BRIEF REPORT ON CONTINUOUS AMBIENT AIR QUALITY DATA OF RAJASTHAN-2019

Rajasthan State Pollution Control Board
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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.

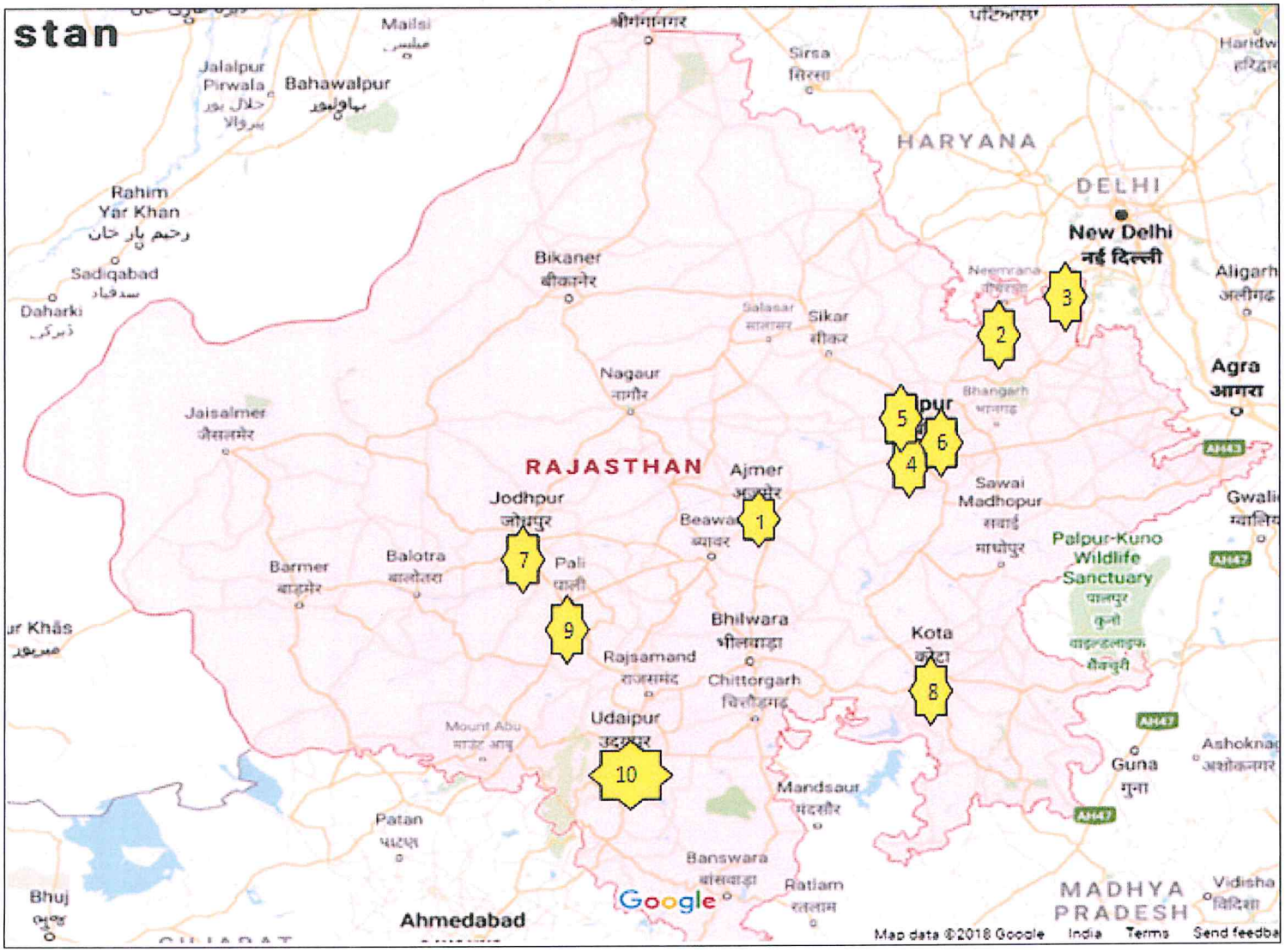
The automatic or Continuous Ambient Air Quality Monitoring Stations (CAAQMS) can monitor pollutants using different analysers, thereby, reducing the chances of manual error, generate data at time-intervals of minutes and transmit the data. CAAQMS monitors air pollutants namely- Particulate matters (PM_{10} 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 (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 -Gas Phase Chemiluminescence
	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 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 to 4 for a period of twelve months from January to December, 2019.

Annual average concentration of Particulate Matter at CAAQMS, Bhiwadi reveals that in the year 2019, values of PM_{10} were found under Poor category (217.12 $\mu g/m^3$) while values of $PM_{2.5}$ were observed to range in Moderate category (103.84 $\mu g/m^3$). During 41.67% of the time in the year high values of PM_{10} were observed & rest of the time the values were under poor to satisfactory category with reference to AQI categorisation while 41.67% of the time in the year high value of $PM_{2.5}$ was observed under moderate and 25 % of time observed values fall under satisfactory and poor categories.

At rest of the locations most of time level of PM_{10} & $PM_{2.5}$ were observed Moderate to Satisfactory category with reference to AQI value.

Highest value of Yearly Average data of PM_{10} was captured at CAAQMS Bhiwadi (217.12 $\mu g/m^3$) followed by Jodhpur (170.92 $\mu g/m^3$) and Lowest value of Yearly Average data of PM_{10} was captured in Alwar (93.59 $\mu g/m^3$).

Highest value of Yearly Average data of $PM_{2.5}$ was captured in CAAQMS Bhiwadi (103.84 $\mu g/m^3$) followed by Jodhpur (80.00 $\mu g/m^3$) and Lowest value of Yearly Average data of $PM_{2.5}$ was captured at Jaipur-3 (36.80 $\mu g/m^3$).

Yearly Average data 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 Annual average (60 $\mu g/m^3$), 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.

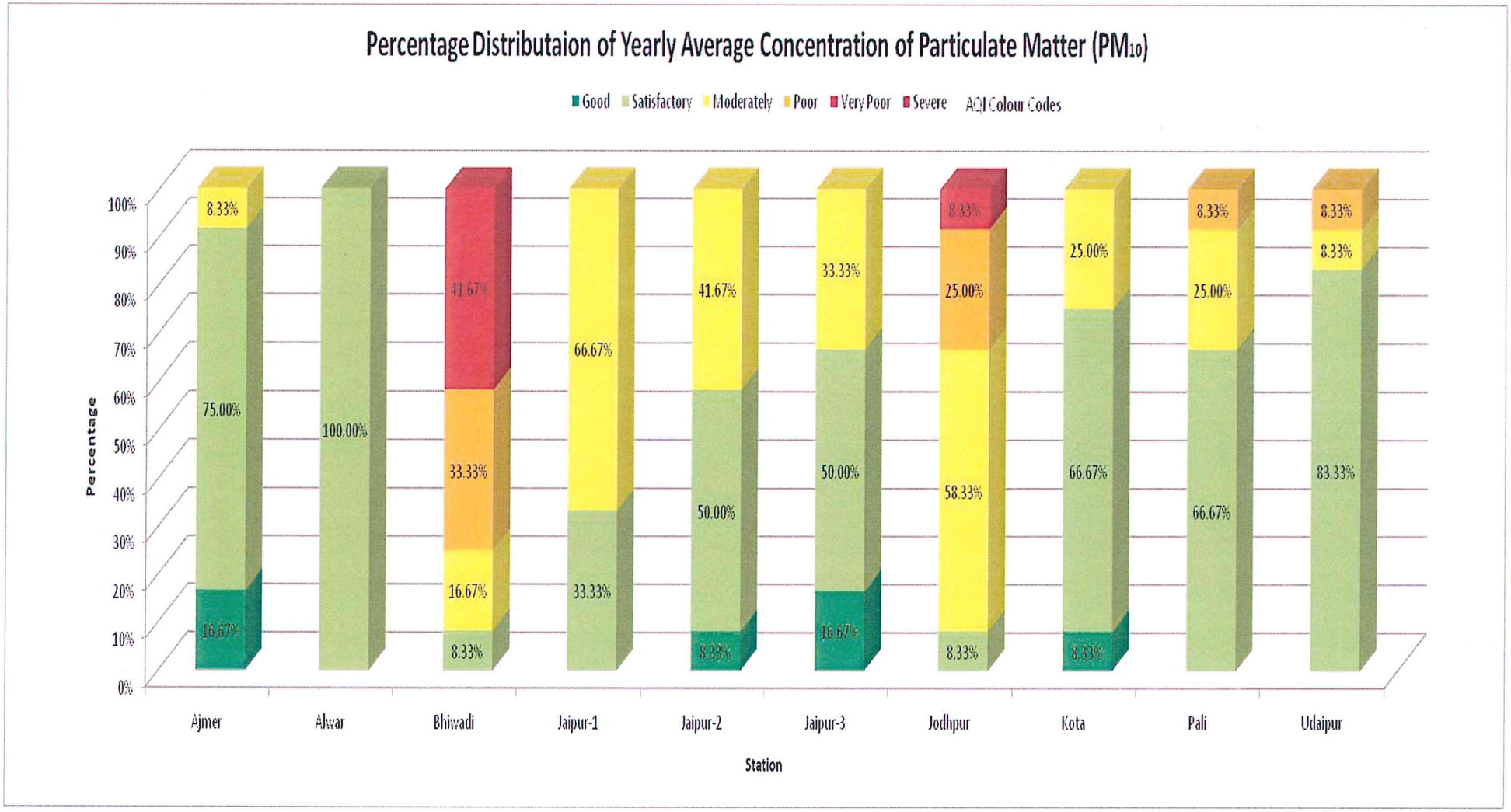
Table no. 4: Monthly average concentration of Particulate Matter (PM_{10})

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	116.96	99.74	93.46	115.69	124.59	109.55	80.34	56.09	57.69	97.93	113.03	103.50	**97.38**
Alwar	97.30	73.49	71.40	111.62	110.59	111.95	103.56	100.57	89.37	79.98	88.31	84.93	**93.59**
Bhiwadi	275.41	224.51	214.14	260.32	255.49	194.28	135.96	127.18	116.52	233.43	294.76	273.39	**217.12**
Jaipur-1	146.54	126.90	110.95	148.44	145.71	128.17	90.53	66.96	80.72	137.50	155.58	169.88	**125.66**
Jaipur-2	125.87	101.82	101.58	136.57	148.06	117.91	75.70	57.23	62.11	144.01	144.54	102.45	**109.82**
Jaipur-3	123.99	100.08	87.02	124.24	131.50	102.29	70.83	46.99	49.68	109.37	121.39	115.88	**98.61**
Jodhpur	145.89	146.18	151.83	233.85	242.39	237.56	185.20	105.02	122.98	168.94	146.57	164.62	**170.92**
Kota	143.10	115.89	128.01	114.57	109.73	102.46	82.48	62.83	51.42	114.02	119.00	135.24	**106.56**
Pali	142.91	109.26	119.08	184.44	180.06	137.73	102.00	79.20	71.15	95.28	109.73	98.68	**119.13**
Udaipur	208.89	160.85	90.92	71.81	99.64	99.18	76.99	61.69	73.24	116.95	118.47	119.30	**108.16**

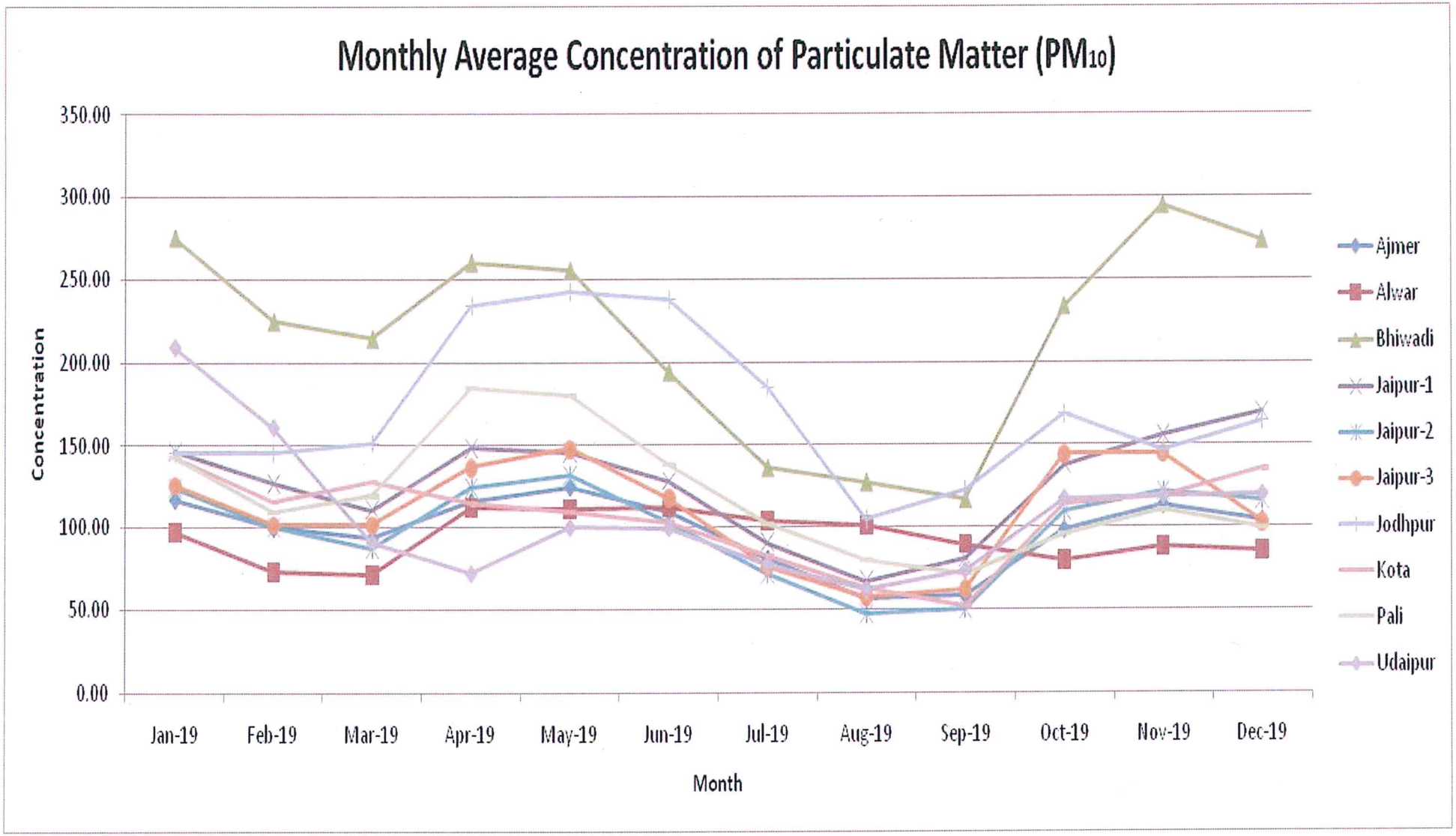
Table no. 5: Monthly average concentration of Particulate Matter ($PM_{2.5}$)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	62.26	50.28	45.70	55.45	62.53	48.20	35.68	26.83	27.95	53.68	58.26	50.63	**48.12**
Alwar	52.13	37.61	34.79	56.80	47.81	49.95	48.73	47.91	46.31	39.35	45.32	45.30	**46.00**
Bhiwadi	158.75	123.00	99.39	106.72	109.23	86.57	60.19	60.51	54.17	94.21	145.49	147.87	**103.84**
Jaipur-1	79.39	68.47	54.20	66.08	60.24	55.46	39.26	32.79	39.22	80.12	88.81	78.20	**61.85**
Jaipur-2	59.51	43.40	39.22	47.05	64.05	48.73	37.03	27.85	31.97	74.28	79.64	50.27	**50.25**
Jaipur-3	42.81	36.44	30.71	42.25	48.03	40.25	30.91	20.22	22.76	38.24	44.80	44.46	**36.82**
Jodhpur	80.08	70.30	68.07	106.55	113.78	110.64	82.53	44.26	48.69	80.16	70.66	84.24	**80.00**
Kota	74.13	53.35	59.33	64.90	51.17	46.86	40.63	30.68	25.02	63.36	64.00	66.36	**53.32**
Pali	70.71	58.22	55.04	78.15	67.87	61.15	46.68	38.43	35.19	47.05	60.65	54.30	**56.12**
Udaipur	71.94	62.78	40.07	29.84	41.62	44.70	33.50	27.70	33.30	54.98	58.88	58.82	**46.51**

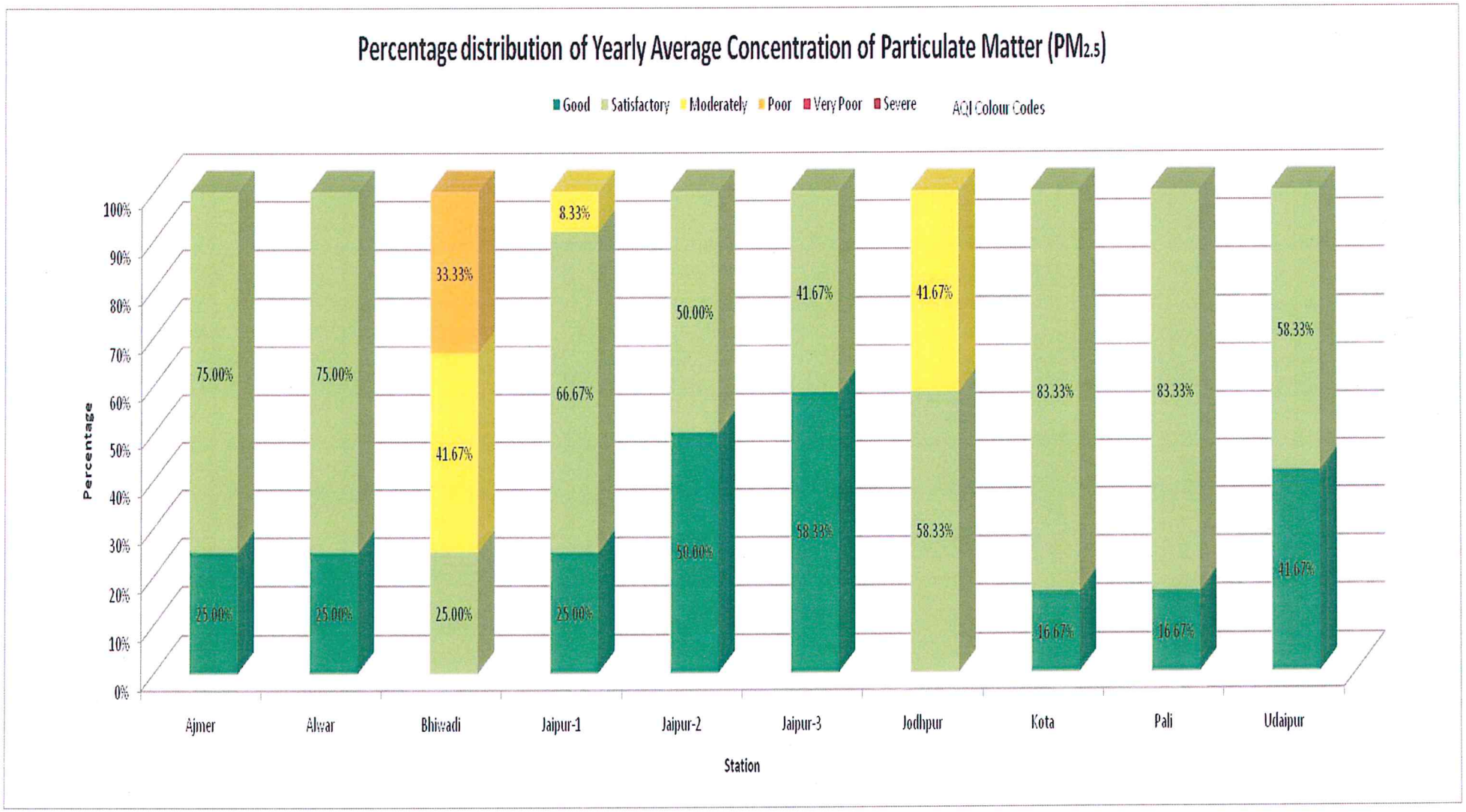
Graph:1 Percentage Distribution of Yearly Average Concentration of PM_{10}



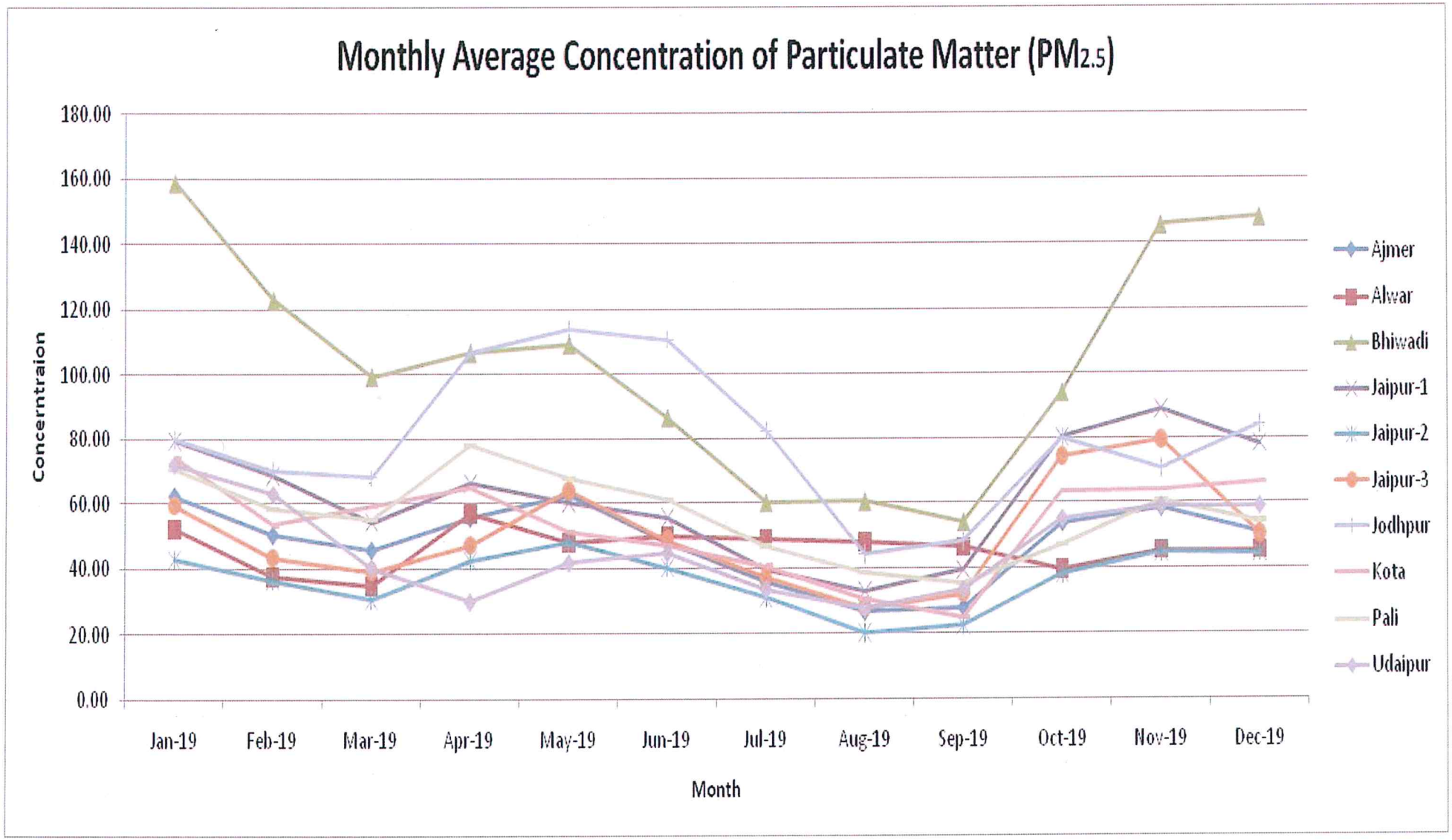
Graph:2 Monthly Average Concentration of PM_{10}



Graph:3 Percentage Distribution of Yearly Average Concentration of $PM_{2.5}$



Graph:4 Monthly 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 5, 6, 7 & 8 for a period of year, 2019.

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 & Jaipur-1, annual average of NO_2 was observed (46.18 & 43.40 $\mu g/m^3$) 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 mg/m^3) and eight hourly standard (2 mg/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.

MAJOR HIGHLIGHTS

Maximum And minimum values during the study period

- NH3- Highest value of yearly average data of NH_3 was captured at Jaipur-2 (43.09 $\mu g/m^3$) and Lowest value of NH_3 was captured at Alwar (20.35 $\mu g/m^3$).
- NO_2- Highest value of Yearly Average data of NO_2 was captured in Bhiwadi (46.18 $\mu g/m^3$) and Lowest value of NO_2 was captured in Jaipur-2 (22.57 $\mu g/m^3$).
- CO - Highest value of Yearly Average data of CO was captured in Jodhpur (1.20 mg/m^3) and Lowest r value of CO was captured in Pali (0.61 mg/m^3).
- SO2- Highest value of Yearly Average data of SO_2 was captured in Bhiwadi (32.87 $\mu g/m^3$) and Lowest value of SO_2 was captured in Ajmer (06.28 $\mu g/m^3$).

Yearly Comparison of Annual Average

Annual Average comparison for the year 2018 & 2019 for the parameters namely- PM_{10}, $PM_{2.5}$, NH_3, NO_2, CO & SO_2 have also been shown in graph no.- 9, 10, 11, 12, 13 & 14 respectively.

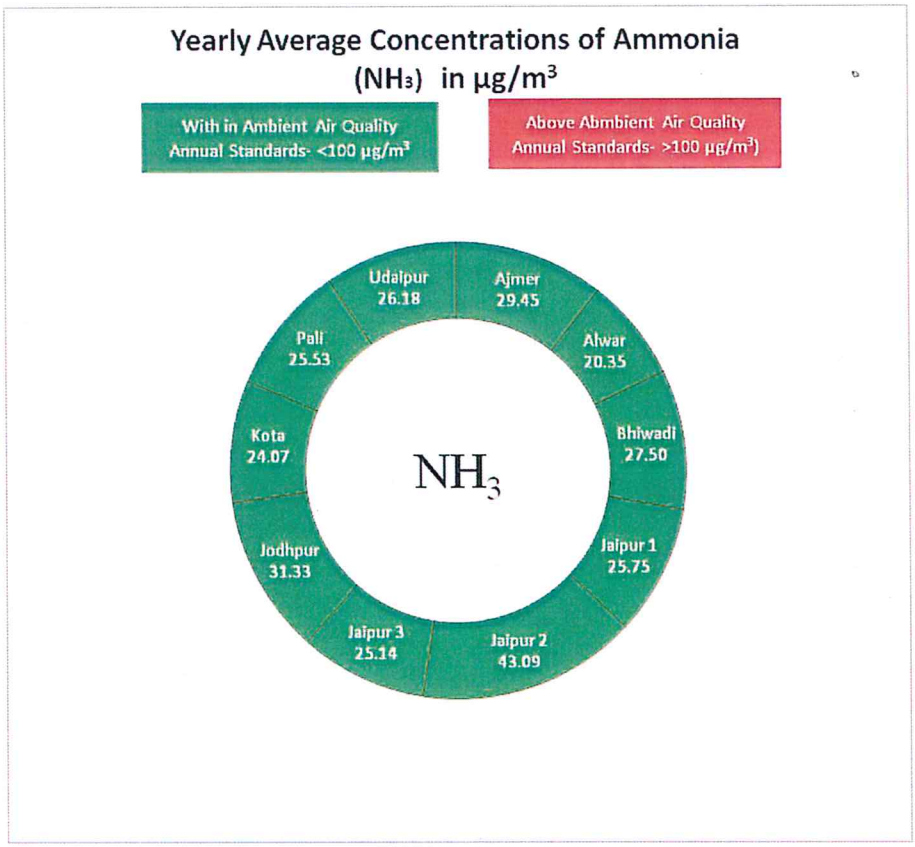
Table no. 6: Monthly average concentration of Ammonia (NH_3)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	33.62	30.79	43.77	30.96	24.18	25.81	25.02	24.57	19.87	26.82	36.05	31.97	**29.45**
Alwar	37.28	30.52	24.89	21.49	15.76	19.53	15.94	12.76	12.50	21.55	13.80	18.13	**20.35**
Bhiwadi	16.58	18.71	33.41	21	13.47	22.93	12.18	16.37	28.98	47.65	54.87	43.84	**27.50**
Jaipur-1	24.62	24.57	23.34	28.72	19.14	21.51	17.77	26.59	29.80	27.09	36.60	29.28	**25.75**
Jaipur-2	26.28	34.06	32.87	30.95	29.57	40.63	26.47	47.30	55.85	62.72	56.00	74.34	**43.09**
Jaipur-3	16.44	20.60	18.46	19.92	19.84	16.98	22.10	20.27	33.41	47.44	31.22	35.02	**25.14**
Jodhpur	24.41	39.38	39.27	30.12	36.08	31.19	21.15	19.33	32.27	34.84	35.01	32.97	**31.33**
Kota	21.81	23.72	40.75	38.08	16.52	10.40	13.36	9.98	28.71	34.35	17.91	33.19	**24.07**
Pali	36.14	22.19	20.69	23.72	28.73	24.06	24.03	30.69	29.72	24.31	20.57	21.58	**25.53**
Udaipur	55.99	51.24	28.85	19.64	14.08	15.03	8.92	15.73	12.05	22.28	25.67	44.71	**26.18**

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	39.57	28.67	26.04	27.29	21.11	18.13	16.51	17.05	16.18	32.99	26.67	33	**25.27**
Alwar	37.50	37.50	45.25	41.01	32.44	30.02	17.02	19.84	21.56	20.67	15.45	19.91	**28.18**
Bhiwadi	54.81	56.47	71.78	52.93	38.4	23.48	24.68	19.72	26.56	73.8	67.02	44.45	**46.18**
Jaipur-1	56.21	42.21	41.94	47.34	32.20	31.10	23.17	31.01	32.42	58.99	58.29	65.96	**43.40**
Jaipur-2	12.66	19.98	20.47	18.70	16.78	23.10	15.68	18.74	18.07	30.28	29.31	47.04	**22.57**
Jaipur-3	26.70	29.65	33.45	38.24	42.41	33.20	23.27	22.94	25.45	48.45	41.27	48.42	**34.45**
Jodhpur	58.07	31.94	29.54	40.38	33.85	41.25	26.61	23.94	28.59	29.00	26.84	19.71	**32.48**
Kota	42.24	44.63	36.66	29.26	19.78	12.63	22.71	24.72	16.75	26.15	24.16	51.82	**29.29**
Pali	35.04	35.45	34.46	34.46	35.80	28.74	24.57	34.30	32.52	28.17	22.71	22.82	**30.75**
Udaipur	56.23	32.95	20.67	22.07	20.52	15.26	10.34	12.79	13.68	23.71	25.30	24.58	**23.17**

Graph: 5 Yearly Average Concentrations of NH_3



Graph: 6 Yearly Average Concentrations of NO_2

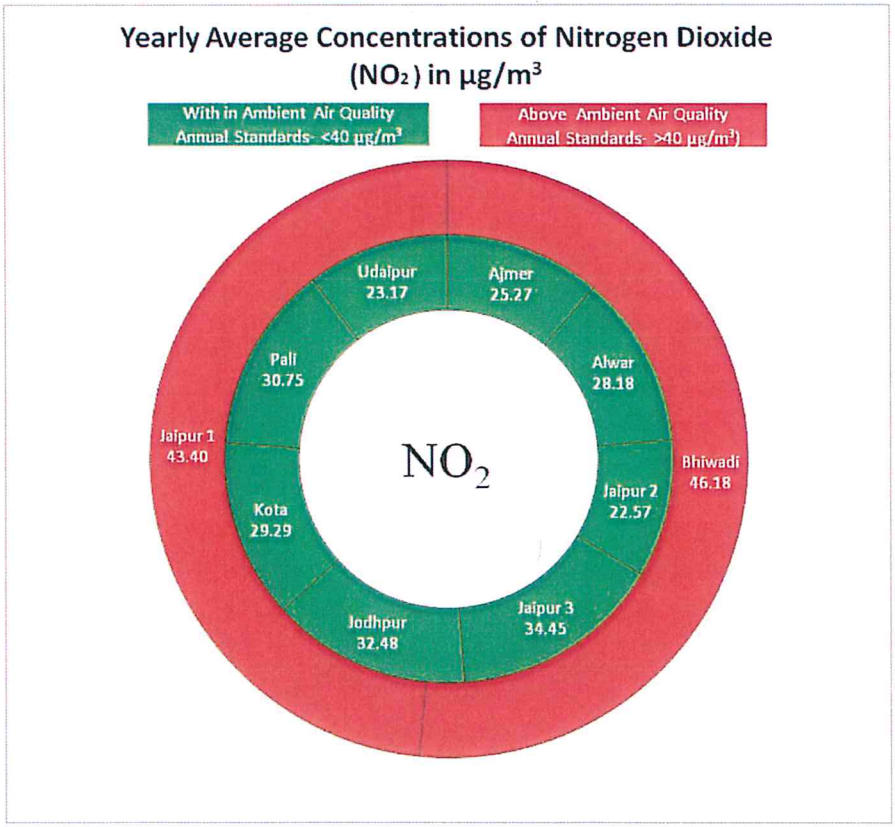


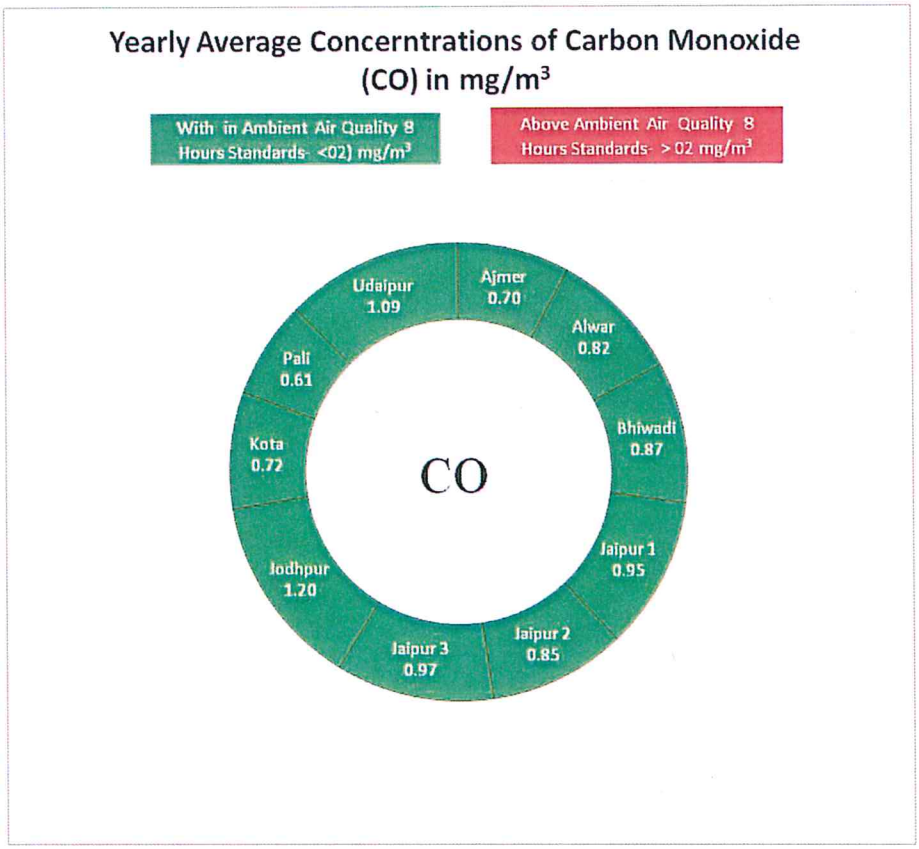
Table no. 8: Monthly average concentration of Carbon Monoxide (CO)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	0.71	0.44	0.37	0.49	0.43	0.43	0.70	1.08	0.97	1.00	0.90	0.82	**0.70**
Alwar	0.92	0.67	0.71	0.74	0.57	0.71	0.75	0.73	0.74	0.89	1.36	1.06	**0.82**
Bhiwadi	0.78	0.85	0.82	0.87	0.81	0.73	0.68	0.7	0.59	1.03	1.36	1.26	**0.87**
Jaipur-1	0.90	1.40	1.18	1.12	0.82	0.80	0.74	0.73	0.85	0.96	0.84	1.06	**0.95**
Jaipur-2	1.24	1.02	0.94	0.95	0.73	0.69	0.46	0.39	0.56	1.17	0.92	1.18	**0.85**
Jaipur-3	1.18	0.91	0.73	1.01	1.04	0.90	0.90	0.99	0.96	1.01	1.01	1.01	**0.97**
Jodhpur	0.89	1.16	1.19	1.31	1.29	1.16	0.90	1.14	1.39	1.25	1.75	0.97	**1.20**
Kota	0.70	0.75	0.64	0.73	0.64	0.61	0.83	0.85	0.76	0.74	0.75	0.69	**0.72**
Pali	0.89	0.62	0.50	0.57	0.53	0.48	0.49	0.52	0.72	0.73	0.63	0.60	**0.61**
Udaipur	1.57	1.19	1.02	0.81	0.83	1.05	0.99	0.96	0.97	1.12	1.29	1.31	**1.09**

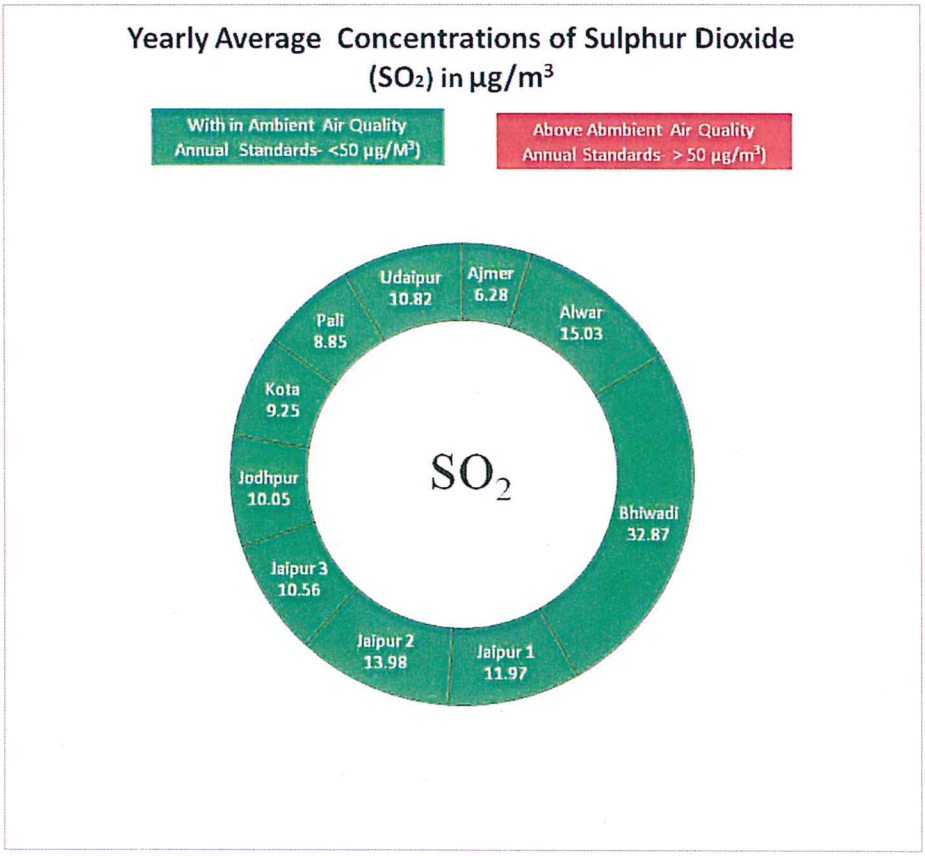
Table no. 9: Monthly average concentration of Sulphur Dioxide (SO_2)

Month/ Station	January	February	March	April	May	June	July	August	September	October	November	December	Average
Ajmer	6.76	6.35	6.47	7.31	6.04	5.32	7.17	5.22	5.92	6.91	5.59	6.26	**6.28**
Alwar	11.27	16.25	17.70	16.96	14.47	15.08	12.64	13.10	17.11	13.82	15.48	16.53	**15.03**
Bhiwadi	40.93	44.02	58.76	51.67	50.62	26.45	11.89	9.51	7.07	35.7	28.73	29.13	**32.87**
Jaipur-1	22.52	13.97	9.74	13.81	11.17	9.18	9.15	9.38	10.93	12.25	10.83	10.72	**11.97**
Jaipur-2	13.62	13.90	13.89	17.01	13.99	16.88	10.47	10.33	12.38	15.65	14.17	15.49	**13.98**
Jaipur-3	9.48	8.53	10.51	12.04	9.67	10.82	9.43	9.11	10.61	12.74	12.33	11.40	**10.56**
Jodhpur	24.38	11.40	12.47	9.19	8.54	8.00	6.55	6.27	7.21	10.09	9.00	7.46	**10.05**
Kota	9.10	9.18	10.70	9.68	9.20	9.59	9.28	8.14	10.55	8.43	8.46	8.73	**9.25**
Pali	9.37	10.39	11.95	19.64	8.51	7.39	5.94	5.84	5.63	8.33	6.54	6.73	**8.85**
Udaipur	14.13	13.15	15.69	12.05	11.97	10.73	5.65	5.71	11.07	9.66	9.28	10.79	**10.82**

Graph: 7 Yearly Average Concentrations of CO

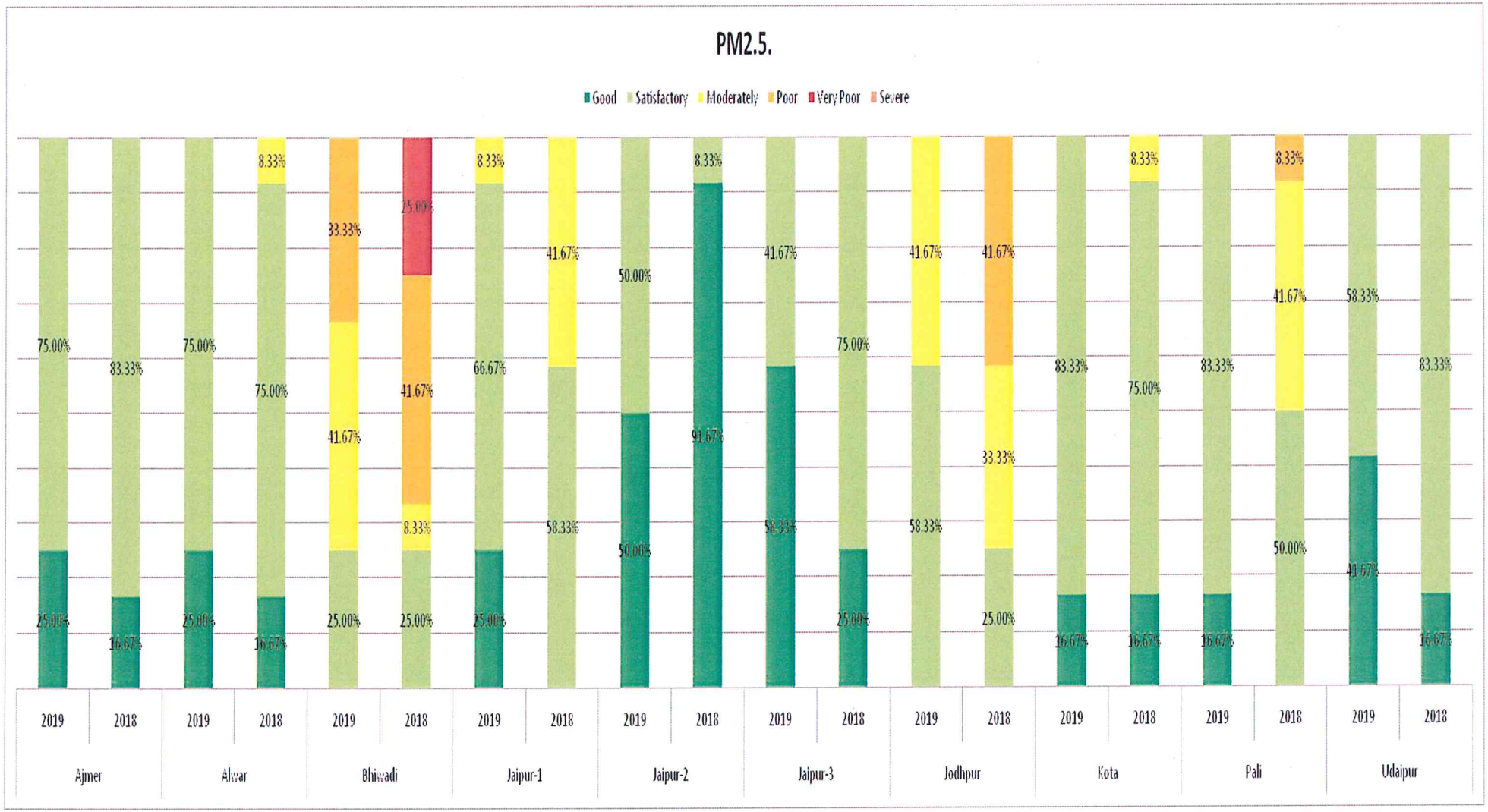


Graph:8 Yearly Average Concentrations of SO_2

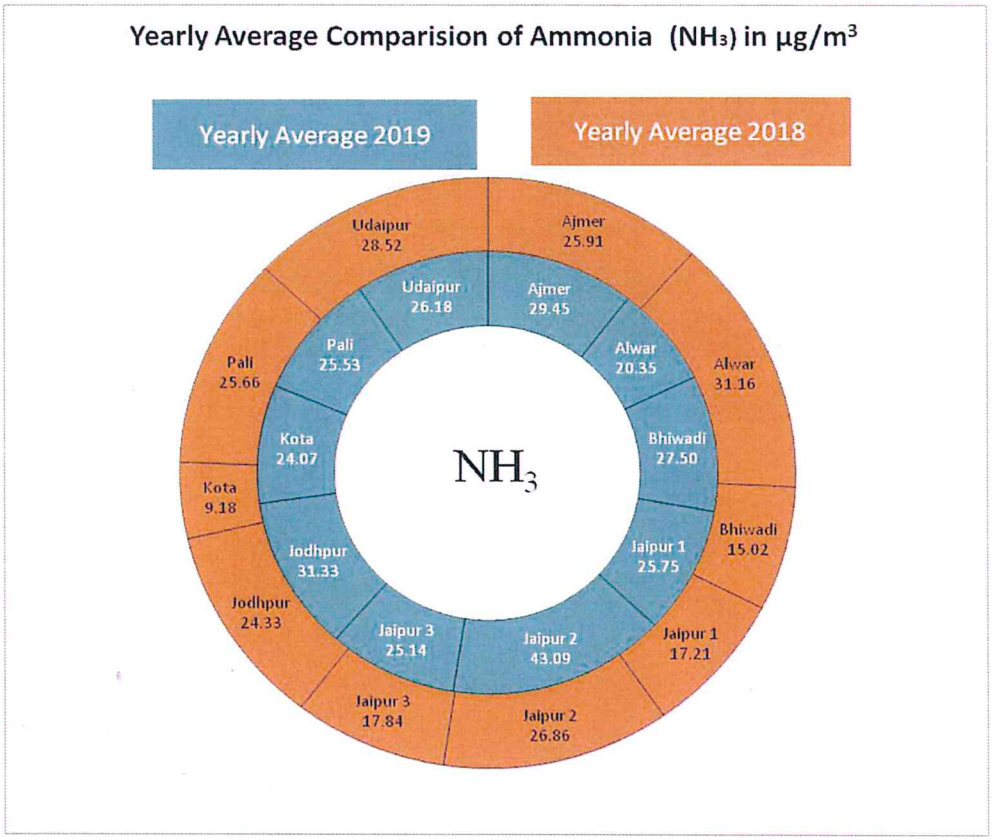


Graph:9 Yearly Average Comparison of PM_{10}

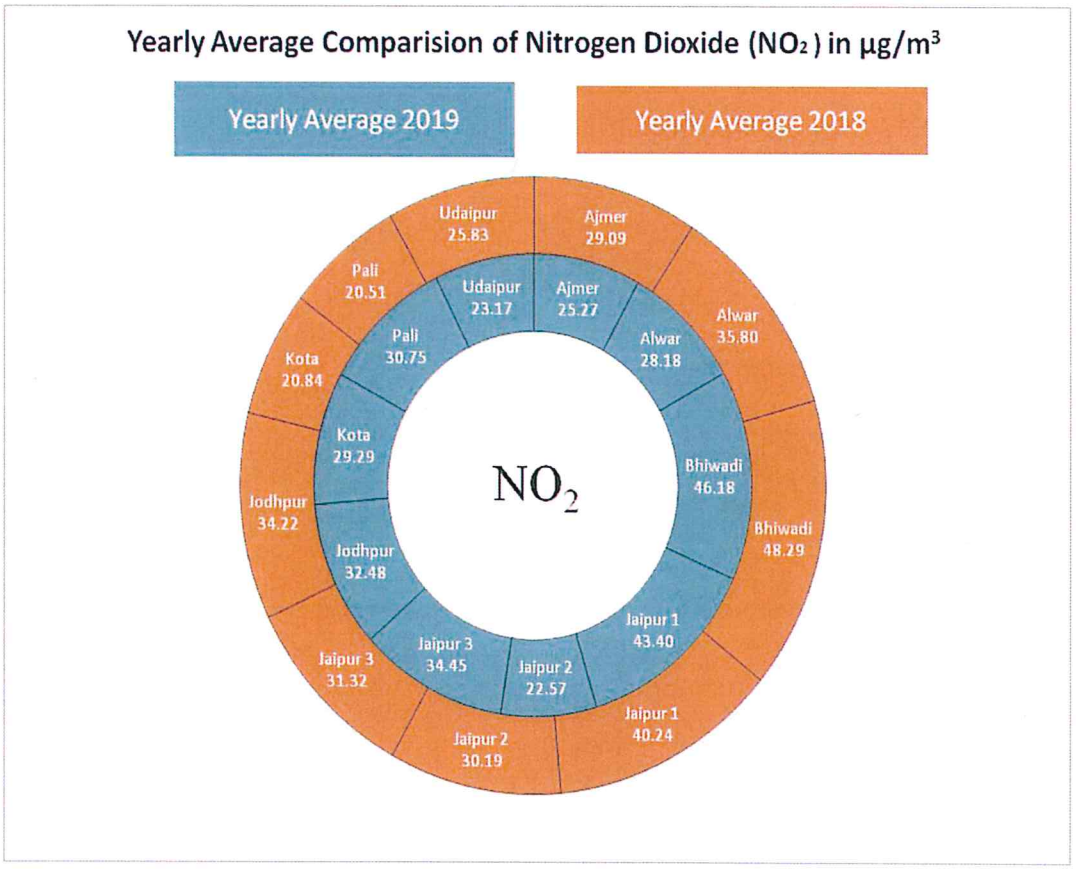
Graph:10 Yearly Average Comparison of $PM_{2.5}$



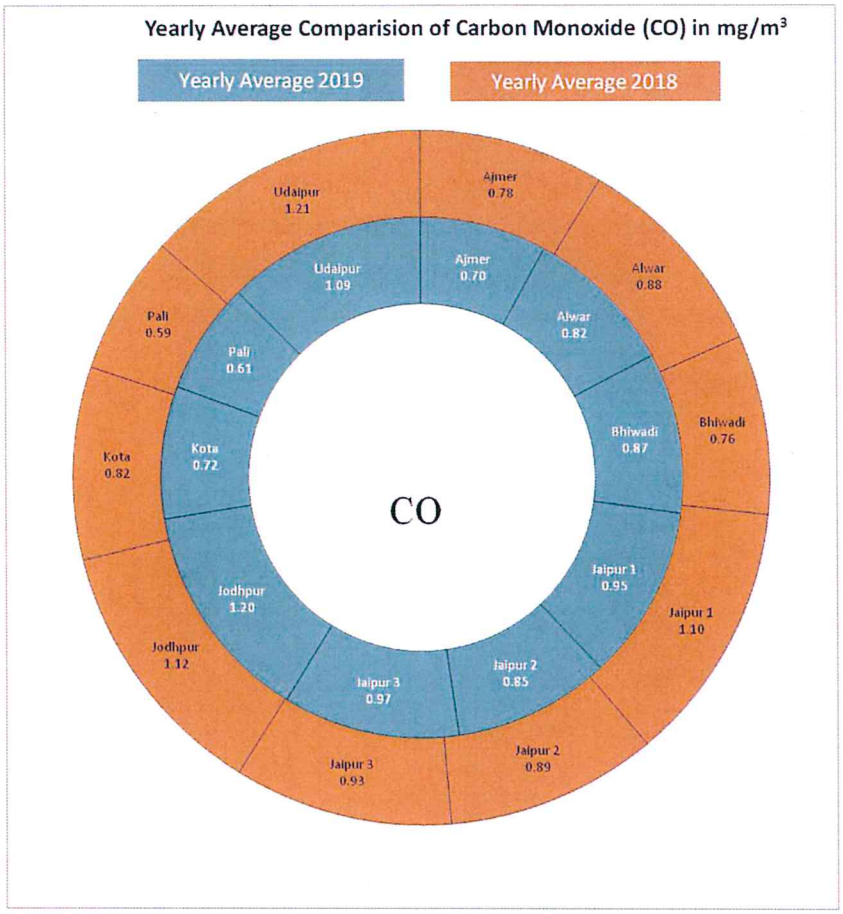
Graph:11 Yearly Average Comparison of NH_3



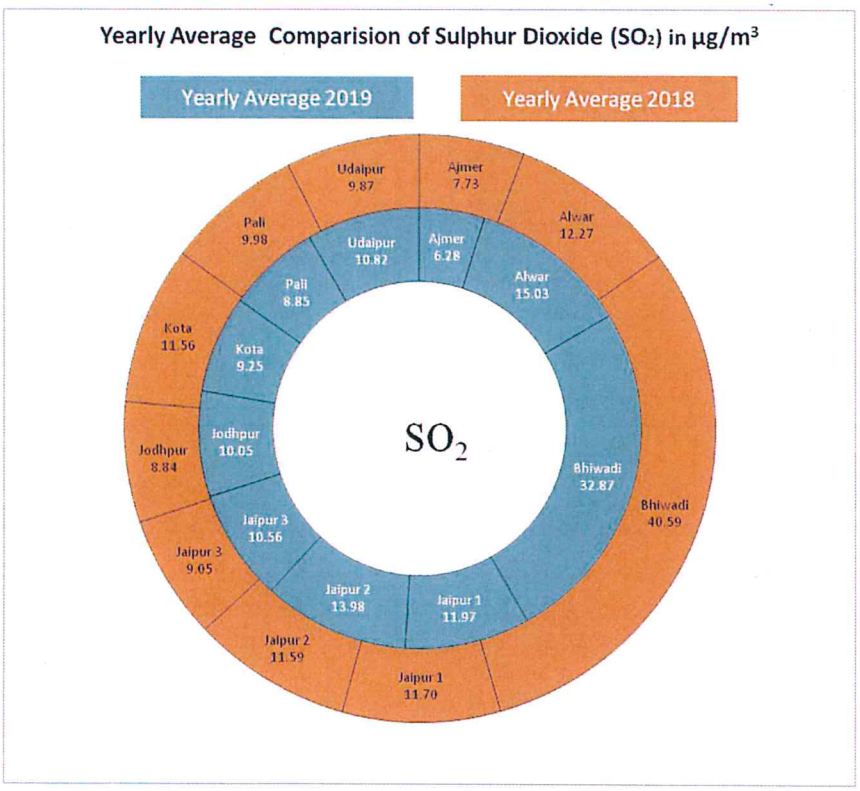
Graph:12 Yearly Average Comparison of NO_2



Graph:13 Yearly Average Comparison of CO



Graph:14 Yearly Average Comparison of SO_2



8. Air Quality Index

Air Quality Index is a tool for effective communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour. There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe.

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

Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints).

AQ sub-index and health breakpoints are evolved for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (upto 24-hours) National Ambient Air Quality Standards are prescribed.

Applications of Air Quality Index Ott (1978) has listed the following six objectives that are served by an AQI:

1. Resource Allocation: To assist administrators in allocating funds and determining priorities. Enable evaluation of trade-offs involved in alternative air pollution control strategies.
2. Ranking of Locations: To assist in comparing air quality conditions at different locations/cities. Thus, pointing out areas and frequencies of potential hazards.

3. Enforcement of Standards: To determine extent to which the legislative standards and existing criteria are being adhered. Also helps in identifying faulty standards and inadequate monitoring programs.
4. Trend Analysis: To determine change in air quality (degradation or improvement) which have occurred over a specified period. This enables forecasting of air quality (i.e., tracking the behaviour of pollutants in air) and plan pollution control measures.
5. Public Information: To inform the public about environmental conditions (state of environment). It's useful for people who suffer from illness aggravated or caused by air pollution. Thus it enables them to modify their daily activities at times when they are informed of high pollution levels.
6. Scientific Research: As a means for reducing a large set of data to a comprehendible form that gives better insight to the researcher while conducting a study of some environmental phenomena. This enables more objective determination of the contribution of individual pollutants and sources to overall air quality. Such tools become more useful when used in conjunction with other sources such as local emission surveys.

Briefly, an AQI is useful for:

General public to know air quality in a simplified way,

A politician to invoke quick actions,

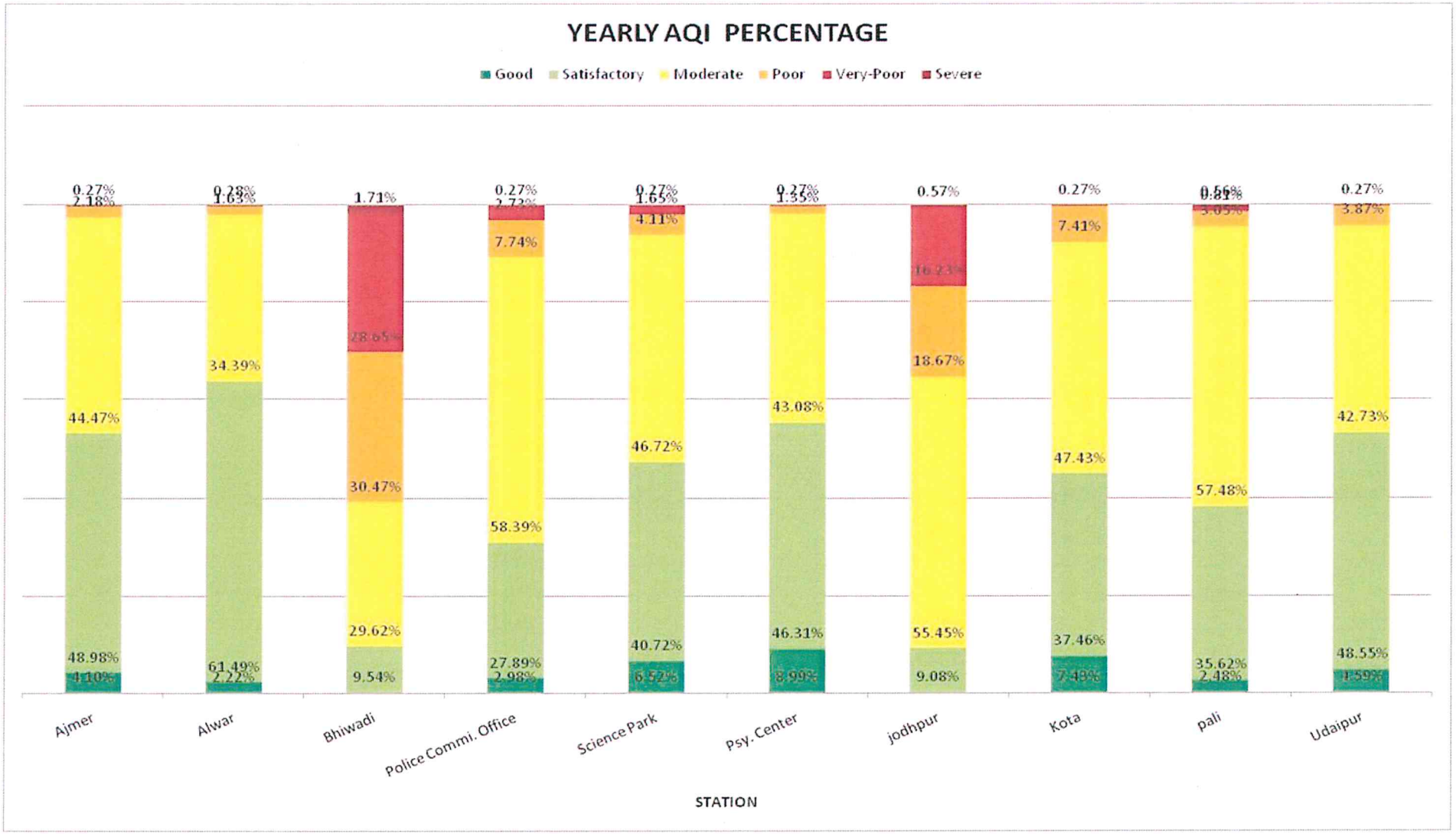
A decision maker to know the trend of events and to chalk out corrective pollution control strategies,

A government official to study the impact of regulatory actions, and

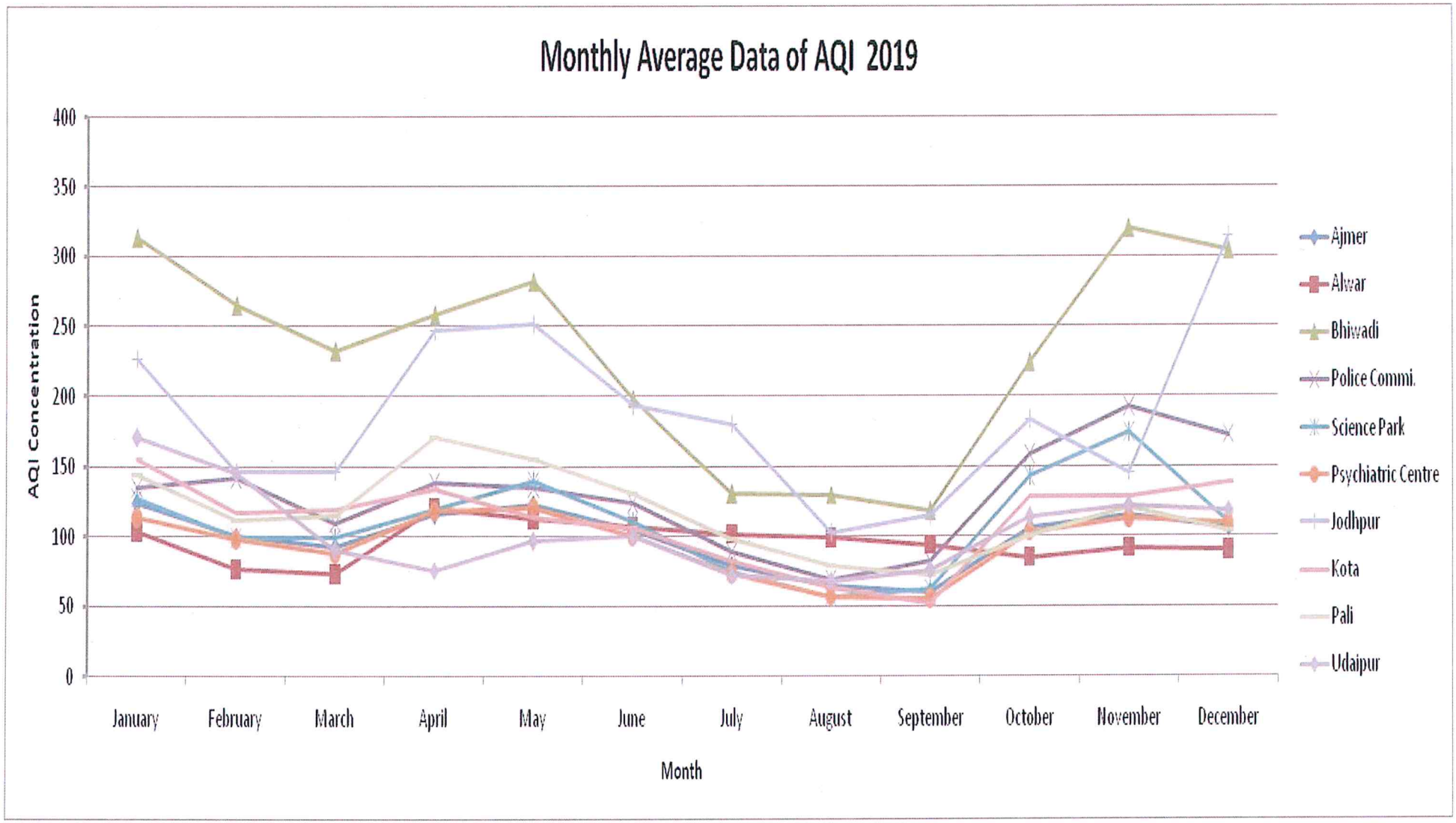
A scientist who engages in scientific research using air quality data.

Air quality index has been prepared on 24 hours basis at all the 10 CAAQMS. On the basis of daily AQI yearly average has been prepared at it is presented in the Graph 13. The AQI chart shows that most of the time air quality was observed Moderate and satisfactory at all the stations except Bhiwadi which is situated in the industrial area.

Graph:15 Percentage of Yearly AQI



Graph:16 Monthly Average Concentration of AQI



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, 2019 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 46.18 $\mu g/m^3$ 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, Shri Nirmal Suthar, Shri Gaurav Kumar Jangid & Ms. Padma Tiwari for his contribution in the formulation of the report.