BRIEF REPORT ON
CONTINUOUS AMBIENT AIR QUALITY DATA
OF RAJASTHAN

(JULY- SEPTEMBER- 2018)

Rajasthan State Pollution Control Board

राजस्थान राज्य प्रदूषण नियंत्रण मण्डल

पर्यावरण विभाग

राजस्थान सरकार

CONTRIBUTION

Overall Guidance	Smt. Aparna Arora, Chairperson, RSPCB Shri K.C.A.Arun Prasad, Member Secretary, RSPCB
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 land of beautiful and diverse landscapes, rich in natural resources and an attractive tourist destination. The State faces the challenge of environmental pollution like other State of India, particularly air pollution due to its geographical features and semi arid climate.

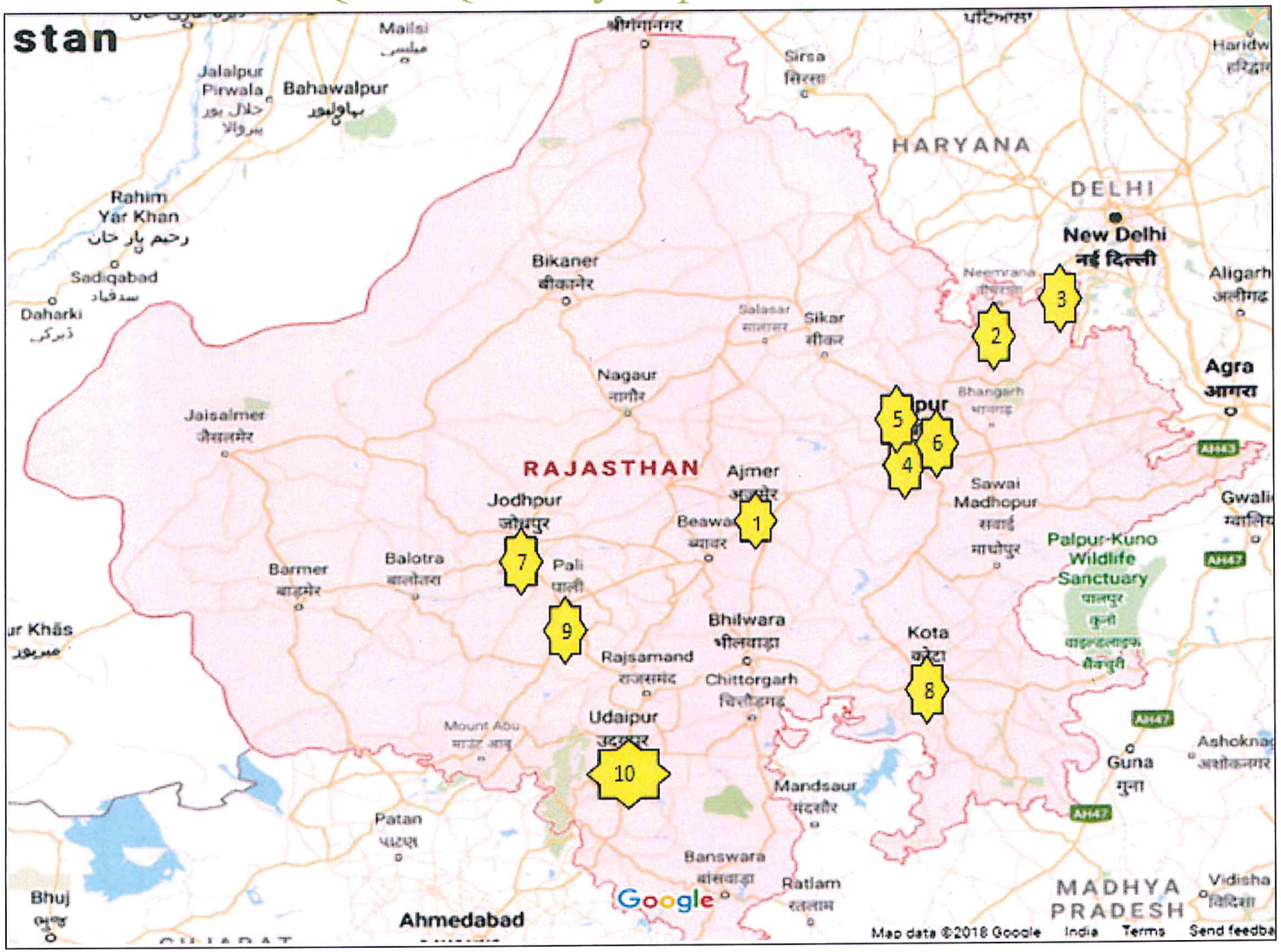
Pollution is a matter of environmental justice. Air pollutants are being let out into the atmosphere from a variety of natural causes like dust storms, weathering of rocks, etc and anthropogenic sources such as industrial operation, heavy transport activity, indoor air pollution, construction and demolition activities, unscientific disposal of waste etc. Different researches show that concentration of pollutants in the ambient air depends not only on the quantities of air pollutants that are emitted but also the ability of the atmosphere, either to absorb or disperse these pollutants.

