Government of the People's Republic of Bangladesh

Ministry of Environment and Forests

Monthly Air Quality Monitoring Report
Reporting Month: December 2013

Clean Air and Sustainable Environment Project
(নির্মল বায়ু এবং টেকসই পরিবেশ প্রকল্প)

January, 2014

Department of Environment

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 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	Sangshad Bhaban, 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.

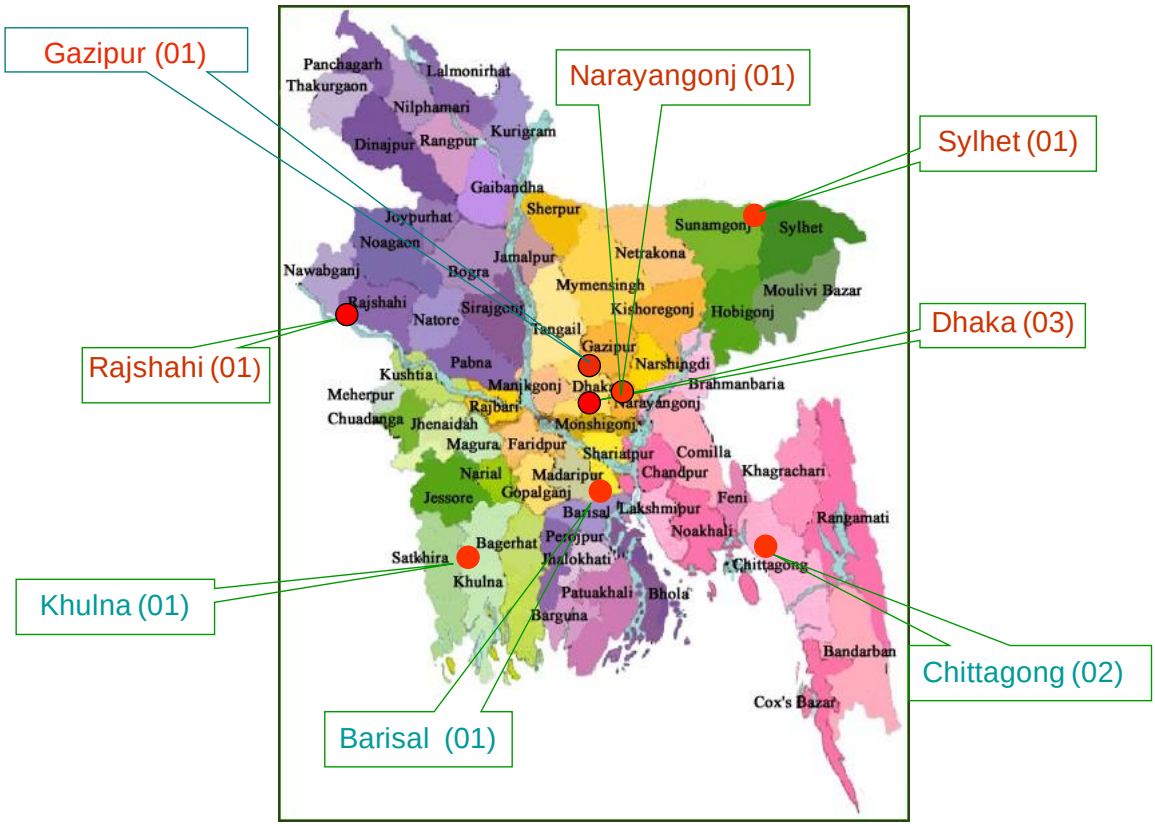


Figure 1: CAMS Location in Bangladesh

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 December 2013 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 with few exceptions. 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 networking. Though Sangsad Bhaban CAMS is now in operation after long shut down but all the gaseous analyzer were found malfunctioning, so data capture rate is low and thus not reported. 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. Some of the old PM analyzers could not be operated due to non-availability of filter paper rolls.

