

Research Article

A GIS Based Study for Air Quality Monitoring of Bikaner City, Rajasthan

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Abstract

The undesirable change in any gaseous substance present in ambient air in such concentration that may tends to be injurious to human beings and other living creature, plant, property. These substances which are responsible for such undesirable changes called air pollutants. A developmental activity like urbanization leads to potent impact on our surrounding environment, many cities around the world become more congested, concerns increase over the level of urban air pollution being generated and in particular its impact on localized human health. An attempt has been made in this study on yearly basis, pertaining to air quality standards of Bikaner city as one prominent city in the state of Rajasthan. Bikaner is the city which lies in desertic region of western Rajasthan is prominently as one of the air pollutant area affected generally by fine dust particles due to composition of soil as gypsum ingredient, despite that agricultural practices are also on large scale other factors like mining in adjoining areas, natural dust storm, three highways passes through and railway network is stretching within city is matter of concern. The study reveals that many times city has become declared as worst polluted city in India especially in context to suspended particulate matters. Some strategic location has been choosen for study which extrapolate the cause condition relationship between air pollution and their both fugitive and nonfugitive sources. The help has been taken from regional office of pollution control board as well as free samplings undertaken by researcher by using high volume sampler. The purpose of study is reveal the data in consonance of previous study that how these pollution datas are keep going in simulation for further mitigative measures and studies.

Keywords

Particulate Matter, Anthropogenic Activities, Emission Standards, Gaseous Pollutants, QGIS Map

1. Introduction

As many cities around the world become more congested, concerns increase over the level of urban air pollution being generated and in particular its impact on localized human health effects such as asthma or bronchitis. In the majority of the developed world, legislation has already been introduced to the extent that local authorities are required by law to conduct regular local air quality reviews of key urban pollu-

tants such as SO_x, NO_x, CO, Particulate Matter (PM_{2.5} and PM₁₀), Ozone, Lead, Ammonia, Benzene(a)Pyrene etc. [1, 2] Bikaner district is located in the north-western part of Rajasthan and encompassed between north latitudes 27°11' to 29°03' and east longitudes 71°52' to 74°15' covering geographical area of 30247.90 km². The district experiences arid type of climate. The National Air Quality Index (NAQI) en-

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Received: 23 November 2024; **Accepted:** 17 December 2024; **Published:** 17 February 2025



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sure comparison amongst various cities so that new measures can be formulated in order to decrease the quantity of particulate matter present in air and helps to sustain the optimum level of parameter pertaining to air environment [3, 4]. In this paper concentration of various pollutants along with various harmful gases for Bikaner city of India is analyzed based on past and recent NAQI data thereby highlighting those areas which are under extensive menace of pollution. [5, 6] Urban pollution is one of major threat, in which air pollution is more prevalent, as the city Bikaner the unscrupulous growth with population and other developmental activities are increasing in last two decades which is matter of cause concern.

The monitoring stations chosen should be free from any interference from the surrounding living stock. Sampling is usually done at 1-1.5 m height [7, 8]. To obtain a representative sample the sample should not be placed under a tree, near a wall or other obstructions that would prevent free air flow from the ambient atmosphere. In our case, sampling was done generally at the ground level of the respective sites so it was well above the prescribed height that is 1.5 m and was free from any obstructions to flow of air.

Name and location of the (03) NAMP (National Ambient Monitoring Program) stations of Bikaner are as:

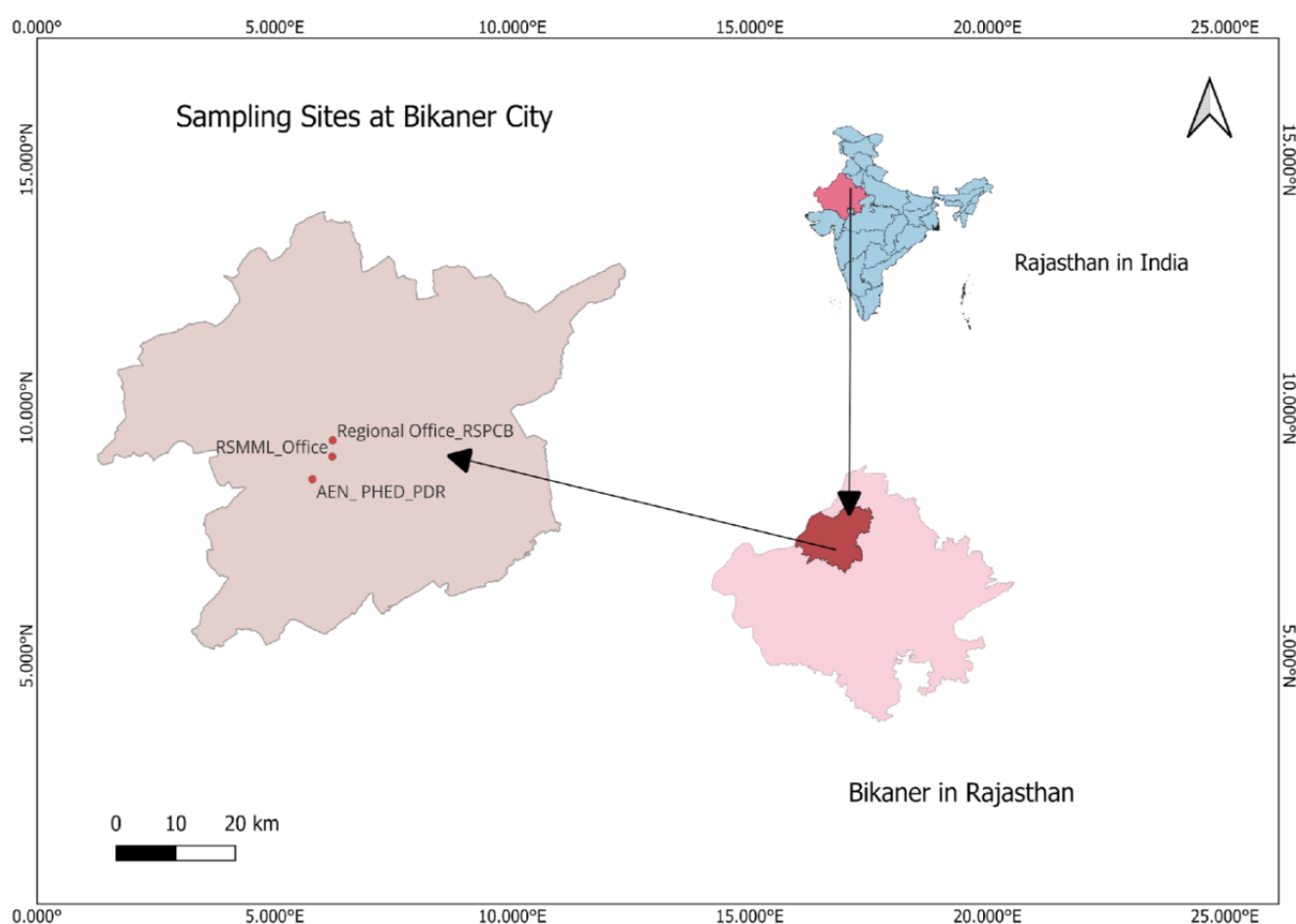


Figure 1. Monitoring sites under NAMP in Bikaner City.

Table 1. Sites under study areas.

S.No.	Name of the Location	Address of the locations	Type of locations	Co-ordinates of location
1	Regional Office, RSPCB	SPL-33, Bichhwal industrial area, Bikaner	Industrial	28.06638358N 73.33637305E
2	RSMML Office	02 Gandhi Scheme, Bikaner	Mixed	28.04009683N 73.33556174E
3	AEN PHED PDR	LaxamiNathjiGhati Road, Hammalon Ki Badi, Bikaner	Residential	28.00320887N 73.30124107E

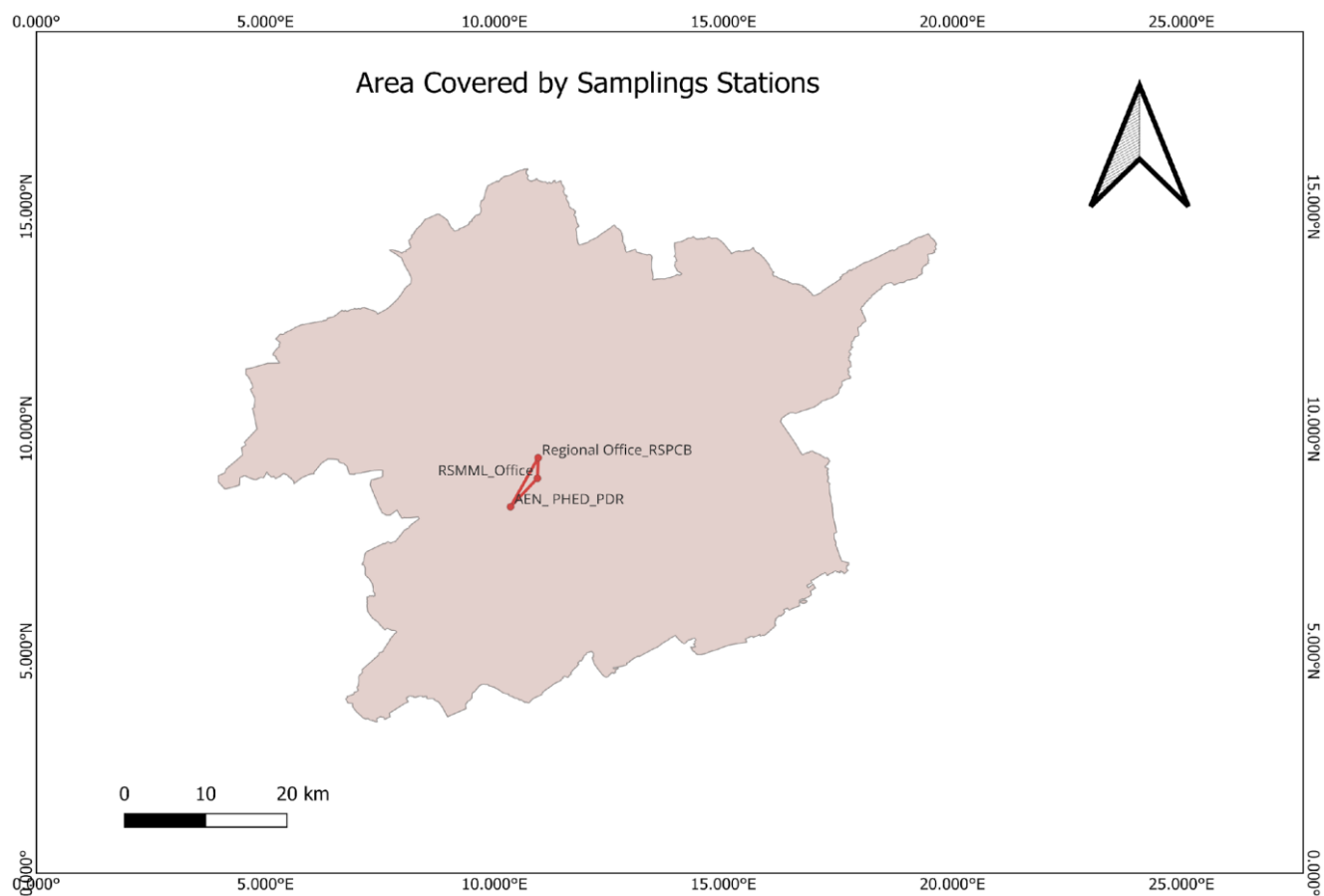


Figure 2. Map of NAMP Stations.

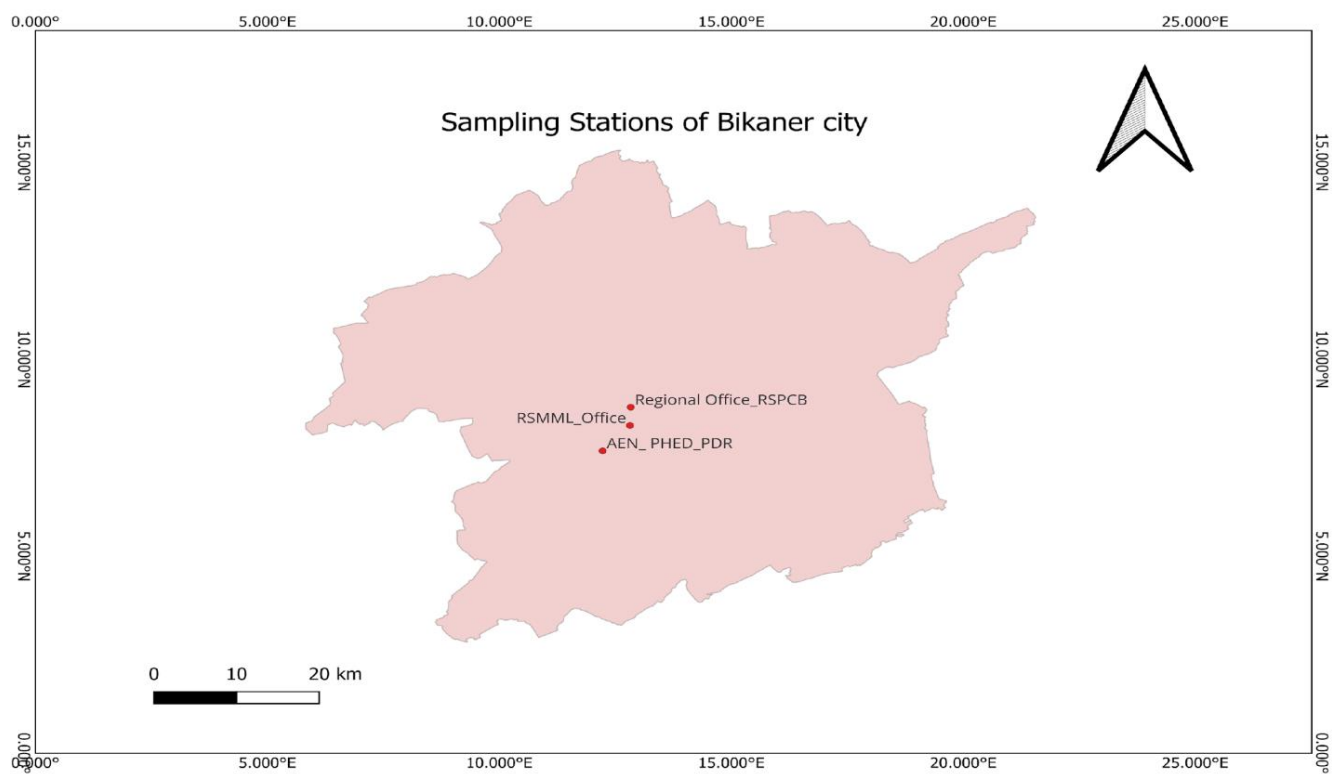


Figure 3. Map of NAMP Stations.

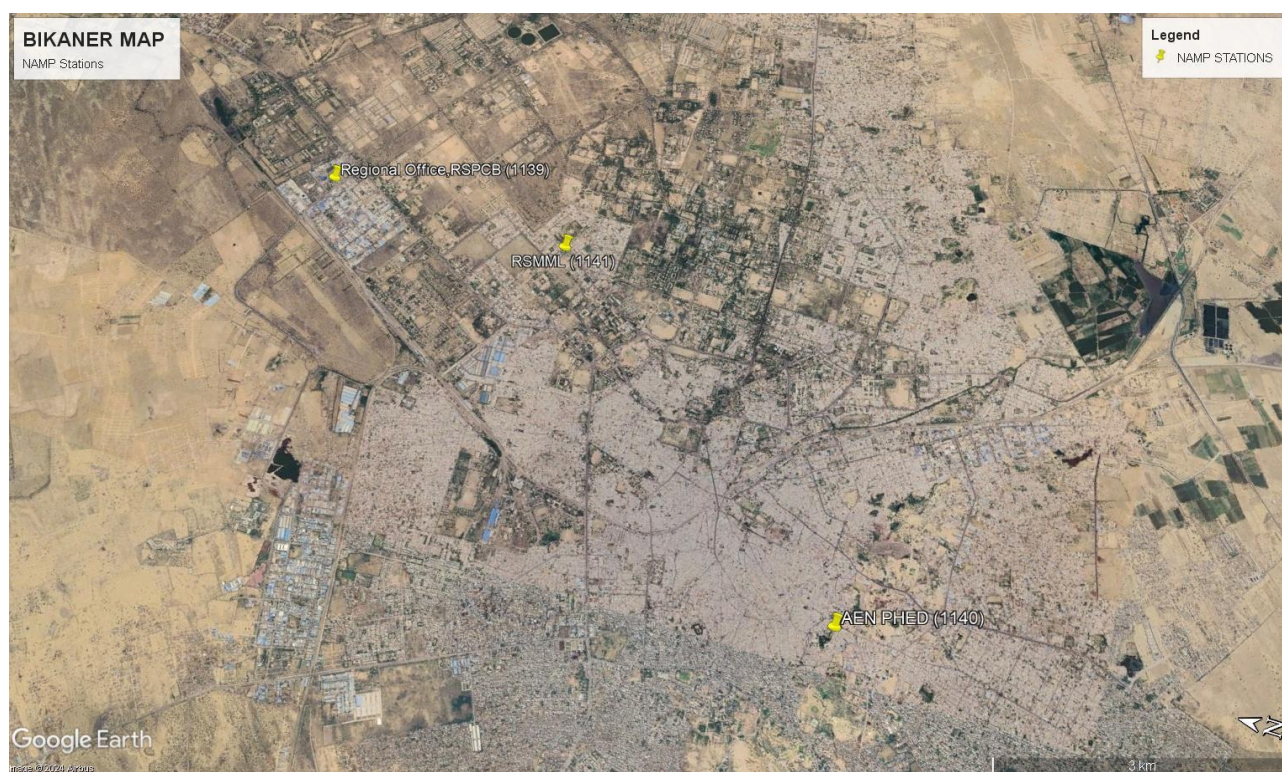


Figure 4. Google Earth Map of NAMP Sites Bikaner City.

2. Methodology

As per the CPCB (Central pollution control board) the methods prescribed for the respirable dust particulate, SO_2 ,

NO_2 pollutants Gravimetric Technique, Modified West and Gaeke method and Improved West and Gaeke method. The methods prescribed for the particulate pollutants and Gaseous pollutants are respectively [9, 10].

Table 2. Pollutants Standards and Methods of Measurements.

Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), $\mu\text{g}/\text{m}^3$	Annual *	50	20	-Improved West and Gaeke Method
	24 Hours **	80	80	-Ultraviolet Fluorescence
Nitrogen Dioxide (NO_2), $\mu\text{g}/\text{m}^3$	Annual* 24	40	30	-Jacob&Hochheiser Method
	Hours **	80	80	-Gas Phase Chemiluminescence
Particulate Matter (Size less than $10\mu\text{m}$) or PM_{10} , $\mu\text{g}/\text{m}^3$	Annual* 24	60	60	-Gravimetric
	Hours **	100	100	-TEOM -Beta attenuation

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

The purpose of this study was measurement to lay down a uniform and reliable method for measurement of Particulate Matter, SO₂ and NO₂ in the ambient air of Bikaner city.

Quantum Geographic Information System is free, open-source software that allows users to create, edit, analyze, visualize, and publish geospatial information. QGIS works by creating new vector layers by tracking over existing maps or aerial imagery. GIS is also integrated with modern technology of remote sensing and GPS [11].

3. Result

The result of monitoring of different sampling sites of NAMP Stations in Bikaner are as shown in tables. Station wise monthly Avg. data of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in Bikaner City.

Table 3. Average data of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) Monthly wise in Regional Office, RSPCB, Bikaner.

MonthParameter	Jan-23	Feb-23	March-23	April-23	May-23	June-23	July-23	Aug-23	Sept-23	Oct-23	Nov-23	Dec-23
PM ₁₀ µg/m ³	153	180	169	160	136	168	149	202	175	186	277	229
SO ₂ µg/m ³	5.75	5.46	5.35	5.25	5.29	5.18	5.13	5.08	4.58	5.2	5.2	5.17
NO ₂ µg/m ³	27.79	24.75	23.98	22.34	24.23	25.54	23.07	22.43	20.39	24.89	30.43	34.03

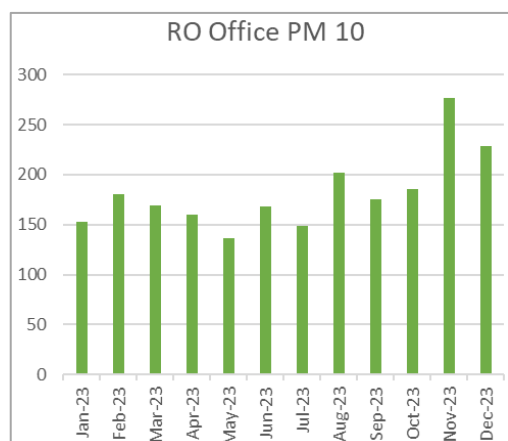


Figure 5. Concentration of PM₁₀ µg/m³ at Regional Office, RSPCB, Bikaner.

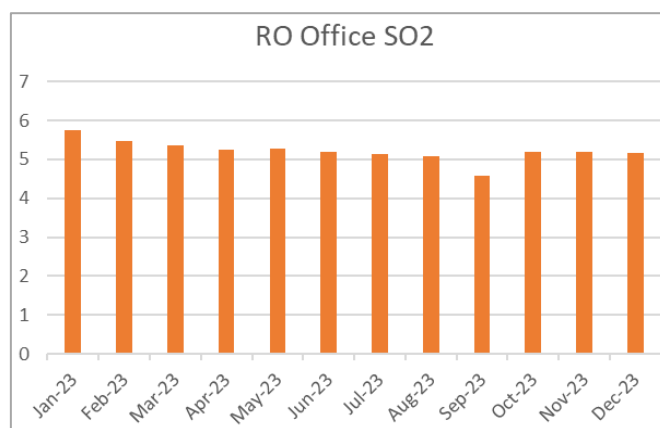


Figure 6. Concentration of SO₂ µg/m³ at Regional Office, RSPCB, Bikaner.

Table 4. Average data of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) Monthly wise in RSMML Office, 02 Gandhi Scheme, Bikaner.

MonthParameter	Jan-23	Feb-23	March-23	April-23	May-23	June-23	July-23	Aug-23	Sept-23	Oct-23	Nov-23	Dec-23
PM ₁₀ µg/m ³	145	133	110	161	143	126	115	146	129	115	202	135
SO ₂ µg/m ³	5.13	5.41	4.97	5.42	5.44	5.31	5.29	5.19	5.2	5.27	5.2	5.2
NO ₂ µg/m ³	25.03	24.58	22.57	23.71	24.56	25.18	24.35	24.7	23.22	24.86	29.95	33.06

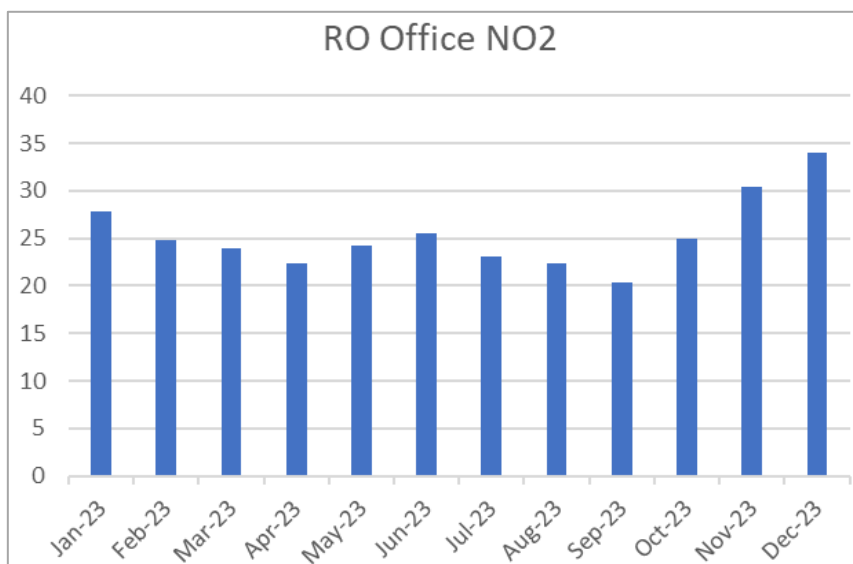


Figure 7. Concentration of NO₂ µg/m³ at Regional Office, RSPCB, Bikaner.

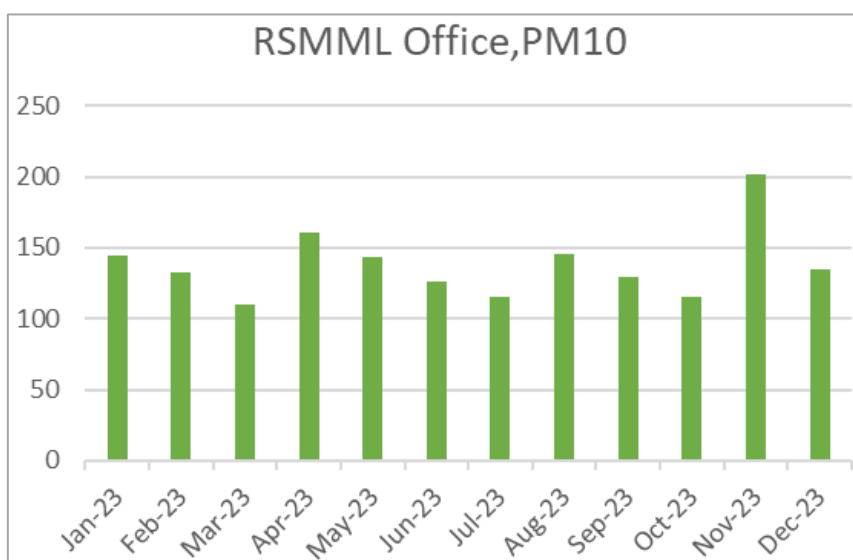


Figure 8. Concentration of PM₁₀ µg/m³ at RSMML Office, 02 Gandhi Scheme, Bikaner.

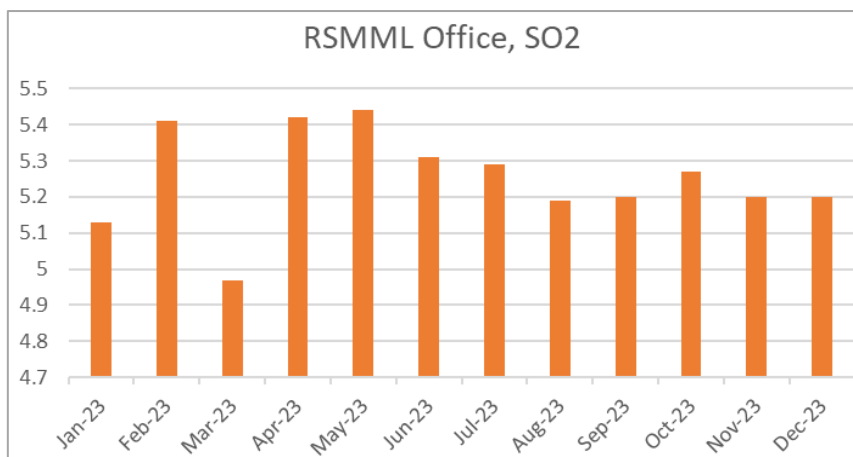


Figure 9. Concentration of SO₂ µg/m³ at RSMML Office, 02 Gandhi Scheme, Bikaner.

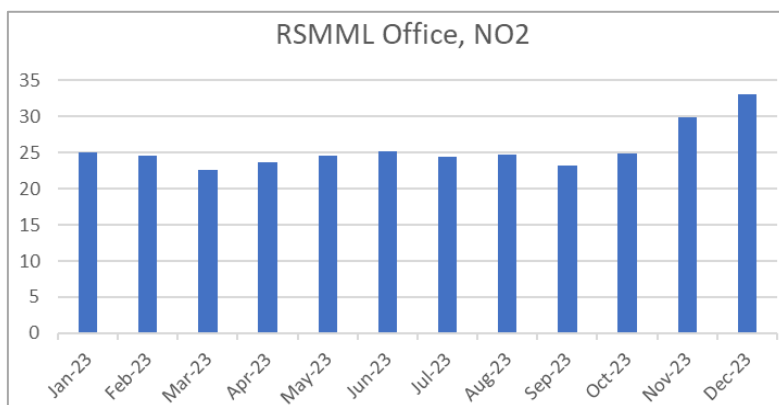


Figure 10. Concentration of NO₂ µg/m³ at RSMML Office, 02 Gandhi Scheme, Bikaner.

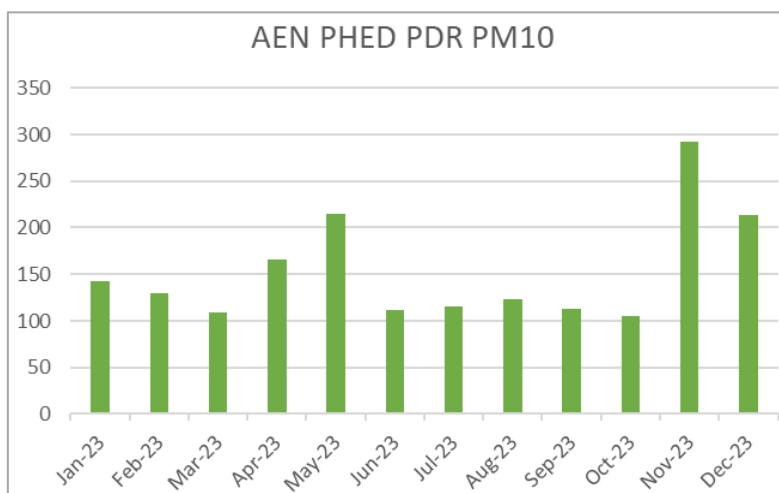


Figure 11. Concentration of PM₁₀ µg/m³ at AEN PHED PDR, Bikaner.

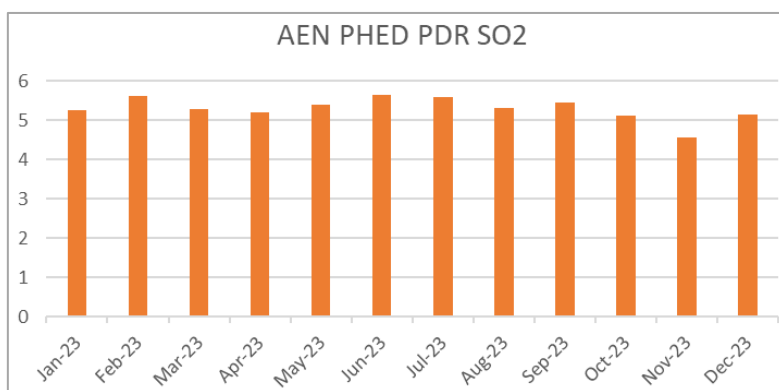


Figure 12. Concentration of SO₂ µg/m³ at AEN PHED PDR, Bikaner.

Table 5. Average data of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) Monthly wise in AEN PHED PDR, Sub division IV, LaxamiNathjiGhati Road, Hammalon Ki Badi, Bikaner.

MonthParameter	Jan-23	Feb-23	March-23	April-23	May-23	June-23	July-23	Aug-23	Sept-23	Oct-23	Nov-23	Dec-23
PM ₁₀ µg/m ³	142	129	109	166	215	111	116	123	113	105	292	213

MonthParameter	Jan-23	Feb-23	March-23	April-23	May-23	June-23	July-23	Aug-23	Sept-23	Oct-23	Nov-23	Dec-23
SO ₂ µg/m ³	5.26	5.63	5.29	5.21	5.39	5.66	5.58	5.3	5.44	5.13	4.56	5.14
NO ₂ µg/m ³	25.98	24.01	23.39	22.82	24.48	25.33	23.94	24.05	23.64	24.89	29.64	33.48

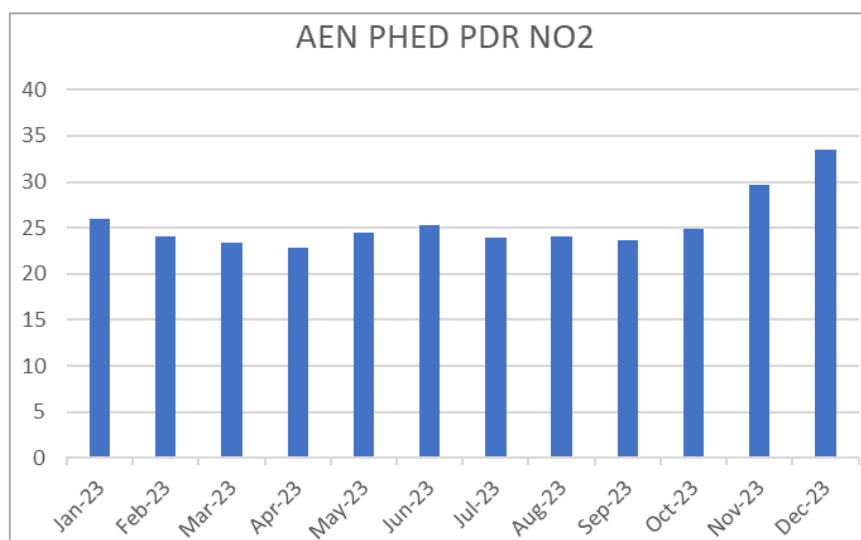


Figure 13. Concentration of NO₂ µg/m³ at AEN PHED PDR, Bikaner.

Table 6. Monthly Average of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in Bikaner City in 2023.

MonthParameter	Jan-23	Feb-23	March-23	April-23	May-23	June-23	July-23	Aug-23	Sept-23	Oct-23	NOV-23	Dec-23
PM ₁₀ µg/m ³	146.89	147.15	130.16	166.49	167.25	133.95	127.28	157.44	145.73	133.55	258.95	191.91
SO ₂ µg/m ³	5.39	5.5	5.4	5.29	5.37	5.39	5.33	5.19	5.26	5.2	5.18	5.17
NO ₂ µg/m ³	26.28	24.44	24.21	22.95	24.43	25.34	23.76	23.73	23.27	24.88	31.21	33.53

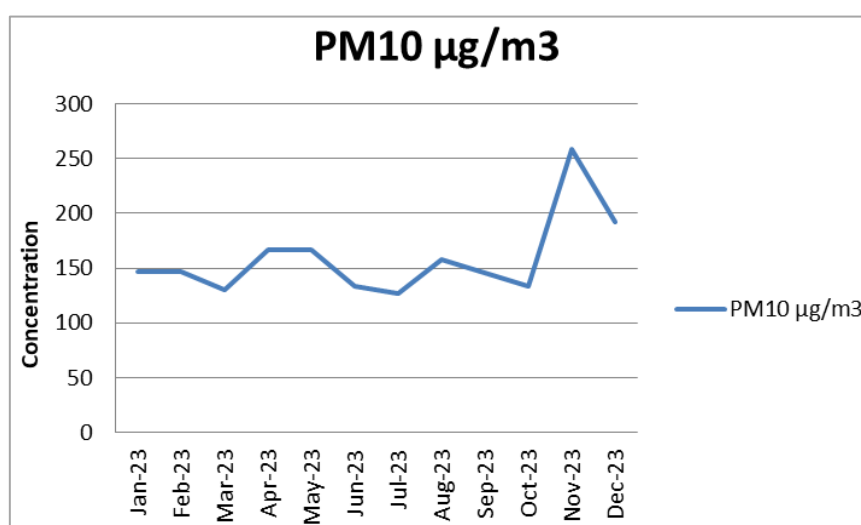


Figure 14. Monthly Average Graph of Particulate Matter (PM₁₀) in Bikaner City 2023.

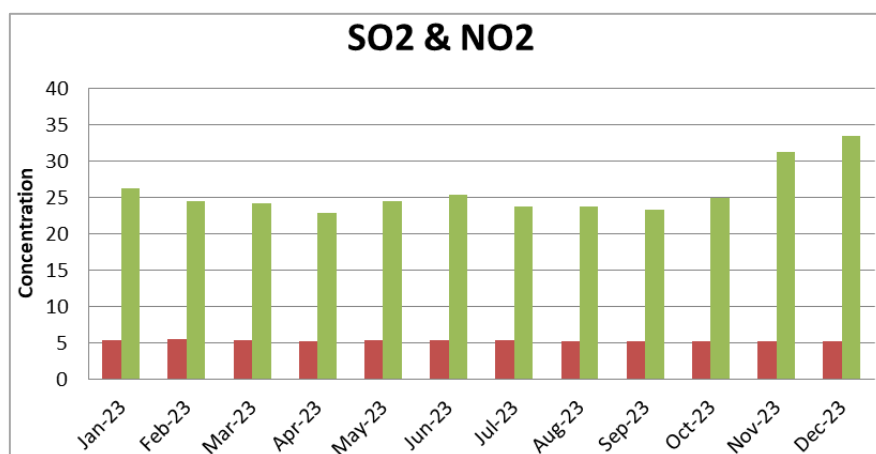


Figure 15. Monthly Average of Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) Concentration in µg/m³ in Bikaner City in 2023.

Table 7. Yearly Avg. Data of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in Bikaner City.

S.No.	Parameter	Yearly (2023) Avg data	Monthly Mini. Avg.	Monthly Max. Avg.
1.	PM ₁₀ µg/m ³	158.89	127.28	258.95
2.	SO ₂ µg/m ³	5.30	5.17	5.5
3.	NO ₂ µg/m ³	25.66	22.95	33.53

4. Discussion

4.1. Regional Office, RSPCB, