



Air Quality Monthly Report

December, 2014



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

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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 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 µg/m³
- (c) The objective is attained when the expected number of days per calendar year with a 24-hour average of 150 µg/m³ 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	Farmgate	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 December 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 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, which are outliers (beyond 3rd and 97th 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.

Inspection of the available data shows that there were number of occurrences of non-compliance for PM₁₀ & PM_{2.5} levels at majority of monitoring stations during the month of December 2014. It is observed that the 24 hr average concentration level of PM_{2.5} exceeded BNAQS for 28 days at Darus-Salam, Mirpur, 27 days at Barisal, 30 days at BARC and 18 days at Narayanganj during the month of December 2014. Such non-attainment occurred for 31 days in Sangshad Bhaban, 29 days at Gazipur, also for 26 days in Agrabad, Chittagong, 22 days in TV Station, Chittagong and 23 days at Sylhet CAMS. Data capture rate of PM_{2.5} at Narayanganj CAMS is low for the reporting month. For PM₁₀ non-attainment with respect to BNAQS occurred for 29 days in Sangsad, 31 days in Darus Salam, 29 days at Gazipur, 31 days at Narayanganj CAMS and 24 days in Agrabad, Chittagong and 16 days in TV station Chittagong, 30 days at Barisal and 12 days in Sylhet CAMS during the reporting month. The monthly average concentration level of PM_{2.5} and PM₁₀ measured at different CAMS were found 99-225 $\mu\text{g}/\text{m}^3$ and 162-397 $\mu\text{g}/\text{m}^3$ respectively during the month of December 2014. From the time series plot of both PM₁₀ and PM_{2.5}, 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_x measured at different CAMS did not exceed the BNAQS during the month of December 2014. NO_x concentrations exceed the BNAQS 22 days in Darussalam, 24 days in Narayanganj CAMS, 05 days in Gazipur CAMS, 02 days at Sylhet and 03 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 December-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.

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 very unhealthy or extremely unhealthy categories.

4. Summary and conclusion

Data obtained from CAMS operated under DoE air quality monitoring network during December 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:

- PM₁₀ and PM_{2.5} are the most critical pollutants. 24-hour average for both PM₁₀ and PM_{2.5} concentrations were found non-compliance at majority of the station with the BNAQS during the month of December, 2014. It is observed that the average concentration level of PM_{2.5} and PM₁₀ were around 99-225 $\mu\text{g}/\text{m}^3$ and 162-397 $\mu\text{g}/\text{m}^3$ respectively during the month of December 2014.
- The gaseous pollutants except NO_x measured at different CAMS did not exceed limit values of the BNAQS. NO_x concentrations exceed the BNAQS 22 days in Darussalam, 24 days in Narayanganj CAMS, 05 days in Gazipur CAMS and 03 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 PM2.5.

During the reporting month a number of analyzer especially SO₂ & NO_x did not produced data and they are under maintenance process.