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. It is observed that the monthly average concentration level of PM2.5 and PM10 measured at different CAMS were around 91-1814µg/m3 and 148-312µg/m3 respectively during the month of December 2013. It is also seen that the concentration level of PM2.5 exceeded the BNAAQS for 31 days at Darussalam & 20 days at Sylhet CAMS, 29 days at Gazipur CAMS & 26 days at Barishal CAMS and 21 days at CDA, Agrabad and 29 days at Rajshahi CAMS respectively. On the other hand PM10 exceeded 28 days at Sangsad CAMS, 30 days at Darussalam CAMS, 08 days at TV Chittagong CAMS & & 29 days at Narayonganj CAMS, 21 days at Barishal CAMS, 31 days at Gazipur CAMS, 15 days at Sylhet CAMS & 22 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. Rainfall data shows that during those days rainfall occurred and PM levels could be low due to washout. 24-hours average PM levels in all cities monitored are found higher than previous month because prevailing dry seasons and lower wind speed. Lower wind speed and occurrences of inversion reduces dispersion of particulate matter and thus increases the PM pollution levels. 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 30 days at BARC CAMS, 27 days at Darussalam CAMS, 11 days at Gazipur (Dhaka) CAMS, 14 days at Rajshahi CAMS, 20 days at Narayonganj CAMS, 06 days at Tv station Chittagong and 04 days at Agrabad, Chittagong.

In general PM pollution levels in the cities monitored during the reporting month found deteriorating compared to previous month in respect of public health. Usually in the wet seasons the pollution level reaches lowest and tends to attain it maximum during dry season begin, which is reflected in the data monitored in all CAMS during month of December. It is observed that average wind speed and precipitation compared to previous month of November has decreased, which reduces 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 all CAMS except TV-Station Chittagong (no wind data available for those stations), Khulna CAMS & Gazipur 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 December 2013 were mainly from north-east direction with few exceptions.

4. Summary and conclusion

Data obtained from CAMS operated under DoE air quality monitoring network during December 2013 have been analyzed and reported. Data availability was over 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 increasing tendency of non compliance with

the BNAAQS during the month of December 2013. Only a few 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 91-1814µg/m3 and 148-312µg/m3 respectively during the month of December 2013.

- All gaseous pollutants except NOx measured at 11 CAMS did not exceeded limit values except BARC, Darussalam, Narayonganj, Rajshahi, Gazipur, TV station & Agrabad Chittagong stations. Maximum 24 hours NOx concentration at these stations found to be around annual average BNAAQS limit values (53 ppb).
- Due to decreased average wind speed and precipitation as well as occurrences of atmospheric inversion during December-13, dispersion and wash out of pollutants decreased and thus the pollution concentration levels showed higher.

At present manual data quality checks and screening are performed for analyzing the air quality data, further strict quality assurance programme that will be developed for this programme which eventually will improve the data quality. During the reporting month a number of analyzers did not produced data and need maintenance. Data from Sangsad Bhaban CAMS were partially available for the whole month due to failure of air conditioning system. Some PM analyzer cannot be run due to lac of PM2.5 and PM10 filter paper at few CAMS. Necessary action for maintenance of the analyzers will be taken.

