BRIEF REPORT ON
CONTINUOUS AMBIENT AIR QUALITY DATA
OF RAJASTHAN-2018

Rajasthan State Pollution Control Board

राजस्थान राज्य प्रदूषण नियंत्रण मण्डल

पर्यावरण विभाग

राजस्थान सरकार

CONTRIBUTION

Overall Guidance	Shri Sudarsan Sethi, Chairman, RSPCB Smt. Smt. Shailaja Deval, Member Secretary, RSPCB Shri K.C.A.Arun Prasad, IFS
Co-ordinator	Dr. V.K. Singhal, C.E.E., RSPCB Shri Raj Kumar Sharma, C.S.O., RSPCB Shri B. R. Chauhan
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

Air quality refers to the condition of the air within our surrounding. Local air quality affects how you live and breathe. Like the weather, it can change from day to day or even hour to hour. Air quality is determined by assessing a variety of pollution indicators. "Good" air quality pertains to the degree which the air is clean, clear and free from pollutants such as smoke, dust and smog among other gaseous impurities in the air. Good air quality is a requirement for preserving the exquisite balance of life on earth for humans, plants, animals and natural resources. The condition when pollution in the air reaches high concentrations and threatens human health, plants, animals and natural resources, that air quality may be termed as "Poor".

Air quality is not the same everywhere. Pollution can build up in isolated pockets, and local sources (an industrial plant or a busy road) can add to the overall poor air quality. Air quality can be degraded by natural or man-made sources. Natural sources include volcanic eruption, windstorm dust etc. Man-made source include pollution from moving vehicles, toxic gases from industries, burning wood or other material in open air, landfills etc. These sources can seriously affect the overall air quality and can lead to severe health problems for humans.

A network of monitoring air quality is required throughout the nation, to ascertain quality of air we breathe. Air quality monitoring helps us in better understanding the sources of air pollution, levels of different air pollutants, effects of air pollution control policy, and exposure of various substances in the air we breathe.

How good or bad is the air we breathe is known through monitoring and interpretation of data vis a vis the standards. There are two methods to monitor ambient air quality of an area namely Manual Monitoring System and Real Time monitoring System.

Ambient air quality monitoring is carried out manually using high volume samplers and respirable dust samplers with gaseous attachments, primarily to monitor PM, SO_2 and NO_2. The monitoring of pollutants is needed to be carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter). As per report of July 2018, CPCB is operating 241 manual stations in 110 cities all over the Nation. In Rajasthan, under CPCB sponsored project called NAMP, State Board has installed manual ambient air monitoring stations at 39 locations in 8 cities namely- Alwar, Bharatpur, Bhiwadi, Chittorgarh, Jaipur, Jodhpur, Kota and Udaipur.

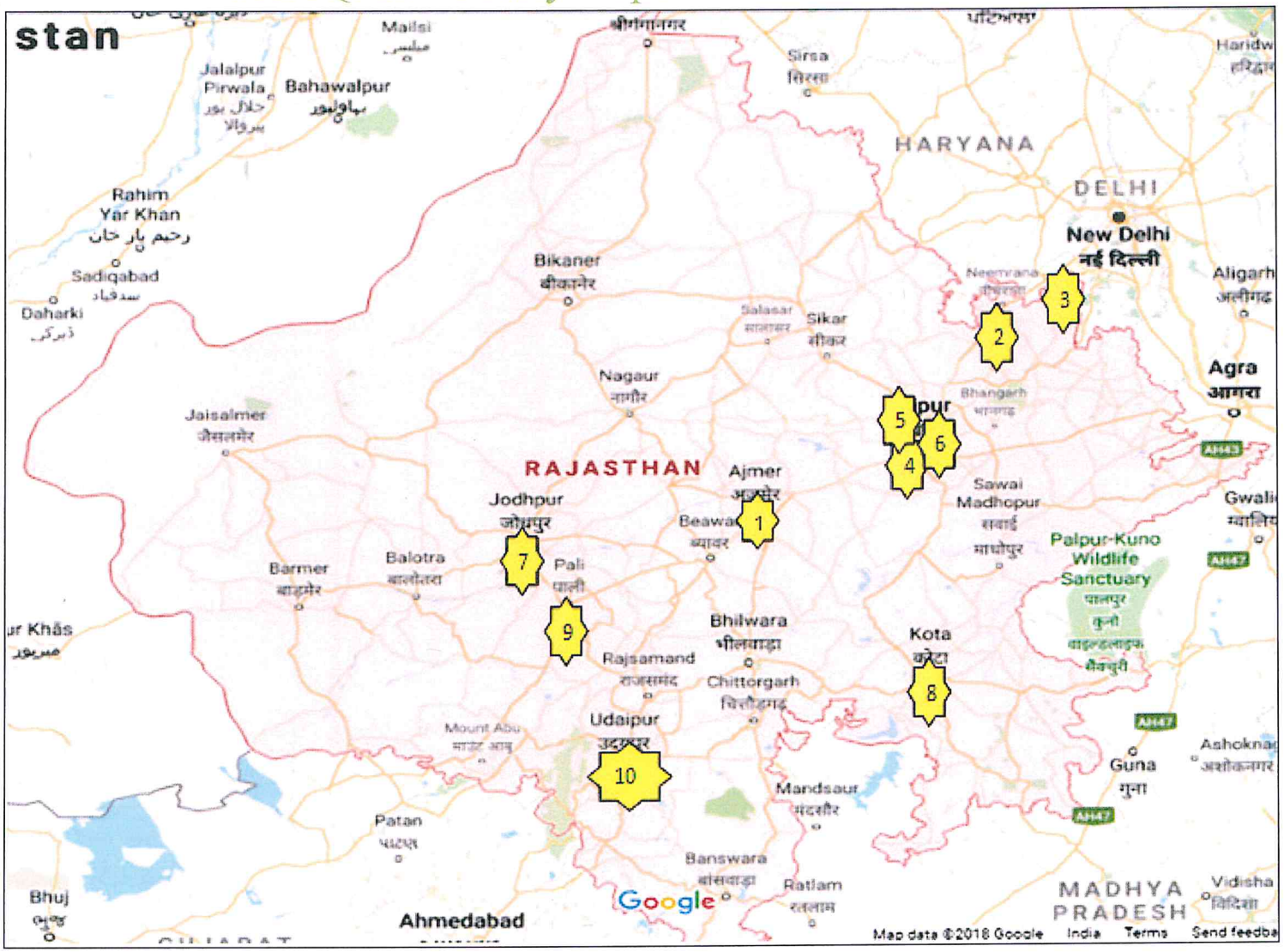
The automatic or Continuous Ambient Air Quality Monitoring Stations (CAAQMS) can monitor pollutants using different analysers, thereby, reducing the chances of manual error, generate data at time-intervals of minutes and transmit the data. CAAQMS monitors air pollutants namely- Particulate matters (PM_{10} and $PM_{2.5}$) and gaseous pollutants (NOx, SO_2, CO, VOC, O_3, NH3) along with meteorological parameters like Temperature, Relative Humidity, Wind Speed, Wind Direction, Solar Radiation etc. The data generated is disseminated online through a digital display board to public.