Table 3: Summary Air Quality and Meteorological data measured during December 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	DNA*	3.18	3.55	DNA*	12.4	6.23	5.37	2.31	4.21	DNA*	DNA*
			Max	DNA*	5.62	6.87	DNA*	24.4	8.03	7.34	3.21	13.8	DNA*	DNA*
			Min	DNA*	1.09	1.48	DNA*	3.99	2.94	3.85	1.54	0.90	DNA*	DNA*
			Excedance(Days)	DNA*	0	0	DNA*	0	0	0	0	0	DNA*	DNA*
			Data capture(%)	DNA*	90	100	DNA*	97	74	89	61	79	DNA*	DNA*
NO ₂ -24 hr	ppb	53 (Annual)	Average	DNA*	DNA*	76.9	35.0	73.4	DNA*	33.7	36.3	DNA*	DNA*	7.87
			Max	DNA*	DNA*	135	67.0	116	DNA*	64.3	66.2	DNA*	DNA*	20.5
			Min	DNA*	DNA*	11.9	4.38	29.3	DNA*	11.5	17.9	DNA*	DNA*	2.94
			Excedance(Days)	DNA*	DNA*	22	5	24	DNA*	3	2	DNA*	DNA*	0
			Data capture(%)	DNA*	DNA*	96	97	97	DNA*	87	95	DNA*	DNA*	97
CO- 1 hr	ppm	35	Average	1.58	3.32	2.55	1.97	1.98	1.07	1.31	1.86	DNA*	0.64	1.52
			Max	2.92	11.4	8.08	7.82	5.09	3.78	5.11	6.97	DNA*	2.24	5.17
			Min	0.76	0.05	0.77	0.05	0.17	0.11	0.29	0.82	DNA*	0.25	0.59
			Excedance(Hour)	0	0	0	0	0	0	0	0	DNA*	0	0
			Data capture(%)	100	85	99	97	97	75	89	95	DNA*	100	97
CO-8hr	ppm	9	Average	1.58	3.42	2.53	1.96	1.97	1.06	1.30	1.86	DNA*	0.64	1.52
			Max	2.78	9.59	6.56	4.67	4.48	2.50	3.31	4.18	DNA*	1.06	4.59
			Min	0.77	0.52	0.86	0.91	0.86	0.38	0.50	0.89	DNA*	0.44	0.77
			Excedance(Hour)	0	4	0	0	0	0	0	0	DNA*	0	0
			Data capture(%)	99	80	99	99	98	74	88	92	DNA*	99	95
O ₃ -1hr	ppb	120	Average	DNA*	6.41	DNA*	DNA*	3.05	DNA*	12.0	6.58	2.27	11.7	6.01
			Max	DNA*	17.8	DNA*	DNA*	22.5	DNA*	54.5	29.0	23.3	58.8	36.0
			Min	DNA*	3.47	DNA*	DNA*	1.06	DNA*	0.10	0.05	0.66	0.05	0.08
			Excedance(Hour)	DNA*	0	DNA*	DNA*	0	DNA*	0	0	0	0	0
			Data capture(%)	DNA*	99	DNA*	DNA*	97	DNA*	87	94	99	98	97
O ₃ -8hr	ppb	80	Average	DNA*	6.41	DNA*	DNA*	3.07	DNA*	12.0	6.62	2.28	11.6	6.08
			Max	DNA*	11.2	DNA*	DNA*	12.3	DNA*	41.7	19.7	13.0	35.1	23.3
			Min	DNA*	5.21	DNA*	DNA*	1.33	DNA*	0.40	0.10	0.93	0.35	0.24
			Excedance(Hour)	DNA*	0	DNA*	DNA*	0	DNA*	0	0	0	0	0
			Data capture(%)	DNA*	98	DNA*	DNA*	98	DNA*	85	92	98	99	95

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

Table 3: Summary Air Quality and Meteorological data measured during December 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	157	141	185	174	225	DNA*	125	99.3	DNA*	DNA*	167
			Max	263	223	273	292	330	DNA*	174	148	DNA*	DNA*	256
			Min	111	99.9	143	125	151	DNA*	91.5	63.9	DNA*	DNA*	117
			Excedance(Days)	31	30	28	29	18	DNA*	26	23	DNA*	DNA*	27
			Data capture(%)	99	97	92	92	71	DNA*	89	87	DNA*	DNA*	91
PM ₁₀ -24hr	µg /m ³	150	Average	236	DNA*	270	287	397	176	195	162	DNA*	DNA*	221
			Max	375	DNA*	392	421	560	230	260	256	DNA*	DNA*	368
			Min	167	DNA*	177	163	276	140	144	123	DNA*	DNA*	158
			Excedance(Days)	29	DNA*	31	29	31	16	24	12	DNA*	DNA*	30
			Data capture(%)	95	DNA*	99	93	97	75	87	78	DNA*	DNA*	94
Solar rad. 1hr	watt/m ²	NA	Average	DNA*	DNA*	131	115	DNA*	DNA*	136	135	DNA*	DNA*	124
			Max	DNA*	DNA*	728	619	DNA*	DNA*	613	636	DNA*	DNA*	602
			Min	DNA*	DNA*	7.17	6.81	DNA*	DNA*	7.30	6.91	DNA*	DNA*	7.77
			Data capture(%)	DNA*	DNA*	100	98	DNA*	DNA*	89	95	DNA*	DNA*	97
Relative Humidity 1hr	(%)	NA	Average	78.7	54.5	78.1	83.4	77.0	DNA*	70.9	75.4	DNA*	DNA*	81.6
			Max	95.8	70.4	97.6	98.8	96.3	DNA*	96.0	98.3	DNA*	DNA*	99.4
			Min	28.7	15.2	29.0	26.8	30.2	DNA*	30.0	33.6	DNA*	DNA*	35.2
			Data capture(%)	100	99	100	98	97	DNA*	89	95	DNA*	DNA*	97
Ambient Temp. 1hr	(°c)	NA	Average	16.7	22.2	19.8	18.2	18.1	DNA*	21.3	20.4	DNA*	DNA*	20.6
			Max	26.4	31.8	29.2	28.1	27.3	DNA*	40.0	28.6	DNA*	DNA*	34.8
			Min	10.2	13.8	12.8	11.7	11.1	DNA*	13.8	13.6	DNA*	DNA*	13.0
			Data capture(%)	100	99	100	98	97	DNA*	90	95	DNA*	DNA*	97
Rainfall 1hr	(m.m.)	NA	Average	0.33	0.40	0.08	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*
			Max	2.66	2.73	3.94	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*
			Min	0.02	0.03	0.02	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*
			Data capture(%)	94	38	93	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*	DNA*

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

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

FIGURE 3: TIME SERIES OF ALL PARAMETERS (SO₂, NO_x AND O₃) MEASURED IN ALL CAMS DURING DECEMBER, 2014

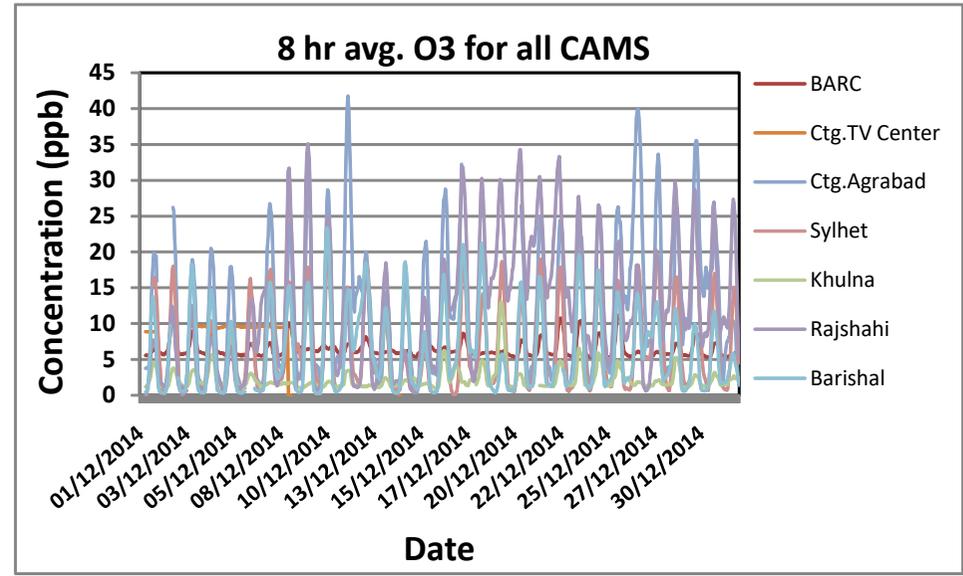
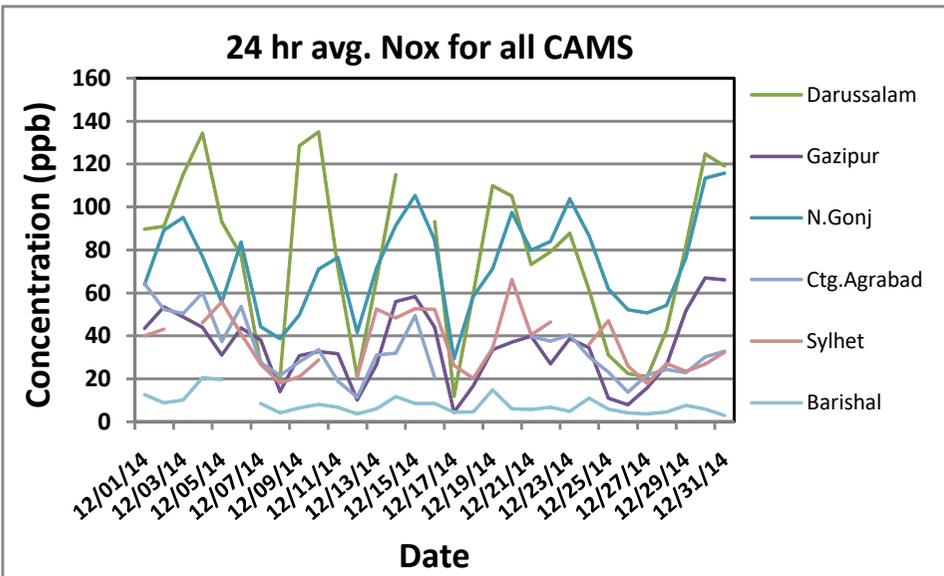
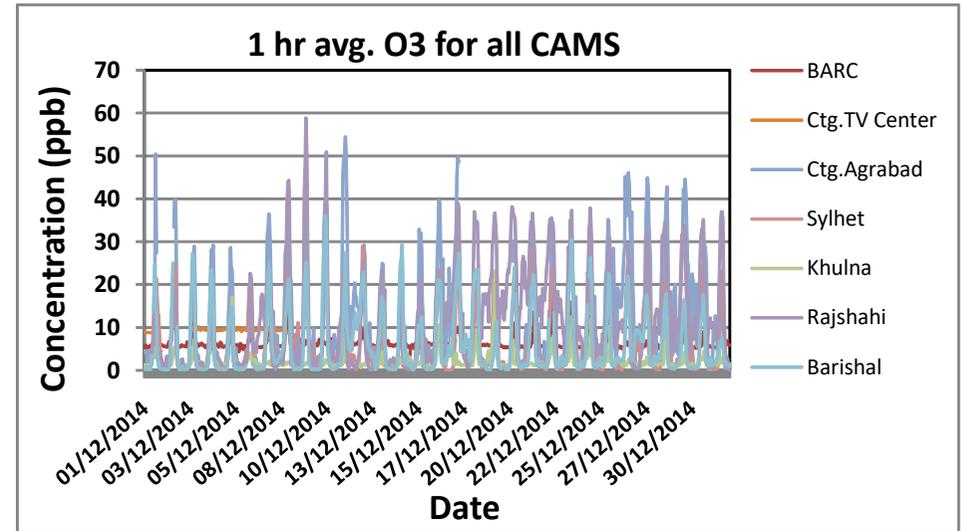
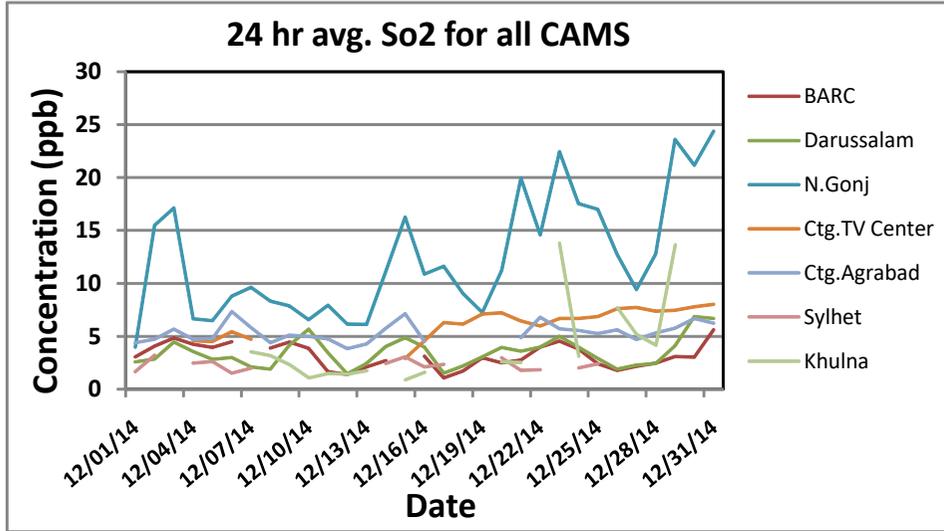