ANNEX

Table 3: Summary Air Quality and Meteorological data measured during December 2013 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	DNA*	7.76	30.2	2.40	10.4	8.74	3.34	2.04	DNA[1]	0.45	2.39
			Max	DNA*	13.3	50.2	3.63	21.1	21.6	6.78	4.09	DNA[1]	0.64	2.82
			Min	DNA*	3.82	9.30	1.57	5.76	3.92	1.57	1.02	DNA[1]	0.32	1.78
			Excedance(Days)	DNA*	0	0	0	0	0	0	0	DNA[1]	0	0
			Data capture(%)	DNA*	97	99	98	100	63	97	96	DNA[1]	53	95
NO_2 -24 hr	ppb	53 (Annual)	Average	DNA*	191	85.7	45.9	61.6	44.8	31.2	26.9	DNA[1]	65.8	10.4
			Max	DNA*	273	178	98.6	101	93.1	139	44.8	DNA[1]	108	21.8
			Min	DNA*	87.5	34.5	18.0	14.2	10.5	2.60	16.3	DNA[1]	43.2	3.71
			Excedance(Days)	DNA*	30	27	11	20	6	4	0	DNA[1]	23	0
			Data capture(%)	DNA*	97	98	98	100	75	94	96	DNA[1]	93	96
CO- 1 hr	ppm	35	Average	DNA*	1.45	3.68	1.75	1.49	1.43	1.58	1.40	DNA[1]	0.51	2.70
			Max	DNA*	6.10	8.44	6.46	4.17	7.42	7.40	7.09	DNA[1]	0.82	6.59
			Min	DNA*	0.05	1.49	0.53	0.19	0.11	0.57	0.05	DNA[1]	0.09	1.25
			Excedance(Hour)	DNA*	0	0	0	0	0	0	0	DNA[1]	0	0
			Data capture(%)	DNA*	81	99	98	100	79	97	76	DNA[1]	95	96
CO-8hr	ppm	9	Average	DNA*	1.37	3.67	1.74	1.48	1.40	1.58	1.33	DNA[1]	0.51	2.70
			Max	DNA*	5.81	6.26	3.93	3.22	4.09	4.65	5.85	DNA[1]	0.69	5.39
			Min	DNA*	0.09	1.64	0.77	0.34	0.23	0.72	0.07	DNA[1]	0.41	1.52
			Excedance(Hour)	DNA*	0	0	0	0	0	0	0	DNA[1]	0	0
			Data capture(%)	DNA*	93	99	99	99	83	99	88	DNA[1]	98	97
O_3-1hr	ppb	120	Average	DNA*	11.5	9.59	DNA*	5.35	15.9	16.9	7.89	DNA[1]	14.7	DNA**
			Max	DNA*	36.2	52.7	DNA*	35.9	52.7	61.8	30.0	DNA[1]	55.7	DNA**
			Min	DNA*	6.56	0.25	DNA*	1.83	9.08	0.05	1.23	DNA[1]	0.05	DNA**
			Excedance(Hour)	DNA*	0	0	DNA*	0	0	0	0	DNA[1]	0	DNA**
			Data capture(%)	DNA*	98	99	DNA*	100	60	96	96	DNA[1]	94	DNA**
O_3-8hr	ppb	80	Average	DNA*	11.5	9.69	DNA*	5.37	16.3	17.0	7.89	DNA[1]	14.6	DNA**
			Max	DNA*	24.4	36.6	DNA*	18.5	44.9	53.0	22.5	DNA[1]	45.9	DNA**
			Min	DNA*	8.50	0.58	DNA*	2.07	9.55	0.15	1.48	DNA[1]	0.23	DNA**
			Excedance(Hour)	DNA*	0	0	DNA*	0	0	0	0	DNA[1]	0	DNA**
			Data capture(%)	DNA*	98	99	DNA*	99	64	98	98	DNA[1]	98	DNA**

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 December 2013 at different CAMS operated under DoE (Cont'd)

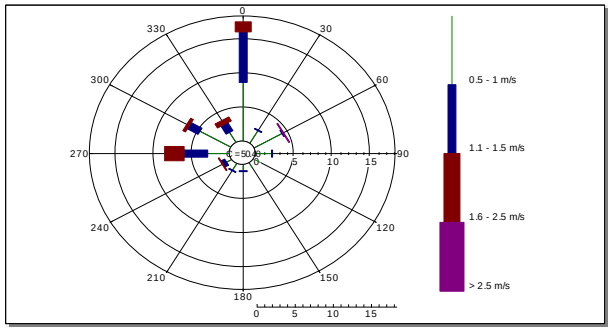
Parameter	unit	NAAQS	Summary	CAMS-1 (S-Bhaban)	CAMS-2 (BARC)[a]	CAMS-3 (D-salam)	CAMS-4 (Gazipur)	CAMS-5 (Narayonganj)	CAMS-6 TV-St (Chittagong)[a]	CAMS-7 Agrabad-(Chittagong)	CAMS-8 (Sylhet)	CAMS-9 (Khulna)[a]	CAMS-10 (Rajshahi)[a]	CAMS-11 (Barisal)
$PM_{2.5}$ -24hr	µg /m^3	65	Average	DNA*	DNA*	181	158	DNA**	DNA**	147	90.9	DNA[1]	113	166
			Max	DNA*	DNA*	268	237	DNA**	DNA**	201	191	DNA[1]	155	262
			Min	DNA*	DNA*	85.4	103	DNA**	DNA**	87.8	32.5	DNA[1]	81.3	100
			Excedance(Days)	DNA*	DNA*	31	29	DNA**	DNA**	21	20	DNA[1]	29	26
			Data capture(%)	DNA*	DNA*	98	89	DNA**	DNA**	74	93	DNA[1]	94	88
PM_{10} -24hr	µg /m^3	150	Average	230	DNA*	277	230	312	94.2	213	148	DNA[1]	DNA*	196
			Max	347	DNA*	499	336	400	294	311	263	DNA[1]	DNA*	279
			Min	110	DNA*	152	153	212	20.6	149	69.5	DNA[1]	DNA*	122
			Excedance(Days)	28	DNA*	30	31	29	4	22	15	DNA[1]	DNA*	21
			Data capture(%)	99	DNA*	97	94	94	57	82	92	DNA[1]	0	86
Solar rad. 1hr	watt/m^2	NA	Average	109	DNA*	143	142	115	DNA*	160	135	DNA[1]	DNA*	144
			Max	562	DNA*	670	681	577	DNA*	636	663	DNA[1]	DNA*	620
			Min	6.06	DNA*	7.52	7.61	3.67	DNA*	7.31	6.39	DNA[1]	DNA*	8.14
			Data capture(%)	100	DNA*	99	98	100	DNA*	97	96	DNA[1]	DNA*	96
Relative Humidity 1hr	(%)	NA	Average	73.1	DNA*	69.0	76.8	DNA*	DNA*	68.1	71.7	DNA[1]	84.8	77.0
			Max	97.0	DNA*	95.7	97.8	DNA*	DNA*	97.1	98.5	DNA[1]	99.7	99.4
			Min	24.0	DNA*	26.1	22.7	DNA*	DNA*	21.9	26.7	DNA[1]	33.0	29.6
			Data capture(%)	100	DNA*	99	98	DNA*	DNA*	97	96	DNA[1]	95	96
Ambient Temp. 1hr	(ºc)	NA	Average	18.0	DNA*	19.9	20.2	DNA*	DNA*	21.4	20.9	DNA[1]	18.8	22.9
			Max	27.7	DNA*	30.6	32.6	DNA*	DNA*	28.5	31.4	DNA[1]	27.9	33.6
			Min	10.3	DNA*	4.79	9.25	DNA*	DNA*	13.4	12.3	DNA[1]	10.3	14.1
			Data capture(%)	100	DNA*	93	98	DNA*	DNA*	97	96	DNA[1]	95	96
Rainfall 1hr	(m.m.)	NA	Average	0.03	1.07	0.04	0.03	DNA**	DNA**	0.02	0.03	DNA[1]	DNA*	DNA**
			Max	0.83	4.28	3.15	0.09	DNA**	DNA**	0.09	0.08	DNA[1]	DNA*	DNA**
			Min	0.02	0.03	0.02	0.02	DNA**	DNA**	0.02	0.02	DNA[1]	DNA*	DNA**
			Data capture(%)	77	67	58	60	DNA**	DNA**	45	52	DNA[1]	DNA*	DNA**

CAMS= Continuous Air Monitoring Station, NAAQS=National Ambient Air Quality Standard, a=Refurbisment CAMS, PM= Particulate Matter

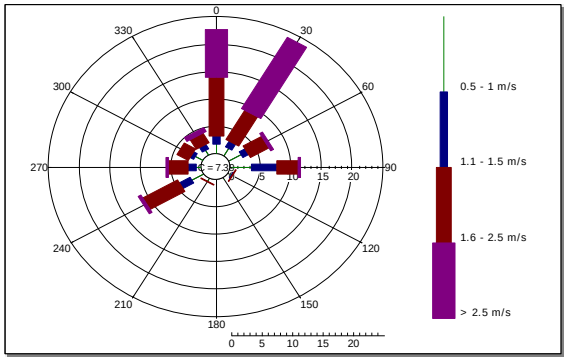
DNA= Data Not Available, 1= DNA due to station not within monitoring network, *=DNA due to malfunction of the analyzer/sensor, **=DNA due to poor data capture rate

Figure 2: Wind frequency distributions (wind roses) from different CAMS monitored for December 2013 (cont'd).