Presently, in order to improve the monitoring capacity, 149 CAAQMS have been set up in various states of India, which are linked with CPCB and their online monitoring data is available at website. State Board has set up 10 Continuous Ambient Air Quality Monitoring Stations in 8 cities of Rajasthan namely Ajmer, Alwar, Bhiwadi, Jaipur, Jodhpur, Kota, Pali and Udaipur.

Both methods of air quality monitoring differ in a number of ways. In Manual monitoring recorded values are indicative and there is immense time lag in reporting the data as it involve different steps in analysis of pollutants. For manual monitoring, the criteria of minimum 104 observations in a year is not met many a times and even 50 or more days of monitoring is considered adequate for annual average estimation. Power failures, instrumental failure, paucity of trained manpower are other limitations with manual monitoring

system. In contrast, Real time monitoring help to address issues related to health advisories as well as for formulation of action plan to meet standards. To ensure the quality of data, analytical quality control and for following guidelines for monitoring and calibration, proper maintenance of instruments and evaluation of ambient air quality monitoring stations play an important role.

The present report is a problem-based descriptive review in which emphasis on the annual level of pollutants has been summarized along with sources of air pollution and some feasible solutions which may be beneficial for environmental legislators and decision makers have been proposed. In the report, monitoring data from 10 Continuous Ambient Air Quality Monitoring Stations located in 08 cities of Rajasthan has been tabulated on basis of their percentage distribution within the year and graphical representations are depicted is context to AQI colour codes which are used to evaluate the Ambient Air Quality Status and related health concerns.



Location No.	Location Detail
1.	Sainik Vishrangarh, Todarmal Marg, Civil Lines, Ajmer.
2.	Rashtriya Madhymik Shikshaparisad, Opposite SMD Circle, Alwar.
3.	Water Supply Complex, RIICO Industrial Area, Bhiwadi.
4.	Police Commissioner Office, M.I. Road, Jaipur (Jaipur-1)
5.	Regional Science Park, Shastri Nagar, Jaipur. (Jaipur-2)
6.	Psychiatric Center, Janta Colony, Adrash Nagar, Raja Park, Jaipur. (Jaipur-3)
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. Measurement Principle

Table no. 2: Principle of particulate matter and gaseous pollutants

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	

3. National Ambient Air Quality Standards

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

Table no. 3: 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 (SO2)	Annual Average	50 µg/m^3	20 µg/m^3	Ultraviolet Fluorescence
	24hours	80 µg/m^3	80 µg/m^3	
Nitrogen Dioxide (NO2)	Annual Average	40µg/m^3	30 µg/m^3	Jacob &Hochheiser Modified (Na-Arsenite)Method -Gas Phase Chemiluminescence
	24hours	80µg/m^3	80 µg/m^3	
Ammonia (NH3)	Annual Average	100µg/m^3	100 µg/m^3	Jacob & Hochheiser Modified (Na-Arsenite)Method Gas Phase Chemiluminescence
	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 minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.				

Results and Discussion

4.1. Data Analysis of 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 4 and 5, it has been presented in Graph 1 and 2 for a period of twelve months from January to December, 2018.

Annual average concentration of Particulate Matter at CAAQMS, Bhiwadi reveals that in the year 2018, values of PM_{10} were found under Severe level (308.98 $\mu g/m^3$) while values of $PM_{2.5}$ were observed to range in Very Poor category (128.66 $\mu g/m^3$). During 75% of the time in the year high values of PM_{10} were observed & rest of the time the values were under poor to moderate category with reference to AQI categorisation while 25% of the time in the year high value of $PM_{2.5}$ was observed under very poor and 25% of time observed values fall under satisfactory categories.

The location of CAAQMS, Bhiwadi clearly explains the high particulate matter concentrations. Industrial emissions, heavy vehicle movement are major contributions to air pollution of the area.

Similar trends of particulate matter values were observed at CAAQMS, Jodhpur. During 2018, approx 8% of the time in year PM_{10} values ranged within both severe level and very poor range, very poor range of PM10 was found in 41.67% of the time in the year while satisfactory conditions were observed during 25% of the time in the year. In contrast to Bhiwadi and Jodhpur observed values of PM_{10} ranges within satisfactory category for approx 92% of the time in the year at CAAQMS Alwar while observed values of $PM_{2.5}$ ranges with Good Categories for approx 92% of time in the year at Regional Science Park, Jaipur (Jaipur-2).

