BRIEF REPORT ON CONTINUOUS AMBIENT AIR QUALITY DATA OF RAJASTHAN FOR THE MONTH OF JANUARY-FEBRUARY AND MARCH- 2018

Rajasthan State Pollution Control Board

राजस्थान राज्य प्रदूषण नियंत्रण मण्डल

वन एवं पर्यावरण विभाग

राजस्थान सरकार

INDEX

CONTRIBUTION

Overall Guidance	Smt. Aparna Arora, Chairperson, RSPCB Shri Ajay Kumar Gupta, Member Secretary, RSPCB Shri K.C.A.Arun Prasad, IFS
Co-ordinator	Dr. V.K.Singhal, C.E.E., RSPCB Shri B.R.Chauhan, C.S.O., RSPCB
Report Preparation and Data Interpretation	Dr. Sanjeev Kumar Sharma, S.O., RSPCB Dr. Kriti Sharma, J.S.O., RSPCB Smt. Vandana Chaturvedi, J.S.O., RSPCB

1. INTRODUCTION

Rajasthan is the largest state of the Republic of India in terms of area. Rajasthan covers an area of 342, 239 km² (132,139 mi²) or 10.4% of India's total area and is located on the north western side of the India. The Great Indian Desert, commonly known as Thar Desert occupies most of the area of the State. The region borders Pakistan to the west, Gujarat to the southwest, Madhya Pradesh to the southeast, Uttar Pradesh and Haryana to the northeast and Punjab to the north. The state capital is Jaipur. Geographical features include the Thar Desert along north-western Rajasthan and the termination of the Ghaggar River near the archeological ruins at Kalibanga, which are the oldest in the subcontinent discovered so far.

One of the world's oldest mountain ranges, the Aravalli Range, cradles the only hill station of Rajasthan, Mount Abu, and its world-famous Dilwara Temples, is a sacred pilgrimage for Jain. Rajasthan has two National Tiger Reserves, Ranthambore and Sariska, as well as Keoladeo National Park near Bharatpur, famous for its bird life.

Since 1991, with the enactment of economic liberalization policies, India experienced rapid industrial growth. This rise enabled growth in the resource intensive manufacturing sector and facilitated rate of material use leading to manifold impacts to the environment.

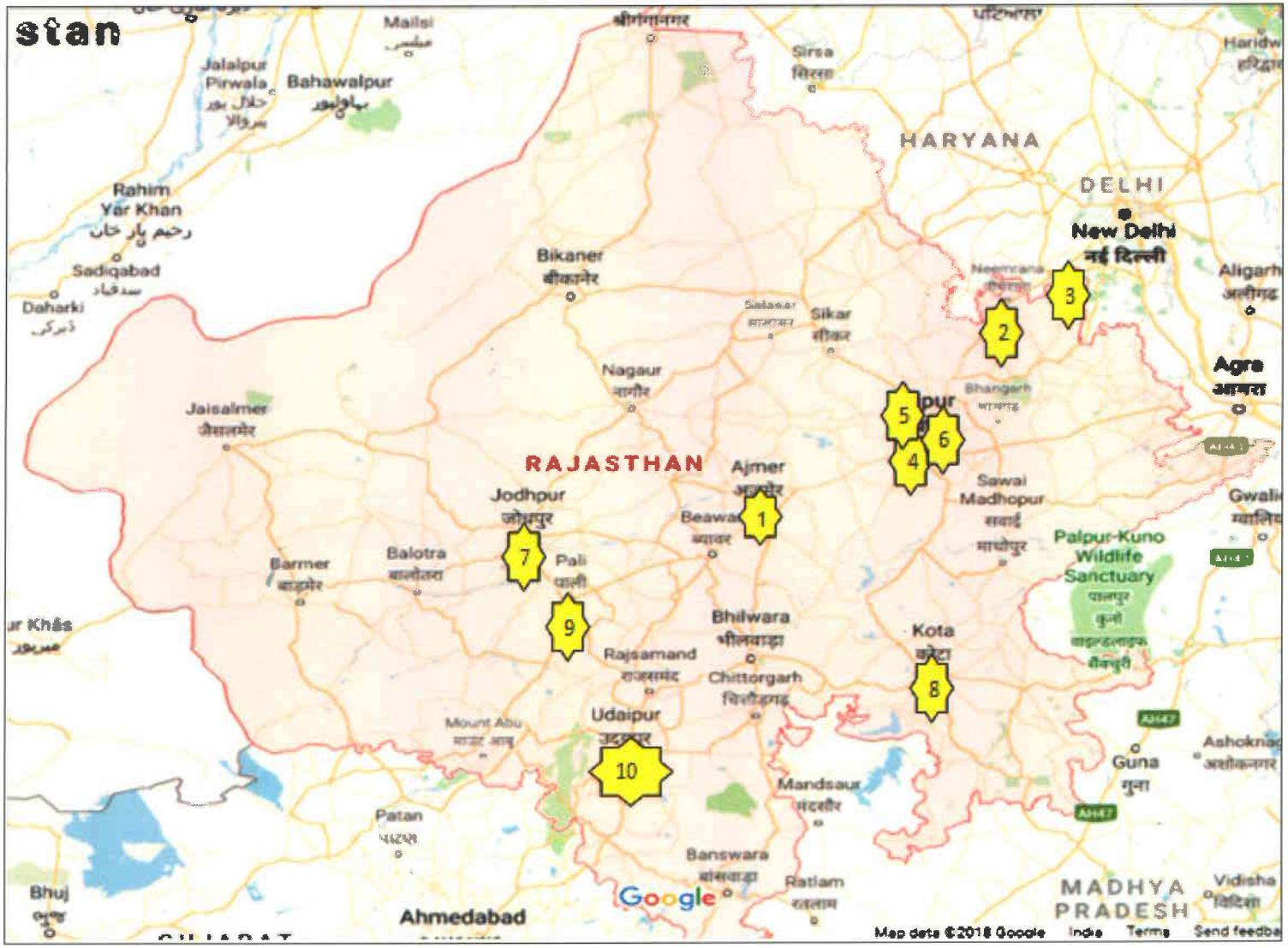
In India, ambient air quality have progressively deteriorated due to anthropogenic sources like rapid urbanization, industrialization, uncontrolled increase of vehicles on poor road conditions, construction debris, lack of public awareness, windblown dust from unpaved road sides and seasonal causes such as dust storms are some of the major pollution sources which can be easily found in any growing city of India. Both, National and State authorities have taken up necessary regulatory steps to reduce ambient air pollution.