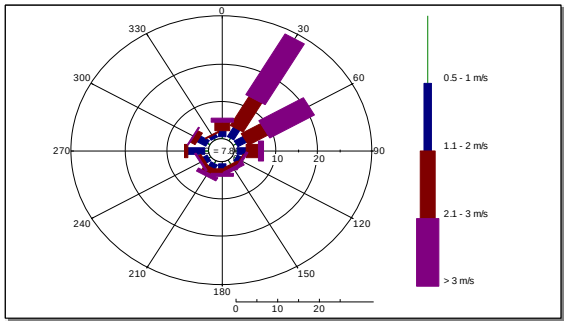
Wind Rose of Narayonganj CAMS



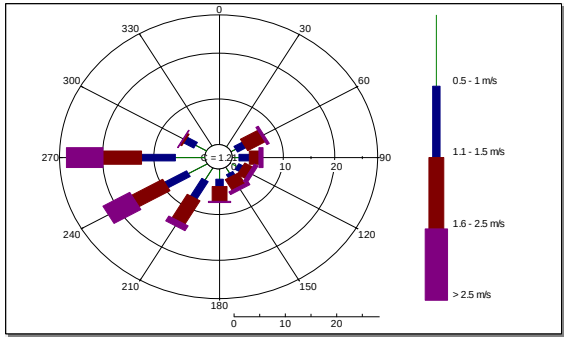
Wind Rose of Agrabad, Chittagong CAMS



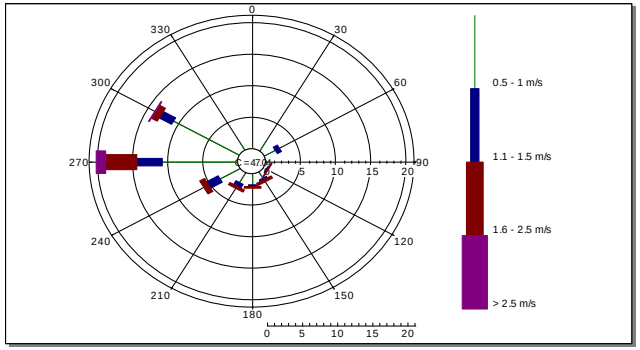
Wind Rose of Sylhet CAMS



Wind Rose of Darussalam CAMS



Wind Rose of Barisal CAMS



Wind Rose of BARC CAMS

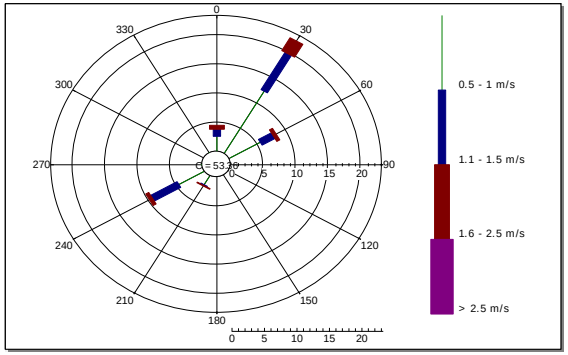
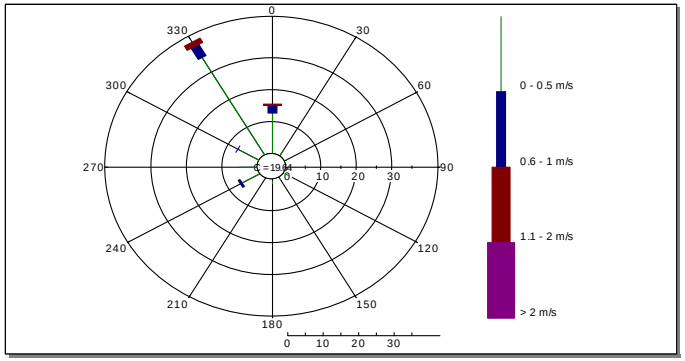
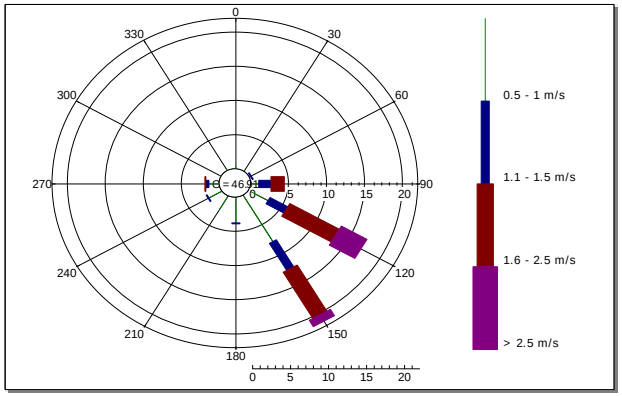