Figure 4: TIME SERIES OF ALL PARAMETERS (CO, PM10 AND PM2.5) MEASURED IN CAMS DURING DECEMBER, 2014

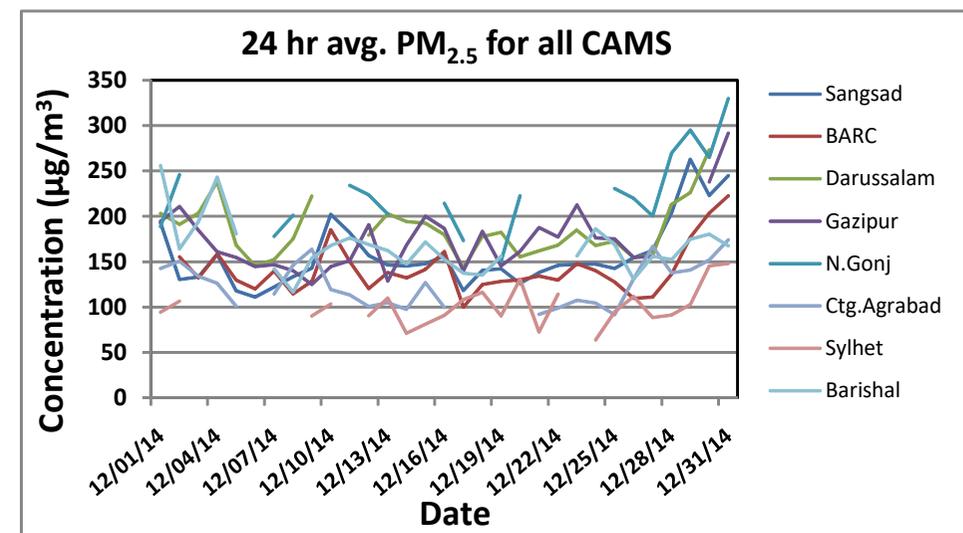
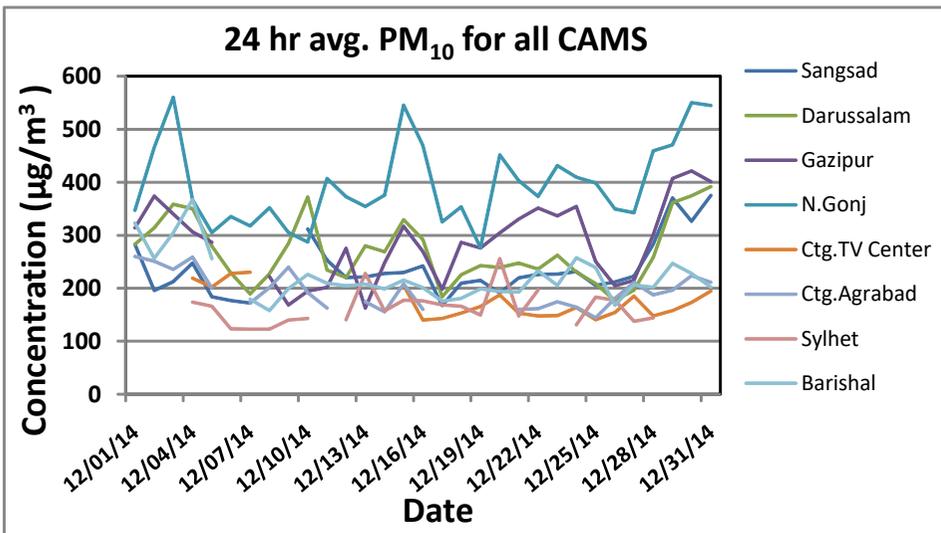
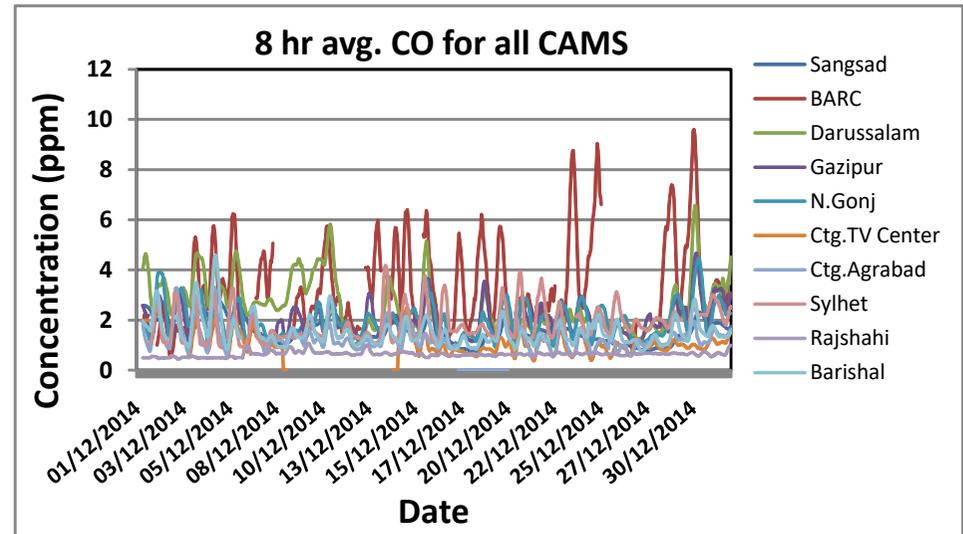
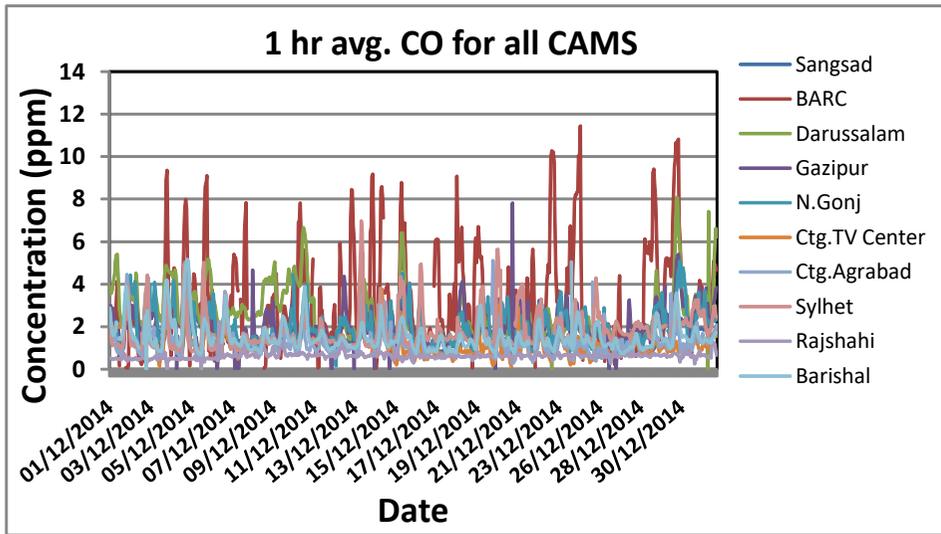


Figure 5: Monthly Summary of AQI for month of December, 2014