The present report is neither a review nor a descriptive educational study. It is a problem-based descriptive review in which emphasis on the 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.

This report presents the monitoring results from 10 Continuous Ambient Air Quality Monitoring Stations located in 08 cities to evaluate the Ambient Air Quality Status and related health concerns.

Table no.1 : Location of CAAQMS

S. No.	Name of city	No of Station(s)
1	Ajmer	1
2	Alwar	1
3	Bhiwadi	1
4	Jaipur	3
5	Jodhpur	1
6	Kota	1
7	Pali	1
8	Udaipur	1



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
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. 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.				

4. Findings and interpretation of the results

This report summarizes results as monthly average concentrations of particulate matter (PM_{10} and $PM_{2.5}$) and gaseous pollutants (CO, SO_2, NO_2 and NH_3) in Tables (No. 4, 5 & 6) and graphical representations (No. 1-5).

Concentrations of PM_{10} was highest (201.24µg/m^3) at CAAQMS Bhiwadi during the month of September 2018, followed by 137.60 µg/m^3 captured at CAAQMS Jodhpur during July (Table no.4).

Particulate matter ($PM_{2.5}$) monthly average concentration showed similar trend as for PM_{10} since highest concentration (68.10 µg/m^3) of $PM_{2.5}$ was also found at CAAQMS Bhiwadi in September (Table no.4). Particulate matter concentration was observed high at CAAQMS Bhiwadi.

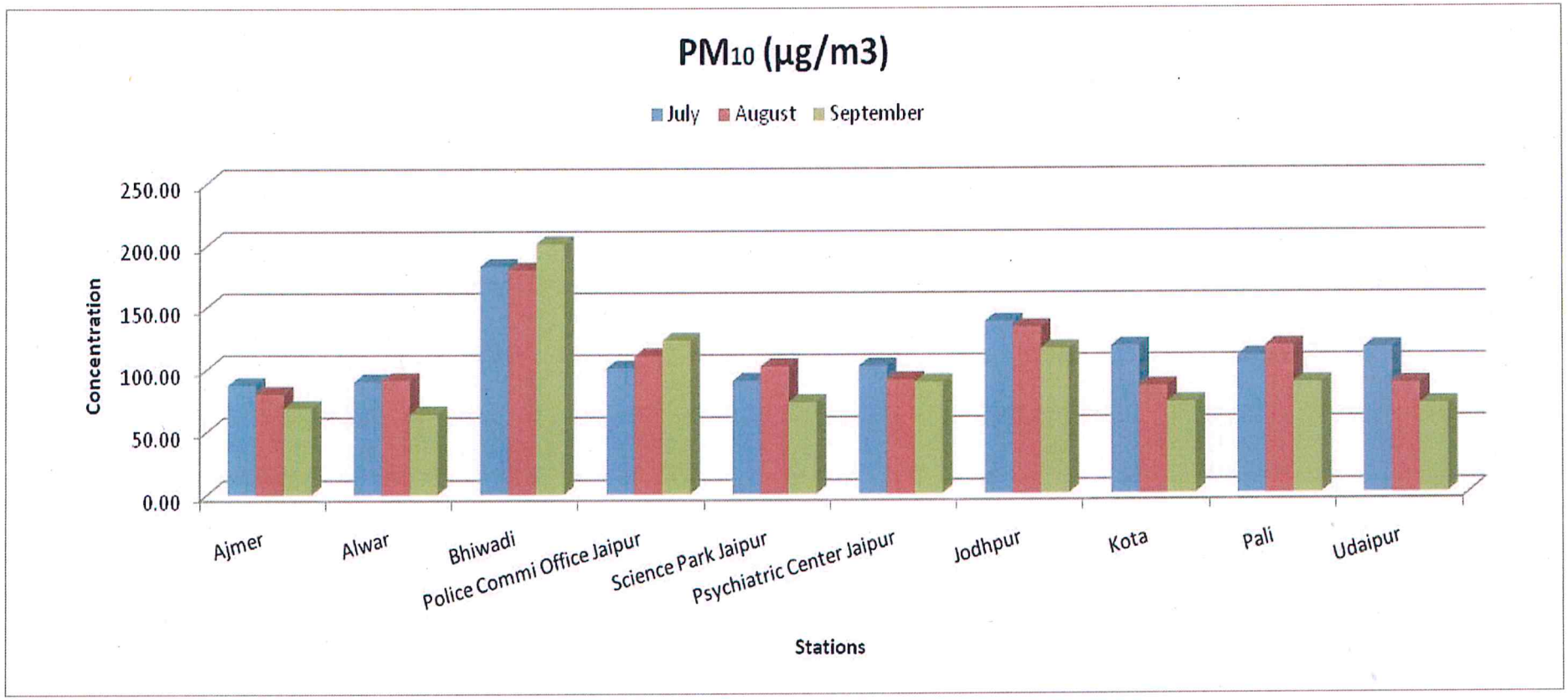
Unlike particulate matter, highest value of monthly average concentration of gaseous pollutants varied with different CAAQMS. CO concentration was highest (1.20 µg/m^3) at CAAQMS Jodhpur during August, SO_2 concentration was found maximum (19.48 µg/m^3) at CAAQMS Bhiwadi during July, highest average concentration of NO_2 was captured at CAAQMS Police Commissioner Office, Jaipur (42.18µg/m^3) while NH_3 concentration was found to be maximum (47.07µg/m^3) during August at CAAQMS Udaipur.(Table no. 5)