2. CAAQMS- MONITORING NETWORK

Rajasthan State Pollution Control Board had installed and commissioned 02 nos of Continuous Ambient Air Quality Monitoring Station (CAAQMS) in July, 2012. These stations are located at Jaipur and Jodhpur in Rajasthan to evaluate the Ambient Air Quality Status of million plus cities of the State.

Recognizing the need to monitor real time and peak concentration levels of critical pollutants avoiding the time lag, State Board further increased the number of Continuous Ambient Air Quality Monitoring Stations (CAAQMS) in July, 2017.

Presently, CAAQMS are located in Jaipur (03 Nos.), and one each in Ajmer, Alwar, Bhiwadi, Jodhpur, Kota, Pali and Udaipur. Every station has a display board which continuously shows captured data of various Pollutants in ambient air. Particulate matters (PM_{10} and $PM_{2.5}$) and gaseous pollutants (NOx, SO_2, CO, VOC, O_3, NH_3) along with meteorological parameters like Temperature, Relative Humidity, Wind Speed, Wind Direction, Solar Radiation etc are continuously captured with the help of CAAQMS. State Board has also installed Central display board for the public awareness, located at Rambag Circle, Jaipur to display the real time captured data of all the 10 nos. CAAQMS continuously.



Location No.	Location Detail
1.	Sainik Vishramgarh, Todarmal Marg, Civil Lines, Ajmer.
2.	Rashtriya Madhymik Shiksha parisad, Opposite SMD Circle, Alwar.
3.	Water supply complex, RIICO Industrial Area, Bhiwadi.
4.	Police Commissionerate Office, M.I. Road, Jaipur
5.	Regional Science Park, Shastri Nagar, Jaipur.
6.	Psychiatric Center, Janta Colony, Adrash Nagar, Raja Park, Jaipur.
7.	Collectrate Office, Jodhpur.
8.	Shreenathpuram New Stadium, Near Gad circle, Kota.
9.	Bangar PG college campus, Indira Colony Vistar, Pali.
10.	Department of Mines & Geology, near Court chauk, Udaipur.

2.1 Monitoring Site

➢ **Alwar :-** • CAAQMS is located in the premises of Rashtriya Madhymik Shikshaparisad, Opposite SMD Circle, Alwar. • The coordinates of the station are 27°33'13.6"N, 76°36'40.1"E.	
➢ **Ajmer :-** • CAAQMS is located in the premises of Sainik Vishrangarh, Todarmal Marg, Civil Lines, Ajmer. • The coordinates of the station are 26°28'21.7"N, 74°38'43.5"E.	
➢ **Bhiwadi :-** • CAAQMS is located in the premises of Water supply Complex, RIICO, Industrial Area, Bhiwadi. • The coordinates of the station are 28°11'57.3"N, 76°50'50.1"E.	
➢ **Police Commissionerate Office:-** • CAAQMS is located in the premises of Police Commissionerate Office, M.I. Road, Jaipur. • The coordinates of the station are 26°55'01.8"N, 75°48'07.3"E.	
➢ **Regional Science Park:-** • CAAQMS is located in the premises of Regional Science Park, Shastri Nagar, Jaipur. • The coordinates of the station are 26°56'24.5"N, 75°47'52.9"E.	

➢ **Psychiatric Center:-**

- CAAQMS is located in the premises of Psychiatric Center, Janta Colony, Adrash Nagar, Raja Park, Jaipur.
- The coordinates of the station are 26°54'10.5"N, 75°50'18.7"E.

➢ **Jodhpur :-**

- CAAQMS is located in the premises of Collectrate Office, Jodhpur.
- The coordinates of the station are 26°17'31.44"N, 73°2''16.49"E.

➢ **Kota :-**

- CAAQMS is located in the premises of Shreenathpuram New Stadium, Near Gad circle, Kota.
- The coordinates of the station are 25°08'38.5"N, 75°49'13.7"E.

➢ **Pali :-**

- CAAQMS is located in the premises of Bangar PG college campus, Indira Colony Vistar, Pali.
- The coordinates of the station are 25°46'15.1"N, 73°20'24.3"E.

➢ **Udaipur:-**

- CAAQMS is located in the premises of Department of Mines & Geology, near Court chauk, Udaipur.
- The coordinates of the station are at 24°35'15.6"N, 73°41'50.9"E.

2.2 Measurement Principle

The measurement of particulate matter is carried out by Environnement S.A. MP101M Analyzer which determines particulate mass concentrations in ambient air.

Working principle for measurement of PM_{10} and $PM_{2.5}$ is Beta Ray Attenuation Measurement. Due to different sampling hood size, PM10 and PM 2.5 are measured differently.

CO concentration is measured by the Environnement S.A. Model No-CO12M analyzer. The working principle of this analyzer is non-dispersive infrared absorption using gas filter correlation and optical / electronic technology.

The Oxides of Nitrogen (NO, NO_2 and NO_x) are measured by the Environnement S.A. AC32M analyzer.

The AC32M analyzer uses gas-phase chemiluminescence's detection to perform continuous analysis of nitric oxide (NO), total oxides of nitrogen (NO_x), nitrogen dioxide (NO_2) and Ammonia (NH_3) with an additional NH_3 Converter (CNH3-S2).

The principle of ESA AF22M Analyzer for the measurement of Sulfur Dioxide in ambient air is the UV fluorescent spectroscopy method.

The Analyser is based on the principle that fluorescent radiation is produced by SO_2 molecules when excited by UV radiation between 210 and 240 nm, the subsequent fluorescent emission is a linear process that is proportional to the SO_2 concentration.