Figure 2: Wind frequency distributions (wind roses) from different CAMS monitored for December 2013 (cont'd).

Wind Rose of Rajshahi CAMS for this month

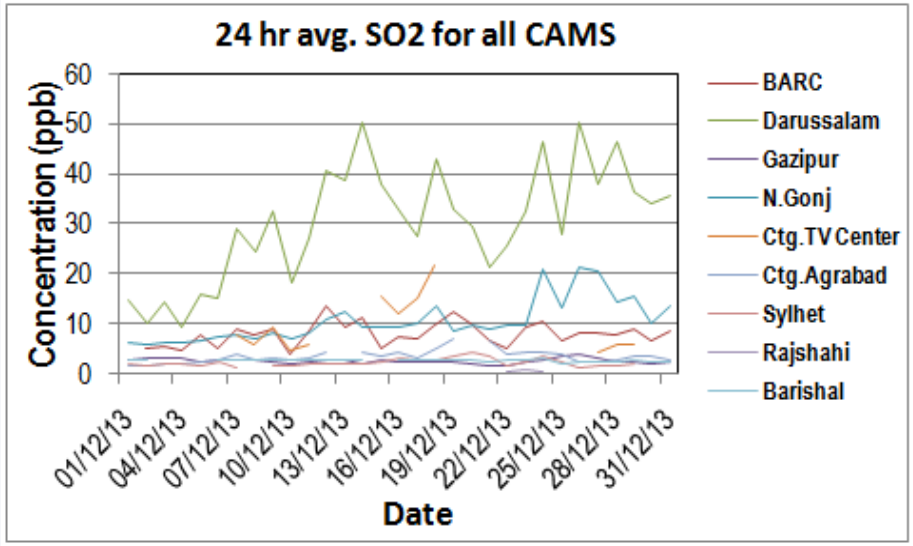


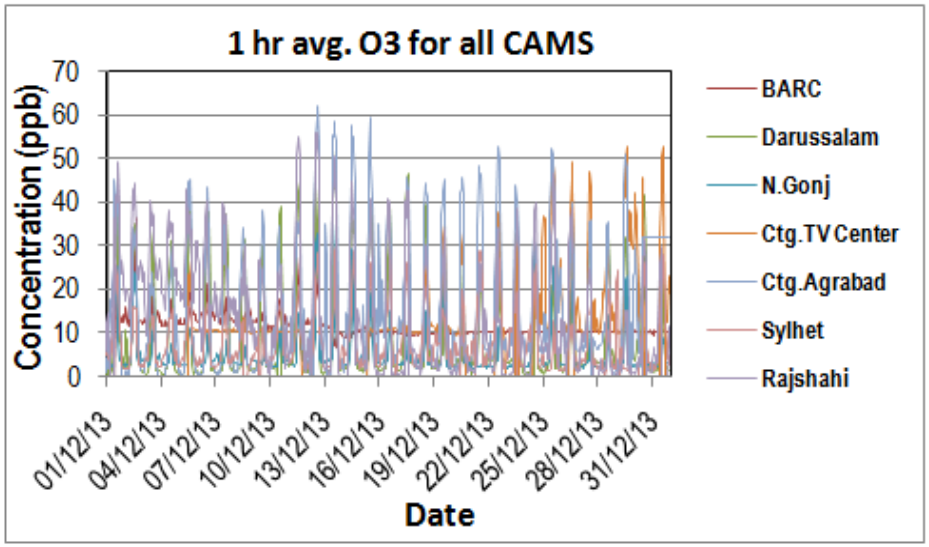
Wind Rose of Sangsad CAMS for this month

