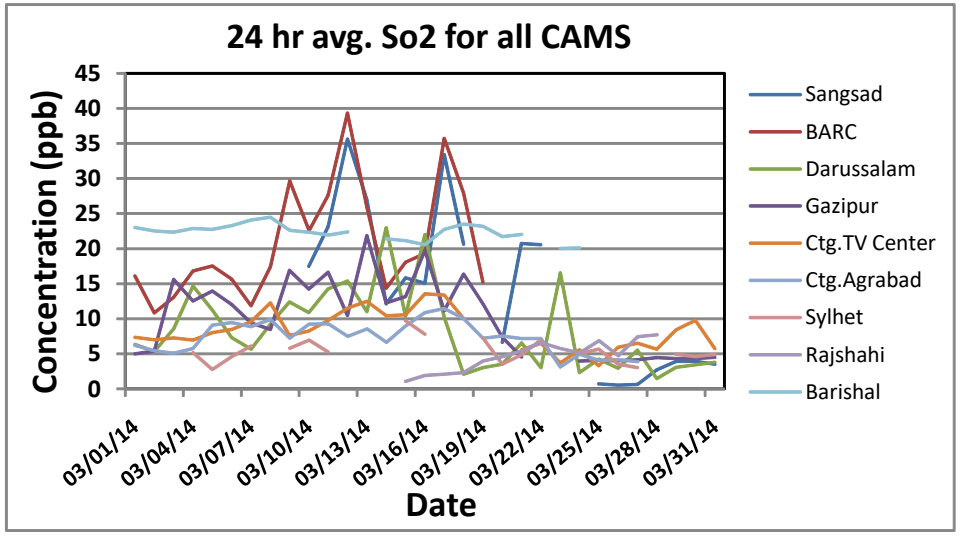


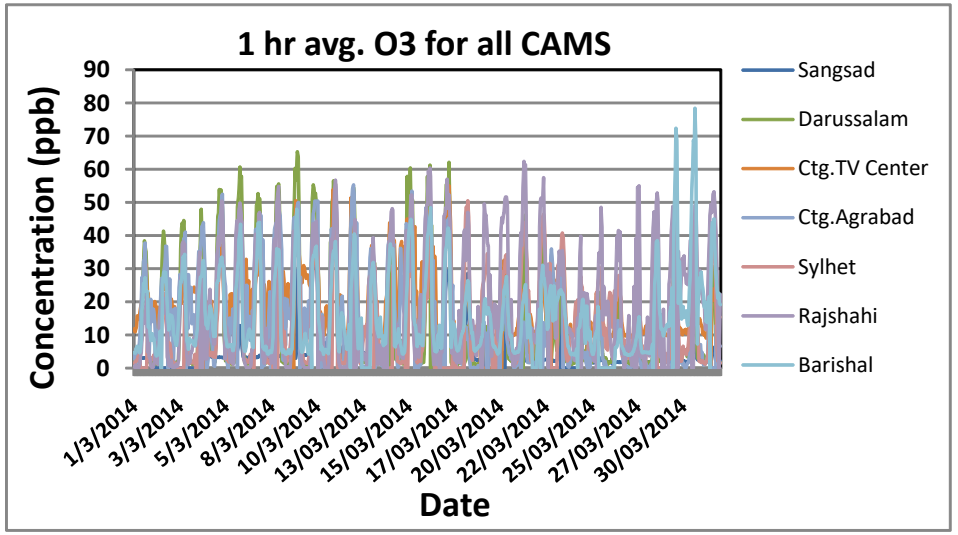
Wind Rose of Narayonganj CAMS

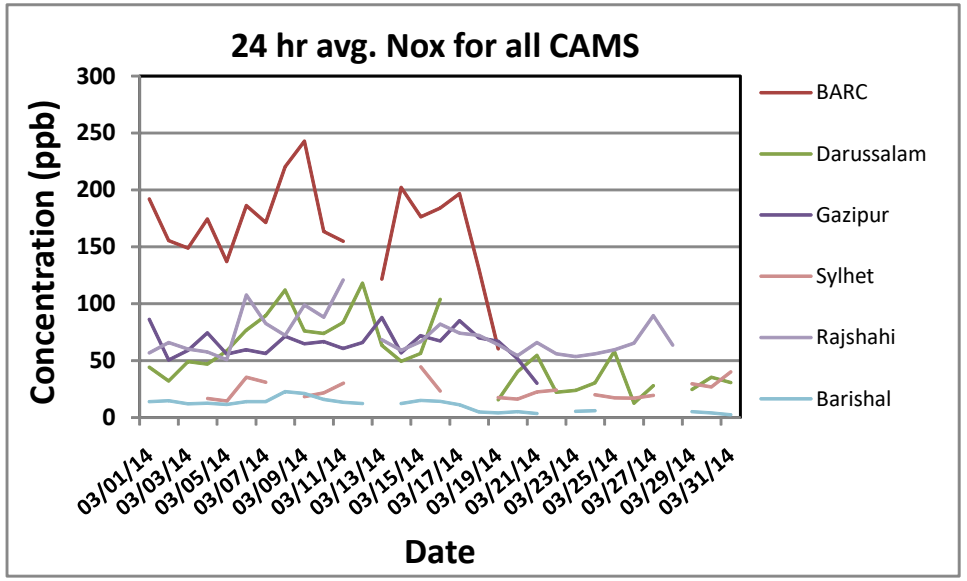


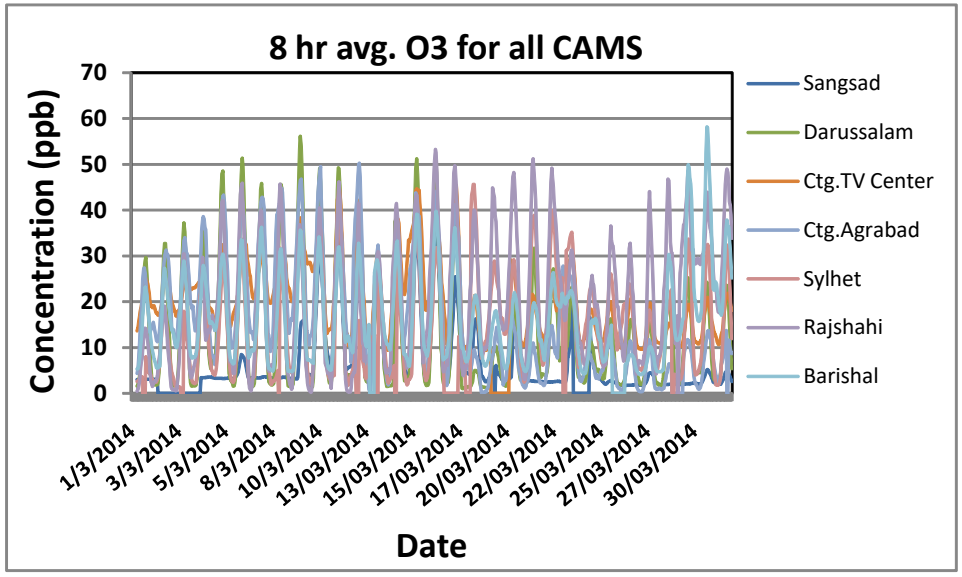
ANNEX

TIME SERIES OF ALL PARAMETERS (SO2, NOx AND O3) MEASURED IN ALL CAMS DURING March 2014









TIME SERIES OF ALL PARAMETERS (CO, PM10 AND PM2.5) MEASURED IN CAMS DURING March, 2014