Table1: Measurement Principle

S. No	Parameter	Description	Principle	Make
1	PM_{10}	Respirable Suspended Particulate Matter (RSPM) <10µm particle size	Beta Ray Attenuation	Environnement S.A.
2	$PM_{2.5}$	Respirable Suspended Particulate Matter (RSPM) <2.5µm particle size		
3	CO	Carbon Monoxide	Non Dispersive Infra Red	
4	SO_2	Sulphur Dioxide	Pulsed Fluorescence	
5	NO	Nitric Oxide	Gas Phase Chemiluminescence	
6	NO_2	Nitrogen Dioxide		
7	NO_X	Oxides of Nitrogen		
8	NH_3	Ammonia Converter		
9	O_3	Ozone	UV Photometry	
10	VOCs	Volatile Organic Compounds	Gas Chromatography	
11	AT	Ambient Temperature	Thermistor	L.S.A.
12	RH	Relative Humidity	Capacitor	
13	BP	Barometric Pressure	Pressure Transducer	
14	RG	Rain Gauge	Tipping Bucket	
15	SR	Solar Radiation	Photo Cell	
16	WS	Horizontal Wind Speed	Anemometer	
17	WD	Wind Direction	Potentiometer	

2.3 National Ambient Air Quality Standards

The ambient air quality objectives/standards are very important in framing Environment Policy. As per CPCB guidelines, the objectives of air quality standards are: -

- To indicate the levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property.
- To assist in establishing priorities for abatement and control of pollutant level; to provide uniform yardstick for assessing air quality at National level;
- To indicate the need and extent of monitoring programme;

The Central Pollution Control Board has revised Ambient Air Quality Standards from time to time. National Ambient Air Quality Standards are depicted in Table 2. These standards are based on the land use and other factors of the area. The guidelines for declaring sensitive areas as recommended by peer/core group of C.P.C.B. are as follows: Sensitive areas – sensitive area may include the following:

1) 10 kms all around the periphery of health facilities so notified by State Pollution Control Boards in consultation with Department of Public health of the concerned state.

2) 10 kms all around the periphery of Biosphere Reserves, Sanctuaries and National Parks, so notified by Ministry of Environment and Forest or concerned States.

3) 5 kms all around the periphery of an archeological monument declared to be of National importance or otherwise so notified A.S.I. in consultation with State Pollution Control Boards.

4) Areas where some delicate or sensitive to air pollution crops/important to the agriculture/horticulture of that area are grown so notified by State Pollution Control Boards in consultation with Department of Agriculture/Horticulture of concerned State.

5) 5 kms around the periphery of centers of tourism and/or pilgrim due to their religious, historical, scenic or other attractions, so notified by Department of Tourism of the concerned State with State Pollution Control Boards.

Table2: National Ambient Air Quality Standards

Pollutants	Time- weighted average	Concentration in		Method of measurement
		Industrial, Residential, Rural &other Areas	Ecologically Sensitive Areas(Notified by Central Govt.)	
PM10	Annual Average*	60 µg/m^3	60µg/m^3	Beta Attenuation Gravimetric TOEM
	24hours**	100 µg/m^3	100µg/m^3	
PM2.5	Annual Average*	40 µg/m^3	40µg/m^3	Beta Attenuation Gravimetric TOEM
	24hours**	60 µg/m^3	60µg/m^3	
Carbon Monoxide (CO)	8hours**	2.0mg/m^3	2.0mg/m^3	Non Dispersive Infra Red (NDIR)Spectroscopy
	1hour**	4.0mg/m^3	4.0 mg/m^3	
Sulfur Dioxide (SO_2)	Annual Average*	50 µg/m^3	20 µg/m^3	Ultraviolet Fluorescence
	24hours**	80 µg/m^3	80 µg/m^3	
Nitrogen Dioxide (NO_2)	Annual Average*	40µg/m^3	30 µg/m^3	Jacob &Hochheiser Modified (Na-Arsenite)Method
	24hours**	80µg/m^3	80 µg/m^3	
Ammonia(NH_3)	Annual Average*	100µg/m^3	100 µg/m^3	Jacob & Hochheiser Modified (Na-Arsenite)Method Gas Phase
	24hours**	400µg/m^3	400 µg/m^3	
Ozone(O_3)	8 hour Average*	100 µg/m^3	100 µg/m^3	UV Photometric Chemiluminescence Chemical Method
	1hours**	180 µg/m^3	180 µg/m^3	
Benzene (C_6H_6)	Annual Average*	05 µg/m^3	05 µg/m^3	Gas Chromatography based continuous analyzer
	24hours**	-	-	
*	Annual Arithmetic mean of minimum104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.			
* *	24 hourly or 8hourly or 01hourly monitored values, as applicable, shall be complied with 98% of the time in a year. However,2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

3. Results and Discussions

CAAQMS installed at different locations are continuously capturing the ambient air quality data as well as meteorological raw data on the basis of different measurement principles (Please refer para 2.2) and 15 minutes average of captured data are being displayed. Analyzers/equipments installed at all the CAAQMS are calibrated daily, weekly and fortnightly as per guidelines issued by CPCB as well as Standard Operating Procedure of the concerning analyzers to ensure proper working of the system.

The captured raw data are directly linked to the CPCB server as well as State Board's server. The captured raw data are validated at the central laboratory using different methods. On the basis of validated data, study was carried out for the period of three months from January, 2018 to March, 2018. Monthly average of the data were prepared and validated for the better understanding.

3.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

Monthly average concentrations of particulate matter viz. PM_{10} and $PM_{2.5}$ have been summarized in Table 3 and it has been presented in Graph 1 and Graph 2 for a period of three month from January to March 2018.

Higher value of PM_{10} was captured in Bhiwadi (365 µg/m3) followed by Jodhpur (295µg/m3) in the month of January in comparison to rest of the months and stations. In the month of January at CAAQMS Bhiwadi higher value of $PM_{2.5}$ (164 µg/m3) was observed followed by Jodhpur (126 µg/m3).