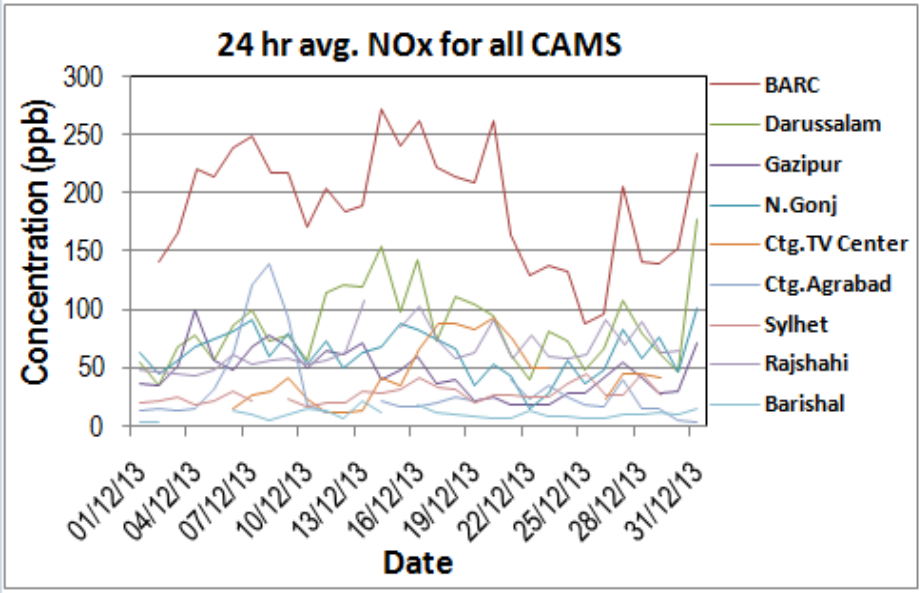


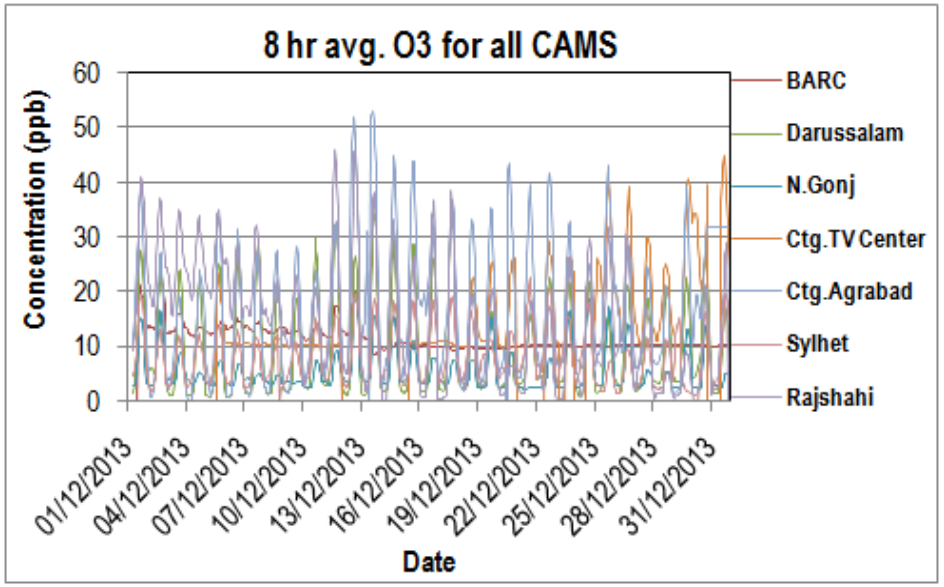
ANNEX

TIME SERIES OF ALL PARAMETERS (SO2, NOx AND O3) MEASURED IN ALL CAMS DURING December 2013









ANNEX

TIME SERIES OF ALL PARAMETERS (CO, PM10 AND PM2.5) MEASURED IN CAMS DURING December, 2013