However, monthly average of CO and SO_2 at all the CAAQMS were observed to be within limit of National Ambient Air Quality Standard, for hourly (4 µg/m^3)and eight hourly (2 µg/m^3) for carbon monoxide and 24 hourly (80 µg/m^3) and Annually (50 µg/m^3) for sulphur dioxide. Similarly, at all CAAQMS, 24 hourly (400 µg/m^3) and yearly (100 µg/m^3) values of NH_3 was observed to be below limits as prescribed for National Ambient Air Quality Standard. (Table no. 3). At Police Commissioner Office, Jaipur, observed values of NO_2 were found slightly higher than the Annual standard during July, may be due to traffic load and vehicle movement.

Table no. 4: Monthly average concentration of Particulate Matter (PM_{10} and $PM_{2.5}$)

Pollutant	PM_{10}			$PM_{2.5}$		
	July 2018	August 2018	September 2018	July 2018	August 2018	September 2018
Jaipur- Police Commissioner Office	100.32	110.26	122.67	46.91	55.01	53.23
Jaipur- Psychiatric Centre	101.86	90.85	89.11	39.47	32.28	31.28
Jaipur- Regional Science Centre	90.05	101.72	72.88	38.93	43.87	37.20
Ajmer	87.13	80.08	68.77	41.66	37.84	34.21
Alwar	89.80	91.09	63.93	46.39	49.57	32.19
Bhiwadi	182.89	180.10	201.24	66.99	63.81	68.10
Jodhpur	137.60	133.28	115.62	59.74	59.97	61.90
Kota	117.69	85.65	72.61	54.79	39.68	30.37
Pali	109.73	117.95	88.26	49.01	54.17	41.76
Udaipur	116.05	87.42	70.64	41.97	36.02	30.14

Graph:1 Concentration of PM_{10} in three month at all CAAQMS



Graph:2 Concentration of $PM_{2.5}$ in three month at all CAAQMS

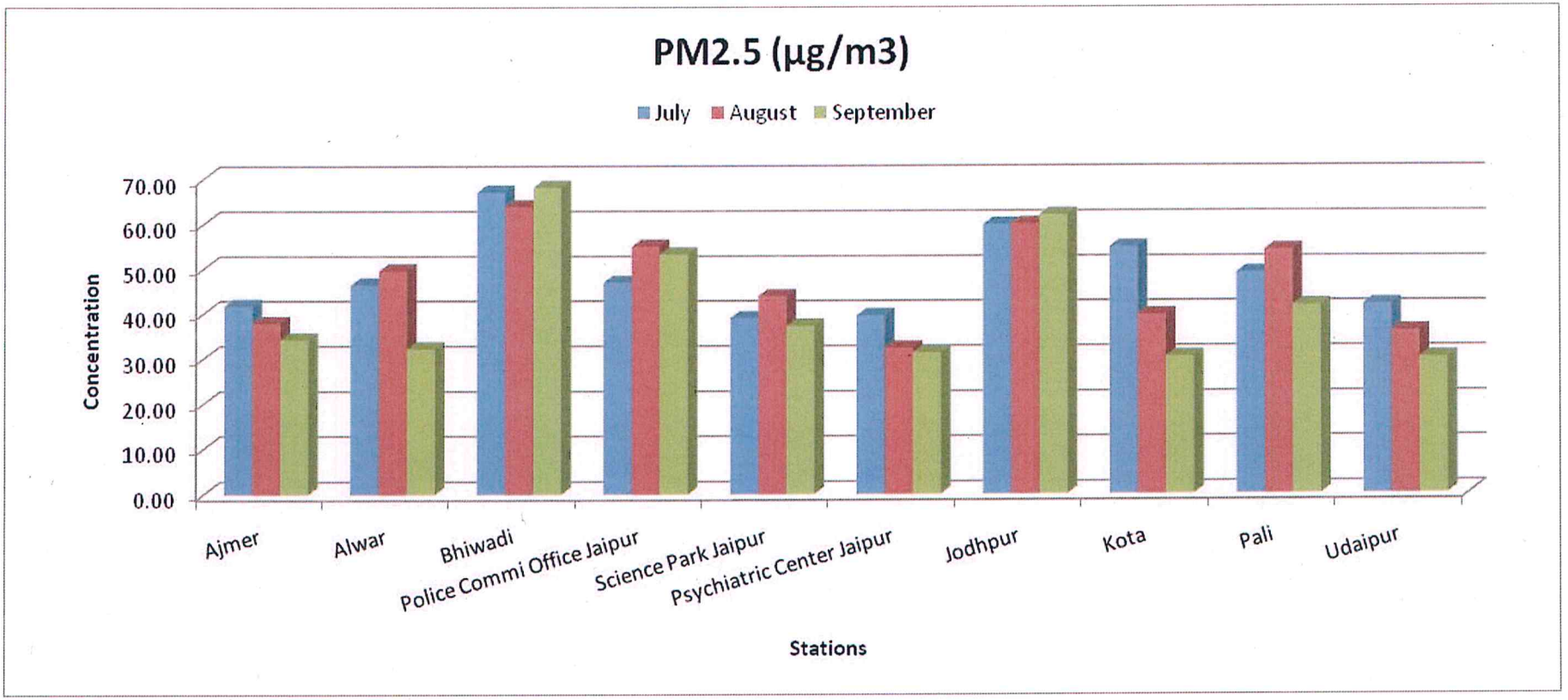


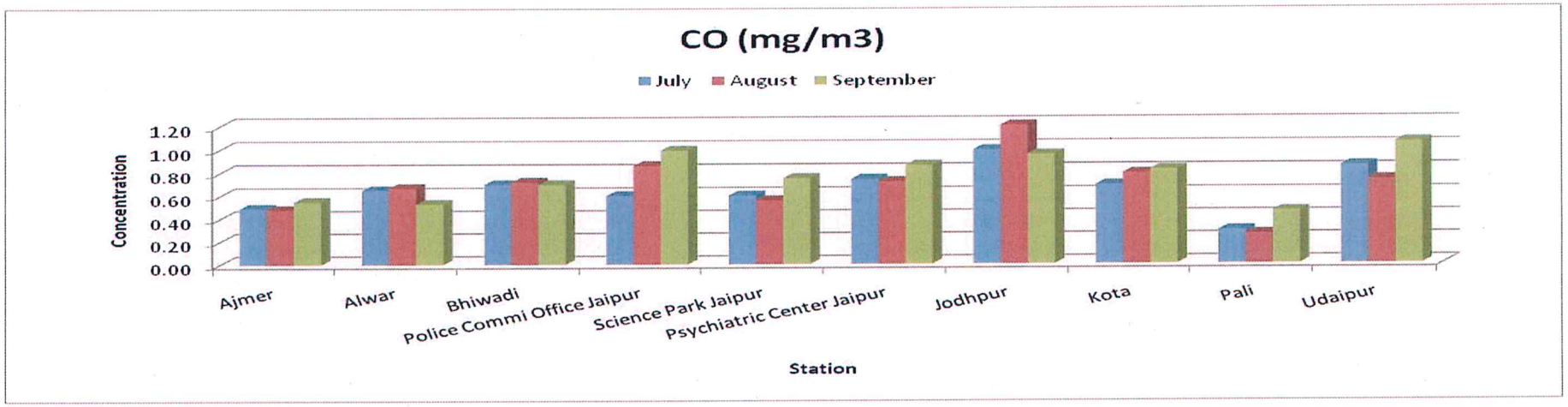
Table no. 5:Monthly average concentration of Gaseous Pollutant (CO, SO_2,)

Pollutant	CO			SO_2		
	July 2018	August 2018	September 2018	July 2018	August 2018	September 2018
Jaipur- Police Commissioner Office	0.60	0.86	0.99	10.61	12.07	10.03
Jaipur- Psychiatric Centre	0.74	0.72	0.86	8.24	8.78	9.50
Jaipur- Regional Science Centre	0.60	0.56	0.75	10.63	8.93	12.01
Ajmer	0.49	0.48	0.55	4.89	6.63	6.25
Alwar	0.65	0.67	0.53	17.06	12.19	6.78
Bhiwadi	0.70	0.72	0.70	19.48	16.90	14.32
Jodhpur	0.99	1.20	0.95	7.03	8.88	8.41
Kota	0.69	0.79	0.82	9.28	8.15	8.85
Pali	0.29	0.26	0.46	5.74	3.58	3.38
Udaipur	0.85	0.73	1.05	8.60	8.48	5.54