Monthly average of particulate matter at CAAQMS Bhiwadi and Jodhpur were found higher rather than rest of the CAAQMS in comparison to National Ambient Air Quality Standards for 24 Hrs (100 µg/m3) and Annual average (60 µg/m3), which is due to industrial impact as well as heavy vehicular movement as the CAAQMS Bhiwadi is located at RIICO Industrial area whereas CAAQMS Jodhpur is located nearby heavy traffic congested area. As per

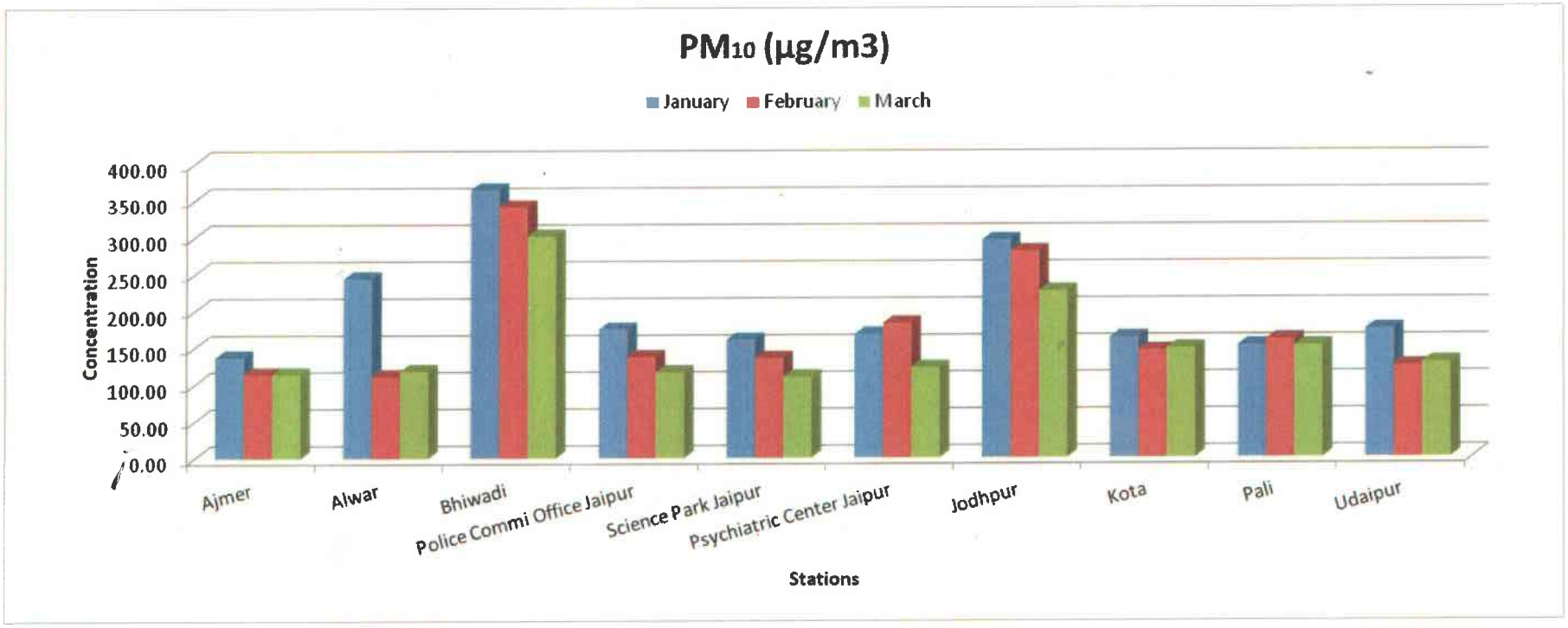
CPCB published report on *"Ambient Air Quality Data of Delhi-NCR"* high value of Particulate matter has been captured in all the CAAQMS located at Delhi. Monthly average value of PM_{10} at CAAQMS located at Noida Sec 125 and Punjabi Bag, were found 410-308-260 µg/m and 326-286-219 µg/m respectively from January to March, 2018 whereas PM2.5 was found 251-144-98 and 247-145-99 for the same location. CAAQMS located in the mixed or residential area also show high values of PM10 and PM2.5. Monthly average value of PM_{10} at CAAQMS located at Gaziabad and R. K. Puram, were found 443-321-285 µg/m and 367-281-225 µg/m respectively from January to March, 2018 whereas $PM_{2.5}$ was found 48-158-130 and 207-152-102 for the same locations.

During winters, there occurs slow dispersion of pollutants which results in more stable atmospheric conditions. These conditions favour build up of pollutants near to the source of pollution which give rise to higher concentrations.

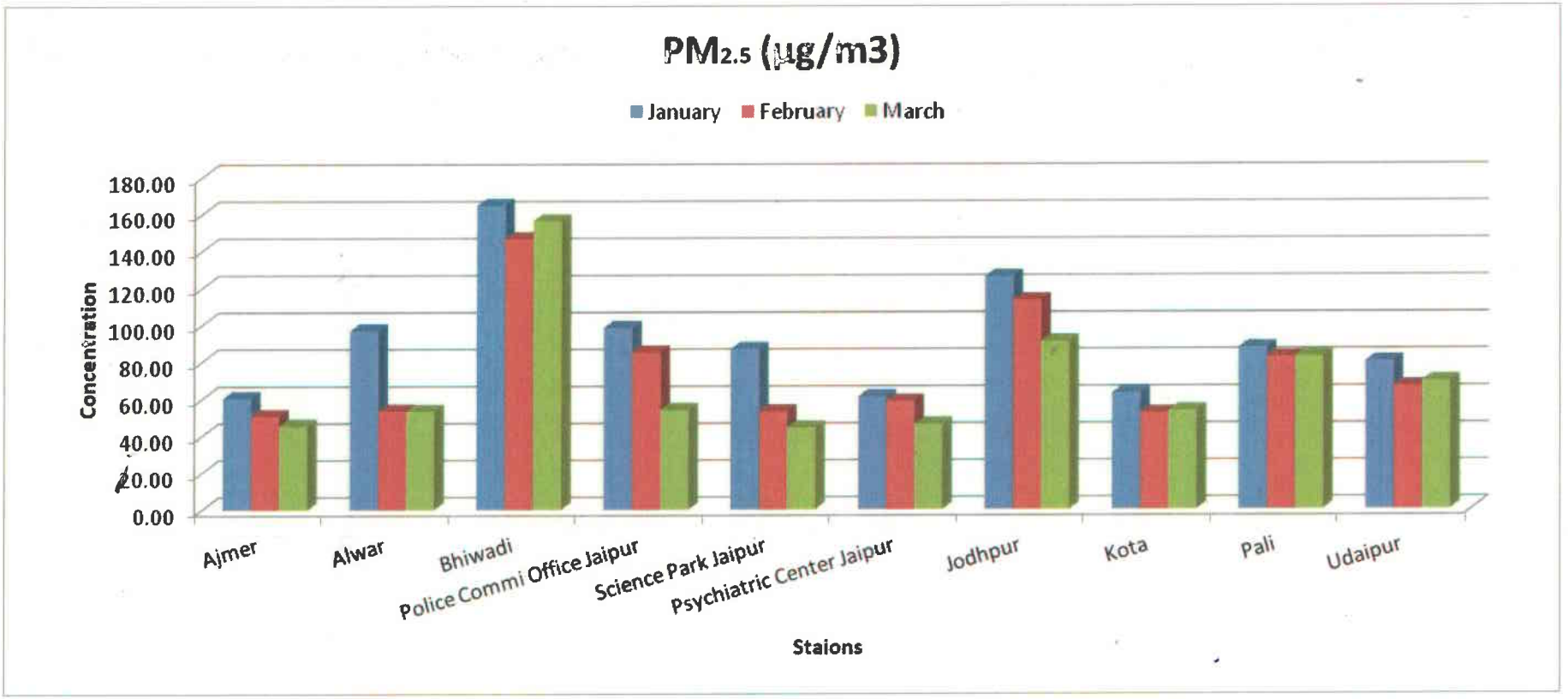
Table3: Data of Particulate Matter (PM_{10} and $PM_{2.5}$)

CAAQMS-PLACE	PM_{10}			$PM_{2.5}$		
	January 2018	February 2018	March 2018	January 2018	February 2018	March 2018
Jaipur- Police Commissioner Office	175.03	137.29	116.80	98.47	85.13	53.95
Jaipur- Psychiatric Centre	167.95	183.17	122.87	61.00	58.67	46.23
Jaipur- Regional Science Centre	160.74	135.80	110.53	86.88	53.04	44.44
Ajmer	136.99	114.19	114.24	60.37	50.64	45.41
Alwar	244.05	111.35	118.33	96.90	53.45	53.37
Bhiwadi	364.63	341.39	301.39	164.60	146.42	156.25
Jodhpur	295.62	280.60	226.93	125.96	113.31	90.92
Kota	163.44	145.63	148.54	62.90	52.20	53.48
Pali	152.05	160.80	151.94	87.49	82.28	82.68
Udaipur	174.18	124.31	128.89	79.87	66.52	69.28

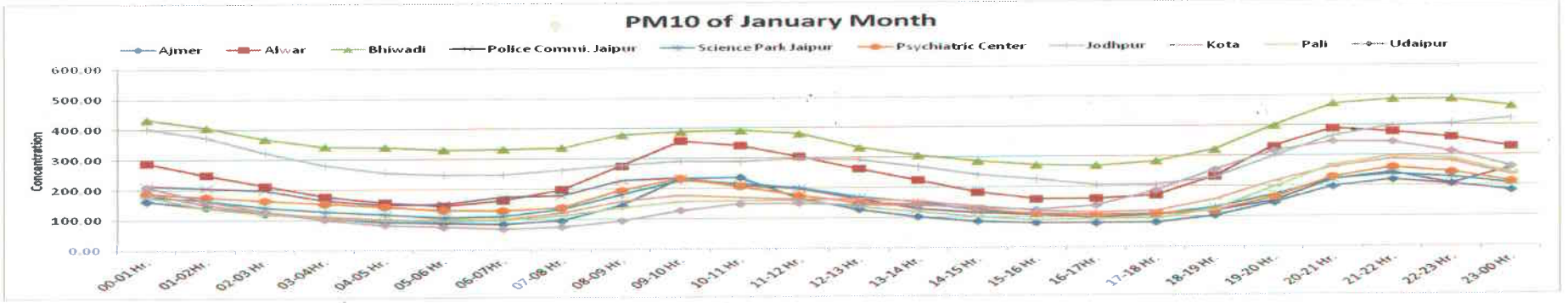
Graph 1: Concentrations of PM_{10} at various CAAQMS

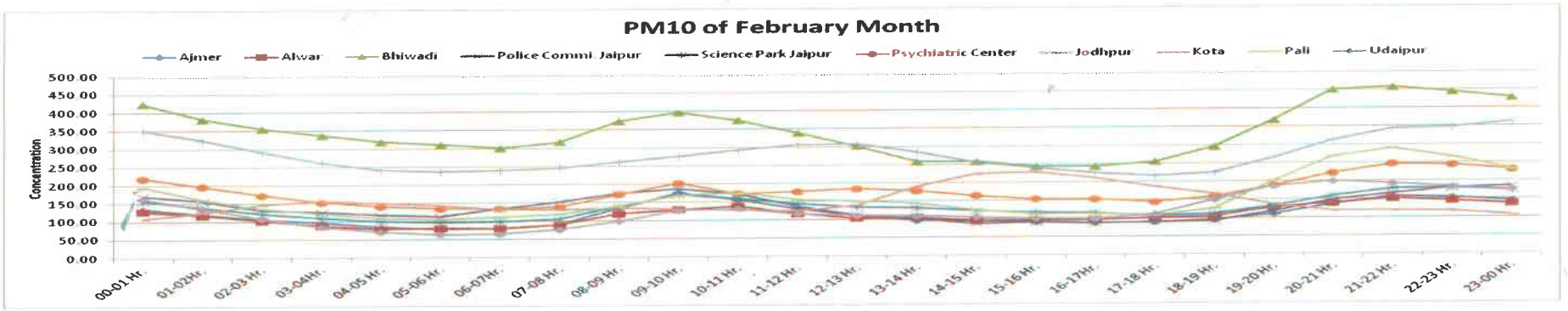


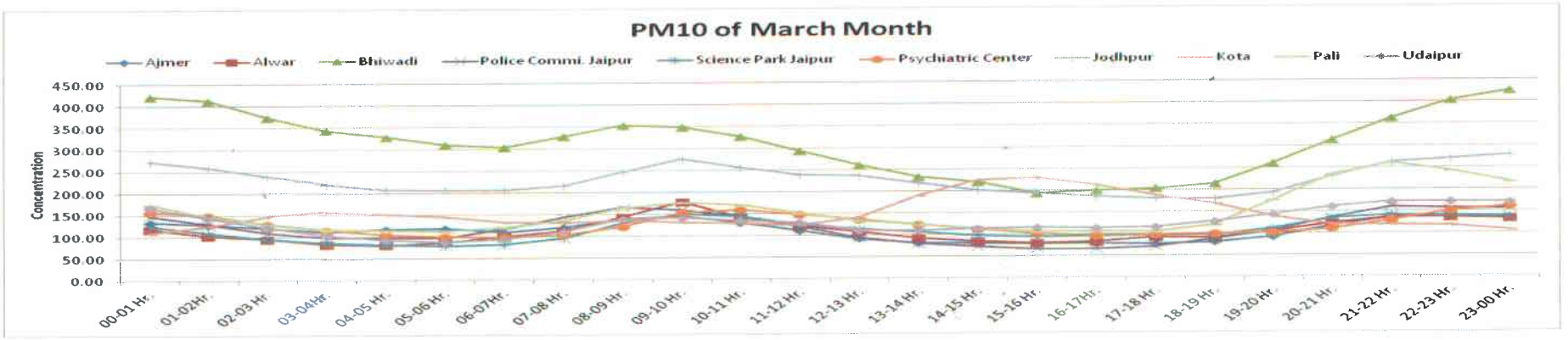
Graph 2: Concentrations of $PM_{2.5}$ at various CAAQMS