At all other CAAQMS excluding Bhiwadi & Jodhpur, values of Particulate Matter were within range from Moderate to Satisfactory during the entire year.

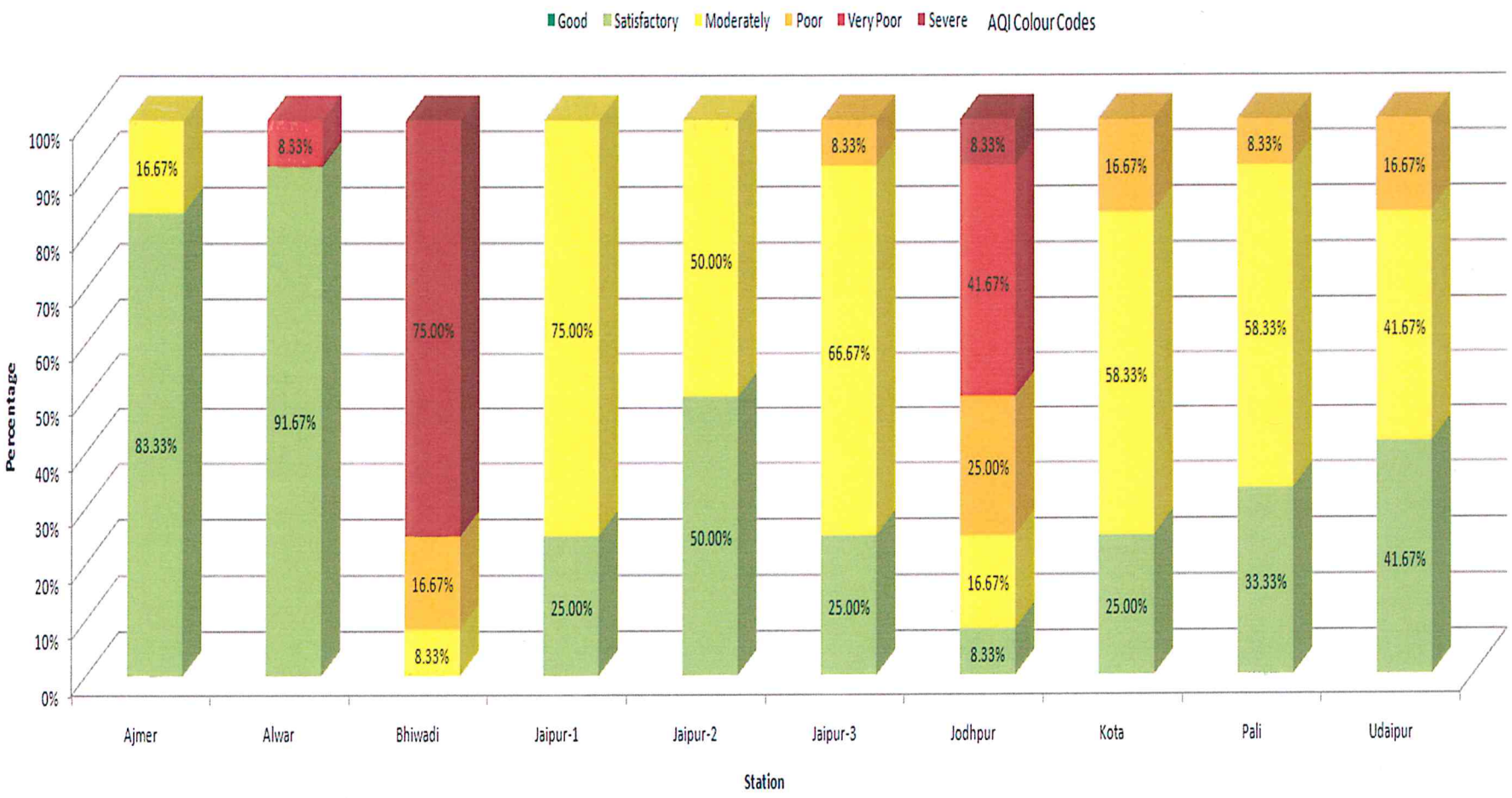
Table no. 4: Monthly average concentration of Particulate Matter (PM_{10})

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	136.99	114.19	114.24	104.61	100.63	94.84	87.13	80.08	68.77	119.28	137.39	118.51	**106.39**
Alwar	244.05	111.35	118.33	76.05	90.43	93.47	89.80	91.09	63.93	89.00	105.00	98.00	**105.87**
Bhiwadi	364.63	341.39	301.39	347.88	363.86	319.59	182.89	180.10	201.24	348.43	384.50	371.86	**308.98**
Jaipur-1	175.03	137.29	116.80	142.63	152.50	147.63	100.32	110.26	122.67	174.33	178.92	133.16	**140.96**
Jaipur-2	160.74	135.80	110.53	156.47	175.48	177.52	90.05	101.72	72.88	81.89	137.24	114.59	**126.24**
Jaipur-3	167.95	183.17	122.87	154.27	179.99	174.23	101.86	90.85	89.11	148.10	155.94	122.03	**140.86**
Jodhpur	295.62	280.60	226.93	279.42	314.31	266.43	137.60	133.28	115.62	197.79	255.25	209.74	**226.05**
Kota	163.44	145.60	148.54	163.77	194.50	145.97	117.69	85.65	72.61	138.87	188.76	154.31	**143.31**
Pali	152.05	160.80	151.94	116.11	222.96	148.02	109.73	117.95	88.26	142.40	158.27	136.44	**142.08**
Udaipur	174.18	124.31	128.89	192.67	167.26	104.44	116.05	87.42	70.64	110.25	201.25	179.63	**138.08**

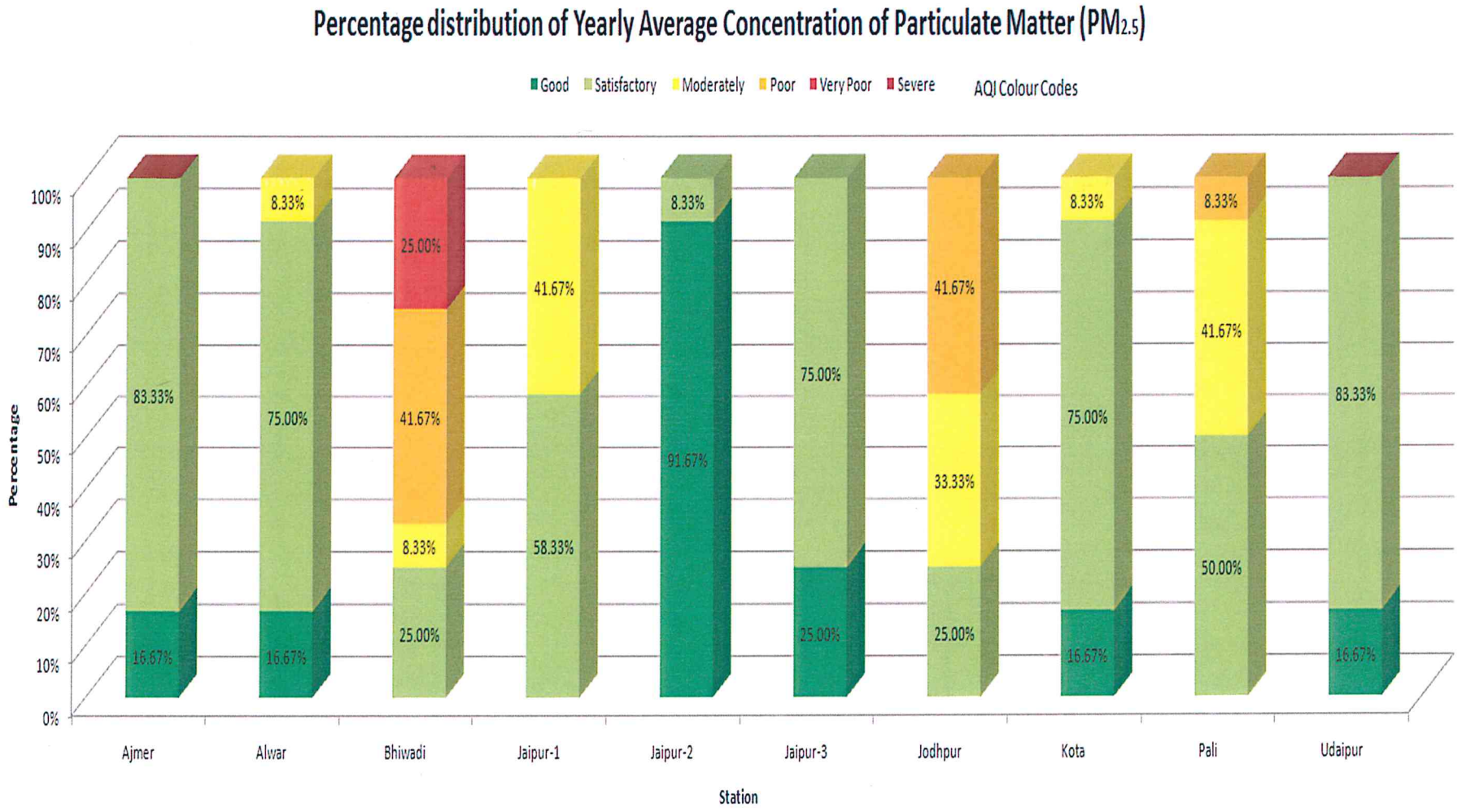
Table no. 5: Monthly average concentration of Particulate Matter ($PM_{2.5}$)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	60.37	50.64	45.41	45.88	51.83	44.89	41.66	37.84	34.21	55.51	69.39	58.05	**49.64**
Alwar	96.90	53.45	53.37	40.51	48.61	46.18	46.38	49.30	32.27	42.00	47.00	55.00	**50.91**
Bhiwadi	164.60	146.42	156.25	152.30	146.58	108.35	66.99	63.81	68.10	127.69	163.48	179.39	**128.66**
Jaipur-1	98.47	85.13	53.95	63.31	79.14	65.10	46.91	54.87	53.23	89.42	101.14	83.69	**72.86**
Jaipur-2	86.88	53.04	44.44	53.98	56.95	63.94	38.90	43.87	37.20	50.66	64.17	60.88	**54.58**
Jaipur-3	61.00	58.67	46.23	50.99	57.50	62.21	39.47	32.28	31.28	49.38	56.71	44.25	**49.16**
Jodhpur	125.96	113.31	90.92	128.70	146.94	122.20	59.74	59.97	61.90	110.12	135.32	111.35	**105.54**
Kota	62.90	52.50	53.20	62.89	78.32	60.42	54.97	39.68	30.37	55.10	85.74	73.86	**59.14**
Pali	87.49	82.28	82.68	57.78	120.84	84.87	49.01	54.17	41.76	65.20	89.09	71.03	**73.85**
Udaipur	79.87	66.52	69.28	64.21	66.19	49.78	41.97	36.02	30.23	41.54	76.25	65.88	**57.31**

Graph:1 Percentage Distribution of Yearly Average Concentration of PM_{10}



Graph:2 Percentage Distribution of Yearly Average Concentration of $PM_{2.5}$



4.2 Data Analysis of Gaseous Pollutants (NH_3, NO_2, CO & SO_2):

Annual average concentrations of gaseous pollutants namely NH_3, NO_2, CO and SO_2 have been summarized in Table 6, 7, 8 & 9 respectively and presented in Graph 3, 4, 5 & 6 for a period of year, 2018.

At all the CAAQMS, NH_3 was found under yearly limit (100 $\mu g/m^3$) of National Ambient Air Quality Standard while NO_2 was found less than Annual Standard (40 µg/m3) of National Ambient Air Quality Standard at all the CAAQMS except Bhiwadi. In Bhiwadi, annual average of NO_2 was observed (48.59 $\mu g/m^3$) which is slightly higher than the annual standard due to its location in the Industrial area.

Monthly average of CO at all the CAAQMS was observed less than hourly (4 $\mu g/m^3$) and eight hourly standard (2$\mu g/m^3$) of National Ambient Air Quality Standard.

Annual Standard of SO_2 was found to be within limit (50 $\mu g/m^3$) at all the CAAQMS.

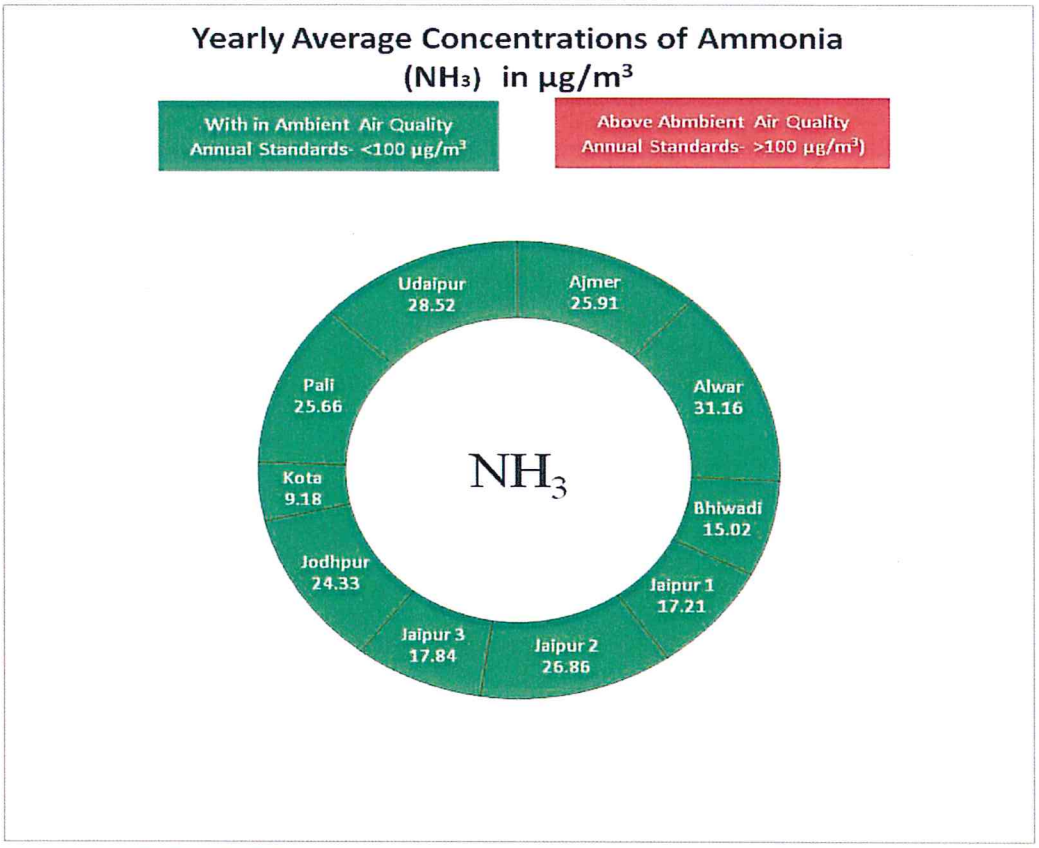
Table no. 6: Monthly average concentration of Ammonia (NH_3)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	39.43	26.80	31.82	27.99	22.03	27.55	19.33	11.58	11.91	23.52	35.00	33.98	**25.91**
Alwar	50.43	24.97	11.50	16.92	43.13	32.22	26.77	30.94	27.60	43.49	33.62	32.28	**31.16**
Bhiwadi	3.66	9.48	13.53	15.40	15.68	13.74	19.60	14.33	9.93	12.94	24.72	27.22	**15.02**
Jaipur-1	22.32	20.40	18.33	24.51	15.97	11.58	21.07	12.27	13.60	15.66	13.99	16.76	**17.21**
Jaipur-2	54.33	34.14	25.42	30.68	24.87	28.05	11.78	8.66	23.04	34.87	15.33	31.17	**26.86**
Jaipur-3	24.35	16.42	23.50	17.22	13.84	15.85	13.19	15.61	15.84	17.96	23.10	17.16	**17.84**
Jodhpur	10.15	14.11	26.58	24.41	23.65	18.15	13.62	12.14	12.50	30.67	38.17	67.85	**24.33**
Kota	13.07	4.24	4.36	6.85	3.56	10.45	10.33	7.97	9.88	9.12	10.15	20.22	**9.18**
Pali	24.63	17.51	25.52	20.87	23.24	19.78	27.70	26.36	22.17	21.89	45.61	32.65	**25.66**
Udaipur	45.60	34.34	27.03	18.10	13.11	21.88	40.77	47.07	18.50	22.82	25.55	27.47	**28.52**

Table no. 7: Monthly average concentration of Nitrogen Dioxide (NO_2)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	42.96	22.05	35.12	27.47	23.44	17.16	14.52	16.95	20.04	34.54	48.08	46.72	**29.09**
Alwar	46.60	37.15	20.15	27.33	29.28	18.56	20.71	25.33	20.18	40.34	72.06	71.96	**35.80**
Bhiwadi	42.03	59.68	75.50	81.98	79.49	24.88	33.10	20.21	19.77	31.21	57.14	54.49	**48.29**
Jaipur-1	75.90	25.99	32.54	44.33	40.03	22.69	42.18	19.56	20.24	46.87	53.49	59.09	**40.24**
Jaipur-2	29.54	57.42	46.33	39.34	28.49	18.23	16.08	13.83	14.09	32.73	39.77	26.46	**30.19**
Jaipur-3	25.73	27.11	42.22	31.07	28.92	20.37	19.46	31.49	34.11	35.14	40.58	40.62	**31.32**
Jodhpur	35.67	58.67	45.52	38.02	23.92	23.20	16.18	22.29	24.46	41.35	42.39	38.93	**34.22**
Kota	25.91	18.62	18.37	9.26	9.12	10.30	24.41	21.02	20.28	33.33	22.96	36.53	**20.84**
Pali	27.49	16.77	11.69	4.49	14.51	16.79	26.61	12.61	22.40	27.00	48.86	16.86	**20.51**
Udaipur	41.65	24.59	26.78	20.16	25.25	27.29	17.87	18.80	20.17	30.44	23.63	33.38	**25.83**

Graph: 3 Yearly Average Concentrations of NH_3



Graph: 4 Yearly Average Concentrations of NO_2

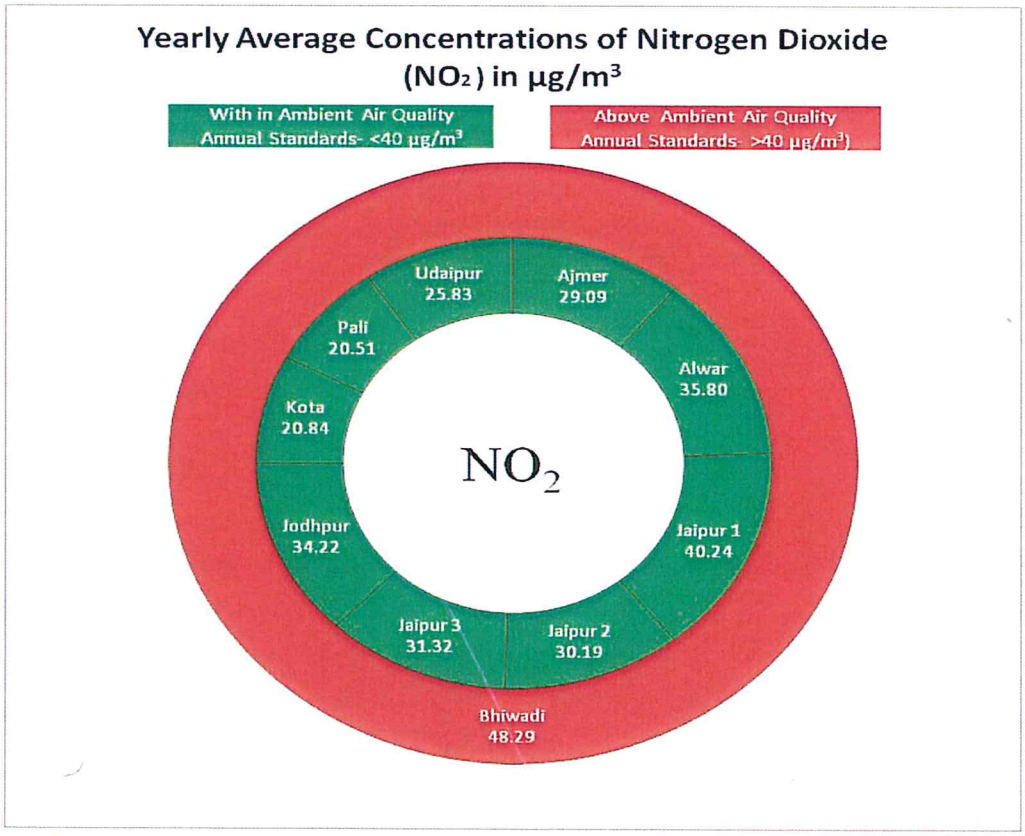


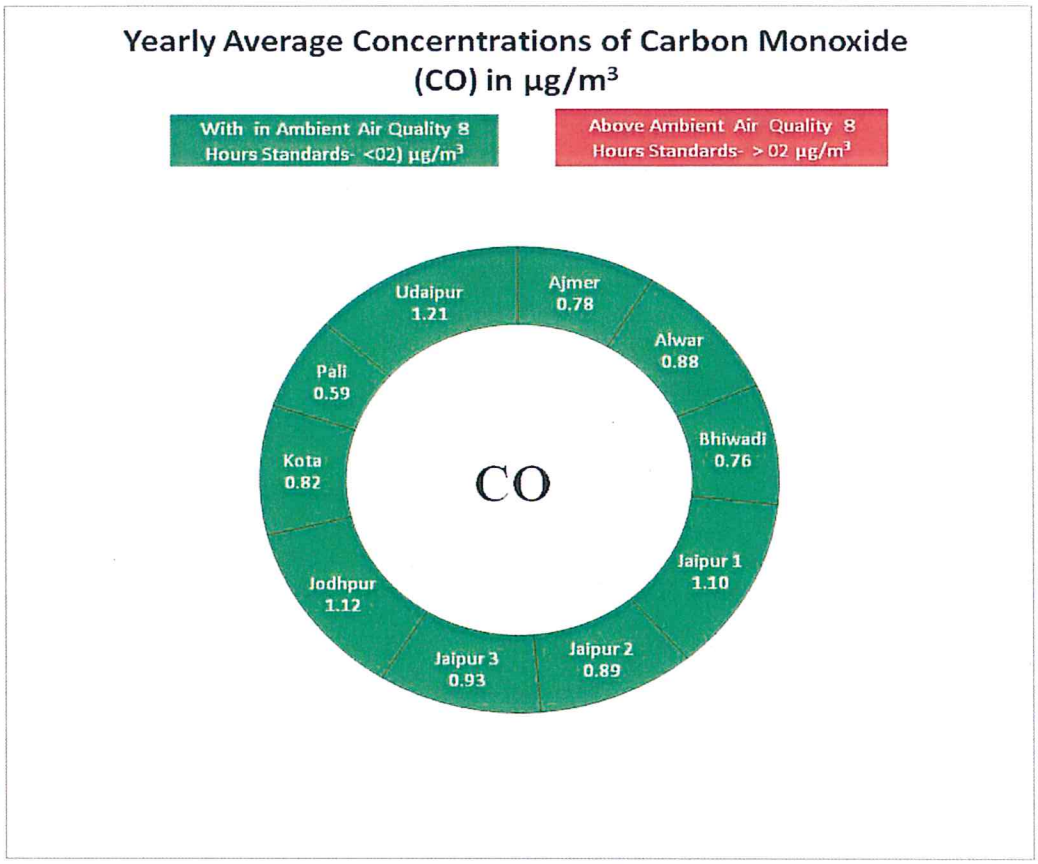
Table no. 8: Monthly average concentration of Carbon Monoxide (CO)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	1.26	0.98	0.91	0.70	0.55	0.48	0.49	0.48	0.55	1.02	0.88	1.07	**0.78**
Alwar	1.26	1.26	0.97	0.93	0.80	0.72	0.65	0.67	0.53	0.79	1.00	1.02	**0.88**
Bhiwadi	1.08	0.74	0.72	0.67	0.64	0.51	0.70	0.72	0.70	0.88	0.84	0.88	**0.76**
Jaipur-1	1.66	1.08	1.24	1.16	1.17	0.76	0.60	0.86	0.99	1.13	1.40	1.21	**1.10**
Jaipur-2	1.16	1.02	0.80	0.62	0.57	0.55	0.60	0.56	0.75	1.25	1.44	1.35	**0.89**
Jaipur-3	1.22	1.00	0.74	0.69	0.84	0.67	0.74	0.72	0.86	1.01	1.42	1.24	**0.93**
Jodhpur	1.15	1.16	1.08	0.87	0.94	0.91	0.99	1.20	0.95	1.22	1.48	1.44	**1.12**
Kota	0.98	0.85	0.81	0.71	0.64	0.63	0.69	0.79	0.82	0.92	1.06	0.90	**0.82**
Pali	0.96	0.79	0.65	0.17	0.48	0.40	0.29	0.26	0.46	0.67	0.95	0.95	**0.59**
Udaipur	1.66	1.30	1.20	1.01	1.16	0.93	0.85	0.73	1.05	1.34	1.66	1.65	**1.21**

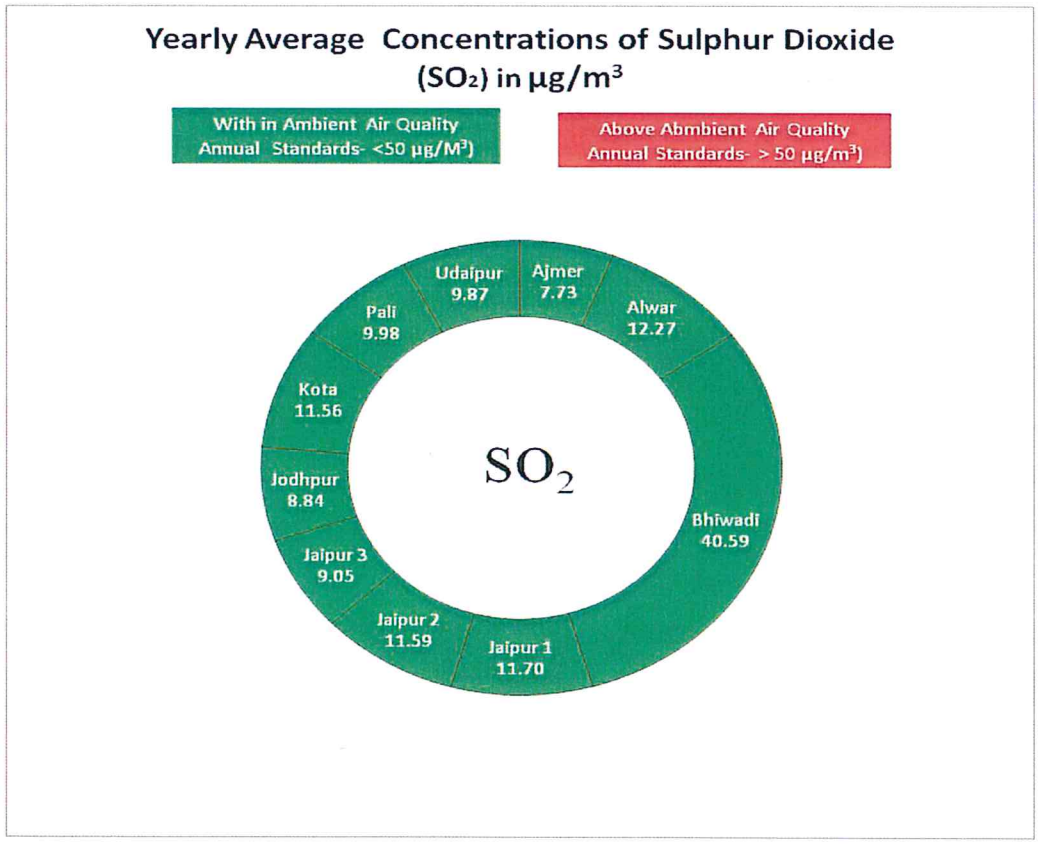
Table no. 9: Monthly average concentration of Sulphur Dioxide (SO_2)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	9.00	9.23	8.75	8.64	8.63	5.38	4.89	6.63	6.25	8.61	7.75	9.26	**7.73**
Alwar	12.67	13.26	10.59	12.35	11.40	11.07	17.06	12.19	6.73	8.41	15.24	16.22	**12.27**
Bhiwadi	47.10	68.42	69.17	65.57	50.75	26.24	19.48	16.90	14.32	38.80	36.71	33.57	**40.59**
Jaipur-1	11.03	11.51	10.90	13.53	10.48	10.10	10.61	12.07	10.03	10.60	10.74	18.85	**11.70**
Jaipur-2	14.62	14.44	10.46	5.20	10.45	12.71	10.59	8.93	12.54	12.65	13.53	12.94	**11.59**
Jaipur-3	10.32	10.57	8.21	8.35	9.43	6.56	8.24	8.78	9.50	9.50	11.10	8.00	**9.05**
Jodhpur	8.45	9.14	6.91	6.95	7.32	6.44	7.03	8.88	8.41	9.25	14.64	12.68	**8.84**
Kota	14.44	20.54	20.08	11.44	9.54	4.32	9.28	8.15	8.85	9.91	12.21	9.90	**11.56**
Pali	14.44	20.54	20.08	2.78	12.85	11.28	5.74	3.58	3.38	6.24	10.12	8.74	**9.98**
Udaipur	11.23	13.03	8.05	8.15	12.39	14.17	8.60	8.48	5.54	6.52	11.47	10.75	**9.87**

Graph: 5 Yearly Average Concentrations of CO



Graph:6 Yearly Average Concentrations of SO_2



5. Ambient air quality and human health

Air pollutants can lead to health problems either directly when they enter an organism or indirectly by the modification of the environment. Numerous studies have found an association between air pollution and several adverse health effects in the population. Pollutants with the strongest evidence for public health concern mainly include particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2).

Particulate matter (PM) is made up of small airborne particles like dust, soot, and drops of liquids. The majority of PM in urban areas is formed directly from burning of fossil fuels plants, automobiles, non-road equipment, and industrial facilities. Other sources are dust and diesel emissions and secondary particle formation from gases and vapors. Coarse particulate matter (PM_{10}, particles < 10 microns in diameter) is known to cause nasal and upper respiratory tract health problems. Fine particles ($PM_{2.5}$, particles < 2.5 microns in diameter; Ultra Fine Particles) penetrate deeper into the lungs and cause heart attacks, strokes, asthma, and bronchitis, as well as premature death from heart ailments, lung disease, and cancer. Studies show that higher $PM_{2.5}$ exposure can impair brain development in children.

The health impacts of particulate matter depend on the level of exposure and the duration of exposure (short-term, between 8 or 24 hours, or long-term). Individual sensitivity to the health impacts of particulate matter can vary and depend upon age, health status, socioeconomic status, occupational exposures and habits of the person etc.

Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain. Very high levels of CO are not likely to occur outdoors, while high levels, which are possible indoors or in other enclosed environments, can cause dizziness, confusion, unconsciousness and death.

Nitrogen oxide (NO) and Nitrogen dioxide (NO_2) are produced primarily by the burning of fossil fuel in transportation sector. NO is rapidly converted to NO_2 in sunlight. NOx (a combination of NO and NO_2) is formed in high concentrations around roadways, and can result in development and exacerbations of asthma, bronchitis, as well as lead to a higher risk of heart disease.

SO_2 is emitted into the air by the burning of fossil fuels that contain sulphur. Sulphur dioxide causes eye irritation, worsens asthma, increases susceptibility to respiratory infections, and impacts the cardiovascular system.

AQI Colour Codes	Related Heath Concerns
Good (0-50)	Minimal Impact
Satisfactory (51-100)	Minor breathing discomfort to sensitive people
Moderate (101-200)	Breathing discomfort to the people with lung, heart disease, children and older adults
Poor (201-300)	Breathing discomfort to people on prolonged exposure
Very Poor (301-400)	Respiratory illness to the people on prolonged exposure
Severe (>400)	Respiratory effects even on healthy people

6. Conclusion

Rajasthan lies in the arid and semi-arid agro-climatic zone of the country and hence presence of dust due to dry climatic conditions coupled with strong hot air movement is common.

Presence of Particulate Matter in the atmosphere goes particularly high during summer months and during winters when the phenomenon of thermal inversion occurs. Yearly average from January to December, 2018 reveals that both the particulate pollutants, PM_{10} and $PM_{2.5}$ are mostly above permissible limits at all CAAQMS sites. Result of the study for Rajasthan is similar with research for other cities of India as the concentration of particulate matter is also high in other

cities. High particulate concentration is due to heavy transport activity in CAAQMS area, apart from industrial emissions, dust from paved roads, use of conventional fuels like wood, cow dung etc for domestic purposes.

Generally all pollutants are observed to be high in concentration during winters due to slow dispersion and dilution of pollutants. Gaseous pollutants namely SO_2, CO and NH_3 were observed within the prescribed limit of National Ambient Air Quality Standard, 2009. NO_2 was also found less than Annual Standard concentration ($40\mu g/m^3$) of National Ambient Air Quality Standard at all the CAAQMS except Bhiwadi where annual average was observed 48.59 $\mu g/m^3$ which is slightly higher than the annual standard due to industrial activities and traffic movement in the surrounding area.

It can be summarised that air pollution at the CAAQMS is primarily because of traffic. 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 and green plantation along highway and within industries are worthy considerations to control air pollution due to transportation. In addition to above, public awareness for environment protection and health concerns related to air pollution and air borne diseases should be created and promoted.

Acknowledgement

We would like to express special thanks of gratitude to Regional officers and Scientific Staff who are engaged in the maintaining CAAQMS under the jurisdiction.

We would also like to thank team of M/s ESA India Pvt Ltd who are doing well for successful working of CAAQMS at all sites. We are also thankful to Shri Suresh Chand Aloria for his contribution in the formulation of the report.