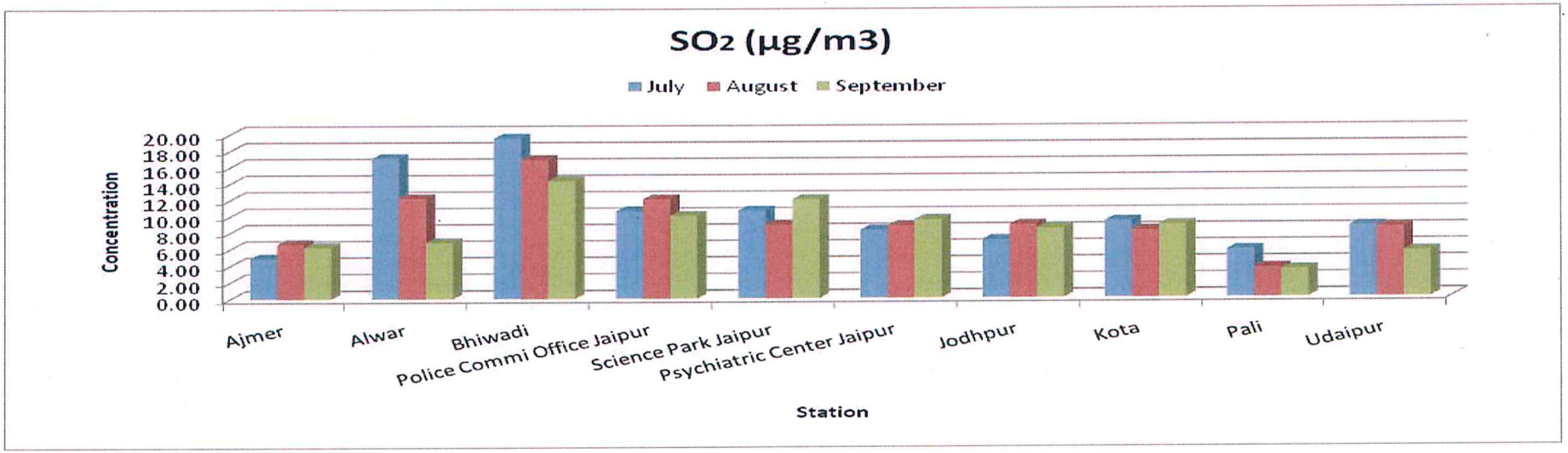
Table no. 6:Monthly average concentration of Gaseous Pollutant (NO_2, NH_3)

Pollutant	NO_2			NH_3		
	July 2018	August 2018	September 2018	July 2018	August 2018	September 2018
Jaipur- Police Commissioner Office	42.18	19.16	20.24	21.07	12.27	13.60
Jaipur- Psychiatric Centre	19.46	31.49	34.11	13.19	15.61	15.84
Jaipur- Regional Science Centre	16.08	13.83	14.09	11.78	8.66	23.04
Ajmer	14.54	16.95	20.04	19.33	11.58	11.91
Alwar	20.72	25.33	20.18	26.77	30.94	27.60
Bhiwadi	33.10	20.21	19.77	19.60	14.33	9.93
Jodhpur	16.18	22.29	24.46	13.62	12.14	12.50
Kota	24.41	21.02	20.28	10.33	7.97	9.88
Pali	26.61	12.61	22.40	27.70	26.36	22.17
Udaipur	17.87	18.80	20.17	40.77	47.07	18.50

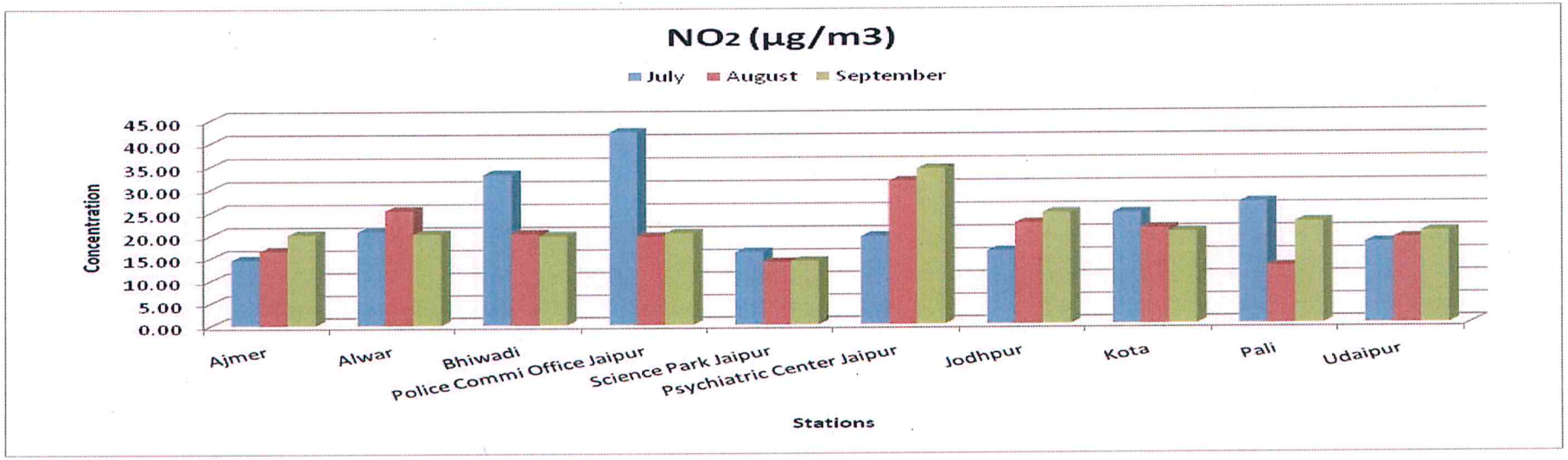
Graph:3 Concentration of CO in three month at all CAAQMS



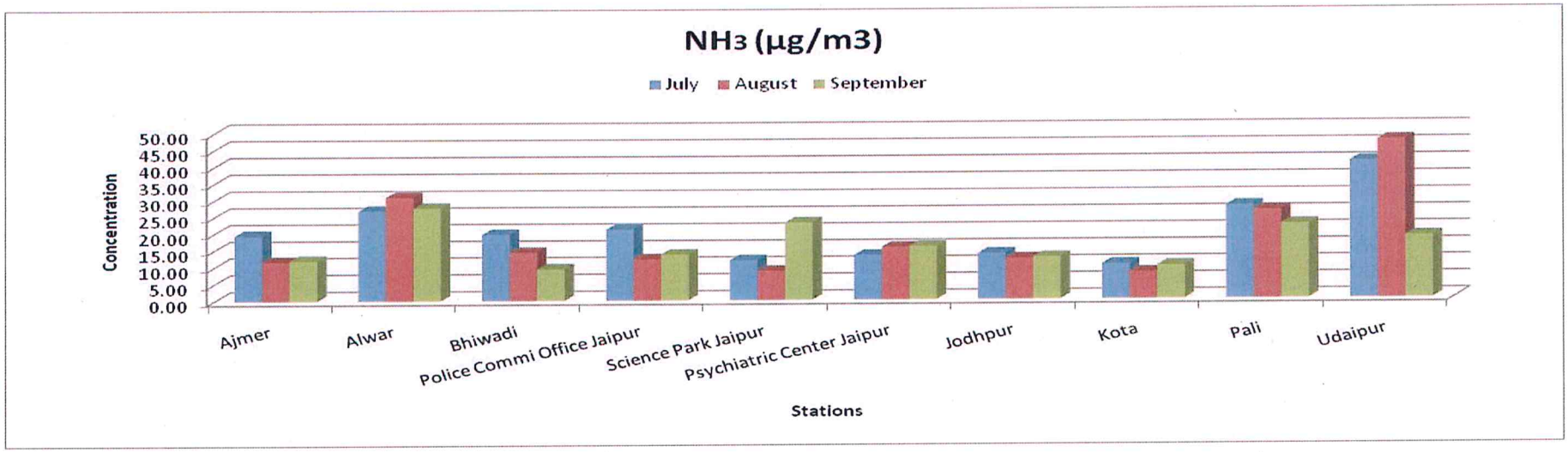
Graph:4 Concentration of SO_2 in three month at all CAAQMS



Graph:5 Concentration of NO_2 in three month at all CAAQMS



Graph:6 Concentration of NH_3 in three month at all CAAQMS



5. Pollution Rose

Pollution rose is a circular histogram plot which displays directional data with reference to concentration of pollutant and the frequency of each class. The pollution rose is basically another means of illustrating the frequency distribution of wind direction temporally correlated with a particular/ selected pollutant.

There are two reasons for constructing pollution rose diagrams:(a) for each wind direction, to depict the associated air quality, either as a mean concentration or as a frequency of the time that pollution levels exceed some designated threshold value of interest; (b) to infer the distribution and strength of emission sources around the sampling station.

Each rose provides a visual indication of the predominant wind direction and associated concentration in which the wind was blowing.

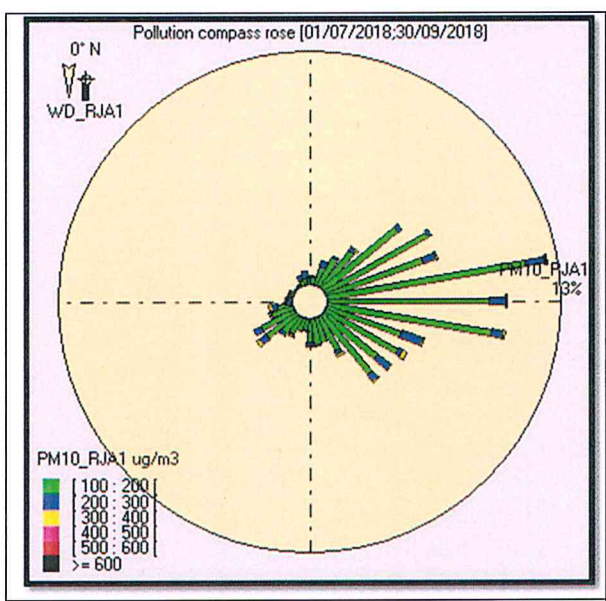
In the pollution rose diagram, location of the plotted symbol in relation to the centre of the diagram indicates the direction from which the wind was predominantly travelling which is correlated with the concentration of pollutant. Symbol's distance from the centre of the plot represents the resultant concerning concentration. Symbols located close to the centre of the diagram indicate a slower resultant wind speed (and perhaps stagnation); symbols located further away from the centre indicate higher wind speeds and ostensibly, more possibility of pollutant transport over a longer distance.

The colour of the symbols reflects the average concentration of pollutant. Some colour symbols with reference to concentration are summarized as below:-

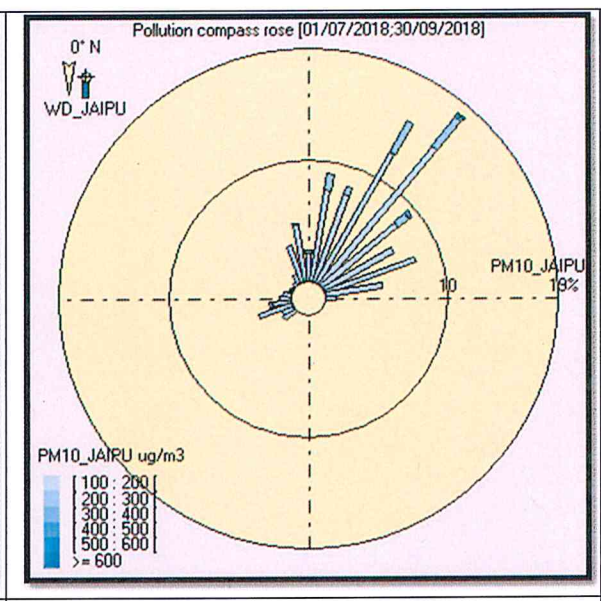
- Light Green symbols indicate a 24-hour average concentration of 10-50 µg/m3 or less
- Yellow symbols indicate a 24-hour average concentration of 50-100 µg/m3
- Red symbols indicate a 24-hour average concentration of 100-150 µg/m3
- Blue symbols indicate 24-hour average concentrations between 150-200 µg/m3
- Green symbols identify 24-hour average concentrations between 200-250 µg/m3
- Sky blue symbols identify concentrations greater than 250 µg/m3 (> 250).

Pollution rose graphics below were produced for Particulate matter for Continuous ambient monitoring sites at Jaipur. The Red, Blue, Green and Sky blue in the plot diagram symbolizes exceedances of the 24-hour PM10 NAAQS.

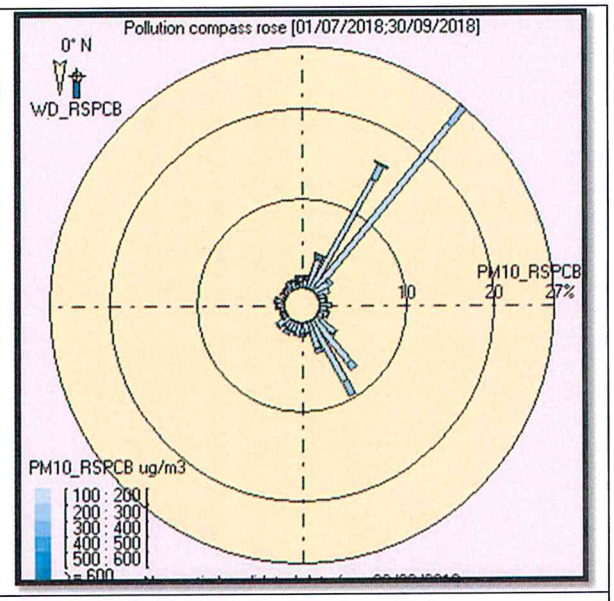
PM_{10} Pollution rose of Jaipur city on the basis captured data of 03 nos. CAAQMS are being displayed in Diagram 1-3.



Police Commissioner Office, Jaipur

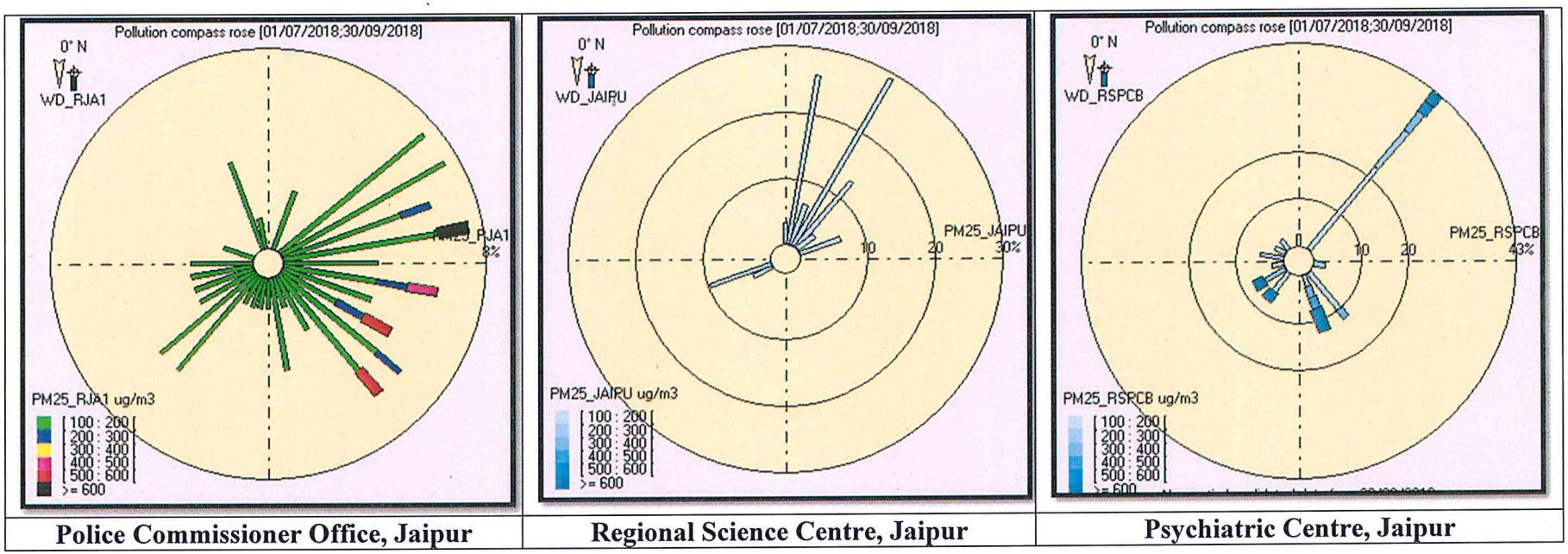


Regional Science Centre, Jaipur



Psychiatric Centre, Jaipur

$PM_{2.5}$ Pollution rose of Jaipur city on the basis captured data of 03 nos. CAAQMS are being displayed in Diagram 1-3.



Police Commissioner Office, Jaipur	Regional Science Centre, Jaipur	Psychiatric Centre, Jaipur

Pollution rose diagram 1-6 indicate impact of local environment pollution source like vehicles' DG set etc.

6. 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. Pollutants enter an organism through three different mechanisms. 1) Inhalation: through breathing. 2) Ingestion: some air pollutants can deposit onto soil or surface water, where they are taken up by plants and ingested by animals, and are eventually introduced into the food chain. 3) Skin contact: this type of contact is less frequent, except in case of accidental pollution or armed conflicts.

Numerous studies have found an association between air pollution and several adverse health effects in the general 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. 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.

As known to all, 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.

Short-term exposure to ozone can cause chest pain, coughing, throat irritation, while long term exposure can lead to decreased lung function. Excessive ozone in the air can have a marked effect on human health. It can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases.

Sulphur dioxide causes eye irritation, worsens asthma, increases susceptibility to respiratory infections, and impacts the cardiovascular system.

Some epidemiological studies provide evidence that long-term NO_2 exposure related to traffic related air pollution may decrease lung function and increase the risk of respiratory symptoms.

7. Conclusion

Monthly average from July, August and September 2018 reveals that both the particulate pollutants, PM10 and PM2.5 are mostly above permissible limits at all CAAQMS. 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 may be due to heavy transport activity in CAAQMS area, industrial emissions, dust from paved roads, other domestic purposes, etc.

It can be summarised that air pollution at the CAAQMS site 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.

Secondly 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.