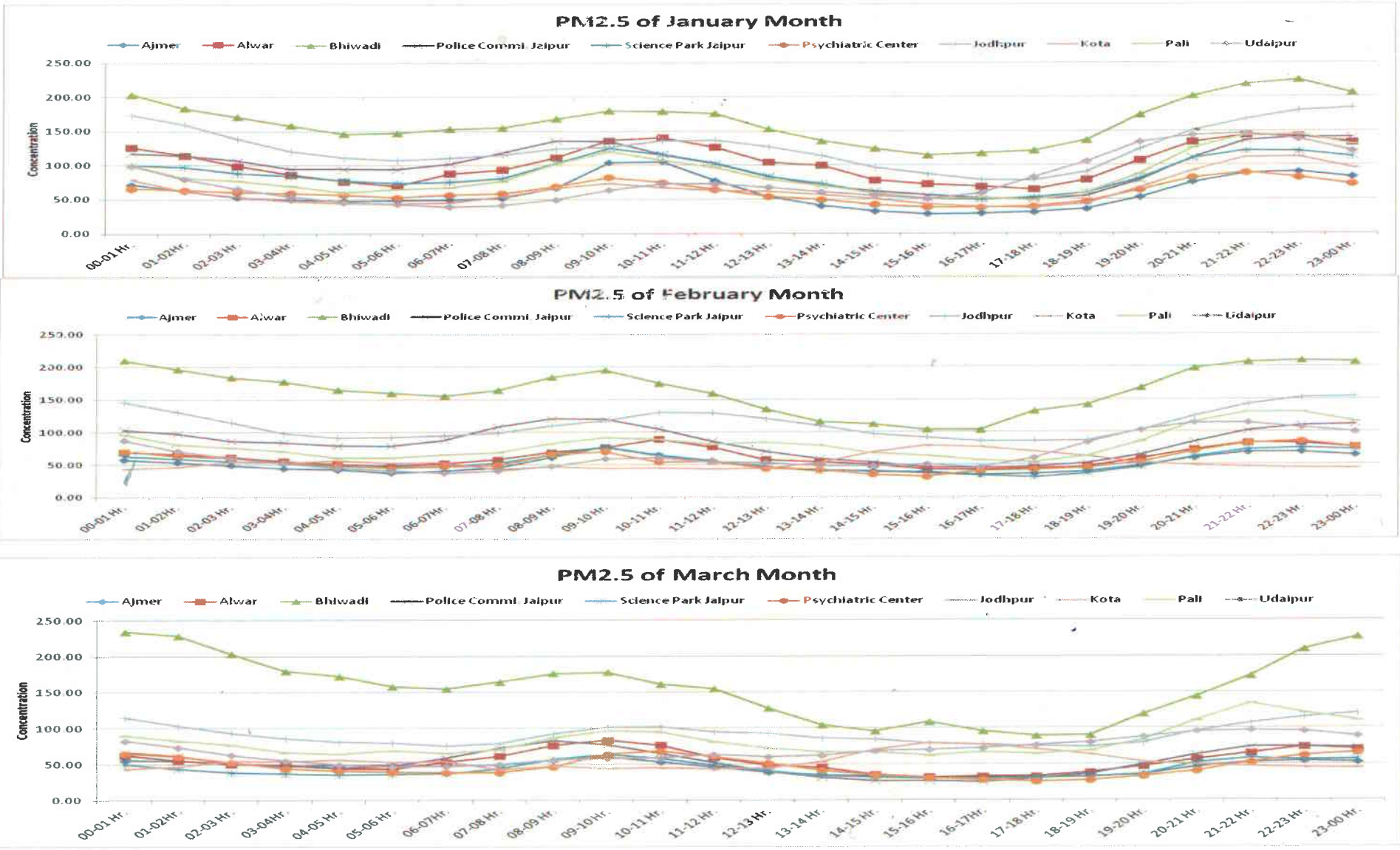
Graph 3: Diurnal Variation of PM_{10} at various CAAQMS







Graph 4: Diurnal Variation of $PM_{2.5}$ at various CAAQMS



The diurnal and daily variation graph for PM_{10} and PM $_{2.5}$ presented in Graph 3 and 4 for the month of January , February and March- 2018. During this quarter PM_{10} and $PM_{2.5}$ values very found high from early morning to noon after that it decreases and again in the evening it gradually increases upto late night. It may be due to different reason particularly traffic load

3.2 Data Analysis of Gaseous Pollutant

Monthly average concentrations of gaseous pollutants namely CO and SO_2 have been summarized in Table 4 and it has been presented in Graph 5 and 6 simultaneously for a period of three month from January to March 2018.

Table4: Data of Gaseous Pollutant (CO, SO_2)

CAAQMS	CO			SO_2		
	January 2018	Feb 2018	March 2018	January 2018	February 2018	March 2018
Jaipur- Police Commissioner Office	1.66	1.08	1.24	11.03	11.51	10.90
Jaipur- Psychiatric Centre	1.22	1.00	0.74	10.32	10.57	8.21
Jaipur- Regional Science Centre	1.16	1.02	0.80	14.62	14.44	10.46
Ajmer	1.26	0.98	0.91	9.00	9.23	8.75
Alwar	1.26	1.13	0.97	12.67	13.26	10.59
Bhiwadi	1.08	0.74	0.72	47.10	68.42	69.17
Jodhpur	1.15	1.16	1.08	8.45	9.14	6.91
Kota	0.98	0.85	0.81	14.44	20.54	20.08
Pali	0.96	0.79	0.65	14.60	16.14	16.91
Udaipur	1.66	1.30	1.20	11.23	13.03	8.05

Monthly average of CO at all the CAAQMS was observed less than hourly (4 $\mu g/m^3$)and eight hourly (2 $\mu g/m^3$) National Ambient Air Quality Standard while SO_2 was also found to be within limit of 24 hourly (80 $\mu g/m^3$) and Annually (50 $\mu g/m^3$) at all the CAAQMS except CAAQMS Bhiwadi for the month of February and March, whereas the captured value of SO_2 was observed higher than annually standard but lower than 24 hourly standards due to impact of industries and heavy vehicles.

Monthly average concentrations of gaseous pollutants namely NO_2 and NH_3 have been summarized in Table 5 and it has been presented in Graph 7 and 8 for a period of three month from January to March 2018.

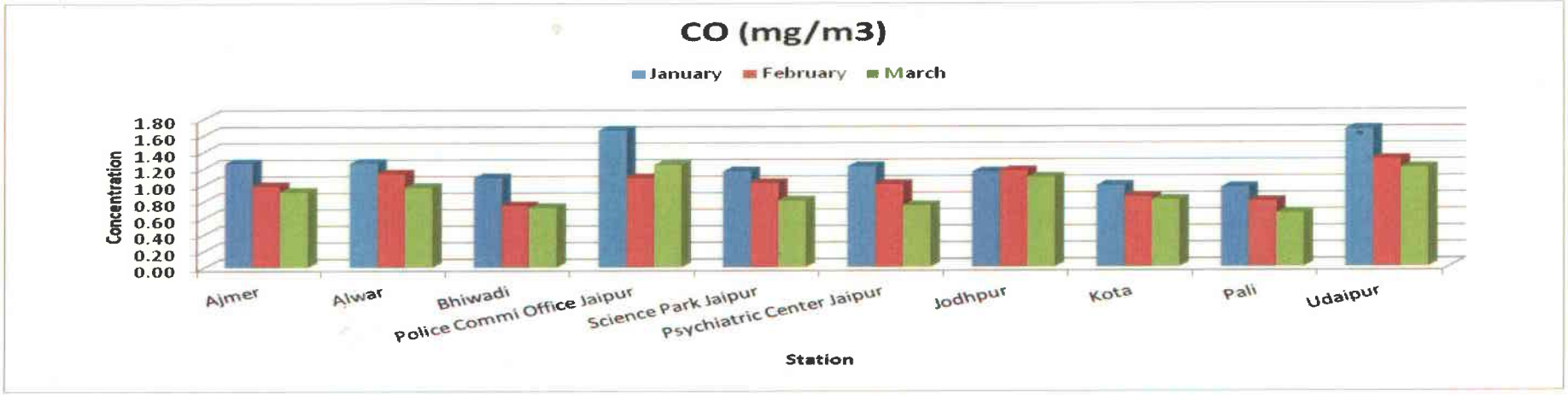
High values of NO_2 are captured in CAAQMS Bhiwadi being situated in the Industrial area. In rest of the CAAQMS stations, value are low NAAQMS.

At all the CAAQMS location NH_3 was found under limit of 24 hourly (400 µg/m3) and yearly (100 µg/m3) National Ambient Air Quality Standard while NO_2 was found less than 24 hourly (80 $\mu g/m^3$) National Ambient Air Quality Standard but at some CAAQMS it was observed higher than Annual (40 $\mu g/m^3$) National Ambient Air Quality Standard. It has also been observed that in month of March observed values were lower rather than the Annual standard except Bhiwadi where higher value is observed due to industries and heavy vehicles. At CAAQMS located at Jodhpur, Regional Science Centre and Psychiatric Centre, Jaipur observed monthly average values of NO_2 were found slightly higher than the Annual standard.

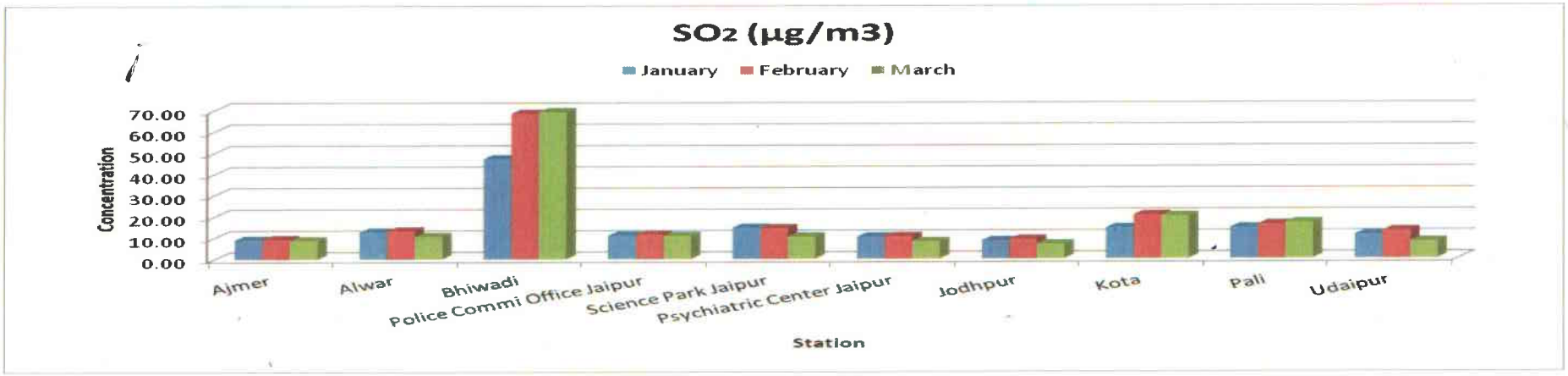
Table 5: Data of Gaseous Pollutant (NO_2, NH_3)

CAAQMS	NO2			NH_3		
	January 2018	February 2018	March 2018	January 2018	February 2018	March 2018
Jaipur- Police Commissioner Office	75.90	25.99	32.54	22.32	20.40	18.33
Jaipur- Psychiatric Centre	25.73	27.11	42.22	24.35	16.42	23.50
Jaipur- Regional Science Centre	29.54	57.42	46.33	54.33	34.14	25.42
Ajmer	42.96	22.05	35.12	39.43	26.80	31.82
Alwar	46.60	37.15	20.15	50.43	24.97	11.50
Bhiwadi	42.03	59.68	75.50	3.66	9.48	13.53
Jodhpur	35.67	58.67	45.52	10.15	14.11	26.58
Kota	25.91	18.62	18.37	13.07	4.24	4.36
Pali	27.49	16.77	11.69	24.63	17.51	25.52
Udaipur	41.65	24.59	26.78	45.60	34.34	27.03

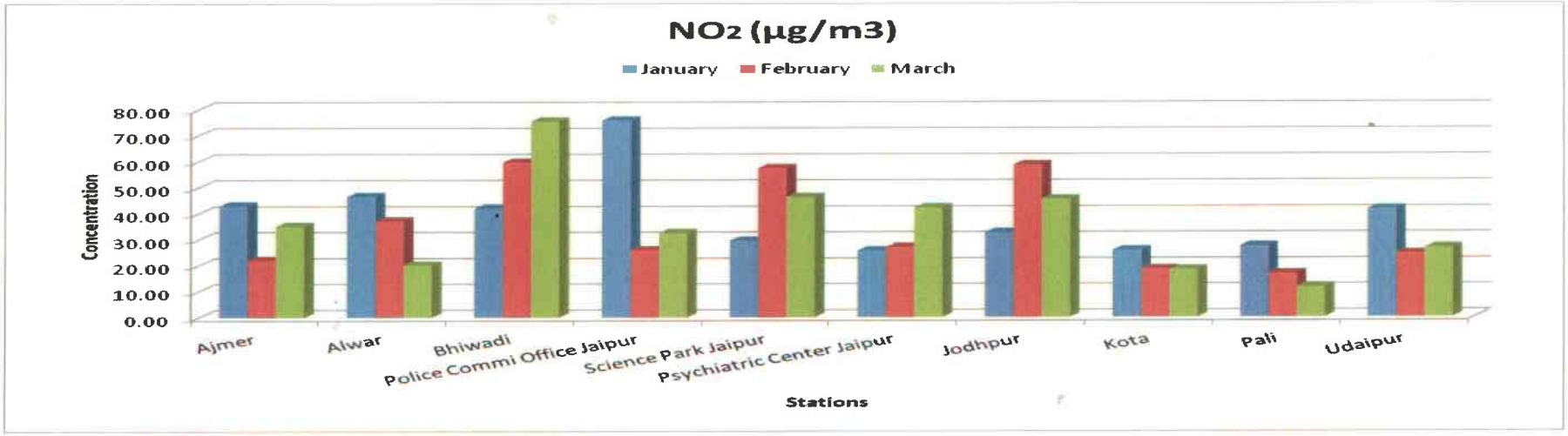
Graph 5: Concentrations of CO at various CAAQMS



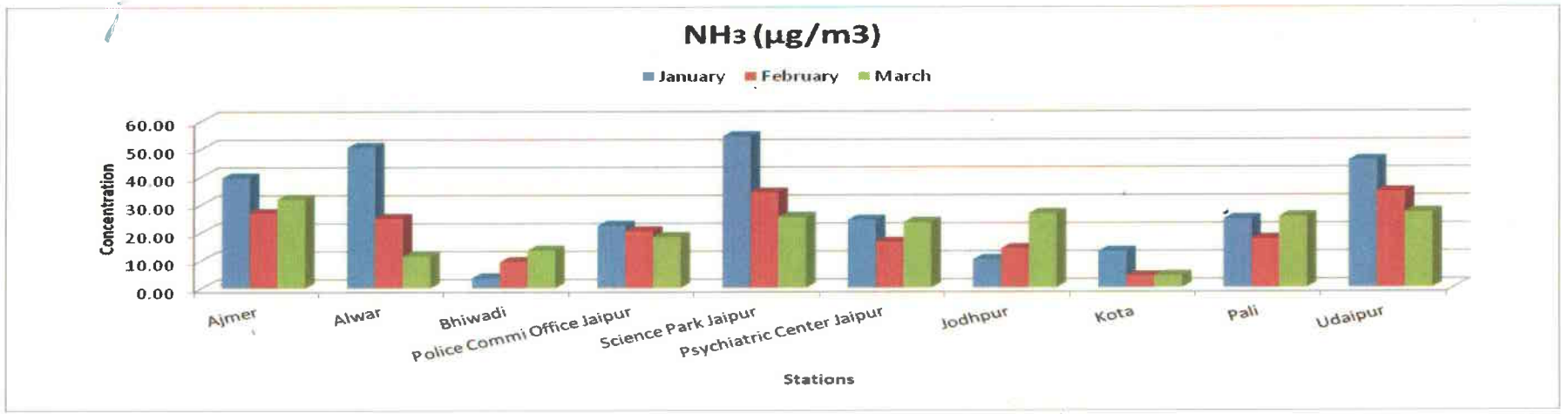
Graph 6: Concentrations of SO_2 at various CAAQMS



Graph 7: Concentrations of NO_2 at various CAAQMS



Graph 8: Concentrations of NH_3 at various CAAQMS



4. Conclusion

Monthly average of Ist Quarter of 2018 i.e. January, February and March 2018 reveals that Particulate Matter (PM_{10} and $PM_{2.5}$) is mostly above prescribed limits at all CAAQMS sites. Results of this study depict that concentration of Particulate Matter in the cities monitored in Rajasthan State is high like other cities of India during the study period. High particulate concentration is due to semi arid geographical conditions of Rajasthan, heavy transport activities in the nearby area, construction/ demolition activities, dust from paved/ unpaved roads etc. apart from industrial emissions. Generally, all pollutants are observed to be high in concentration during winters due to thermal inversions.

It may be summarised that air pollution at the CAAQMS site is primarily because of traffic and geographical condition. Traffic diversions, provision of alternate routes, restricting heavy vehicles movement through residential roads, arranging for periodic vehicle maintenance and encouraging public transport instead of private vehicles are worthy considerations to control air pollution due to transportation. In addition to above, public awareness for environment protection should be adopted and green plantation along highway and within industries should be encouraged. It may, thus be concluded that strict implementation of environmental regulations, wide public awareness for protection of environment is of utmost importance in present day scenario.

Acknowledgement

We express special thanks to Regional Officers and Scientific Staff who are engaged in the maintaining CAAQMS under the jurisdiction.

Secondly, we would also like to thank team of M/s ESA India Pvt Ltd who is operating and maintaining CAAQMS at all sites in the State of Rajasthan.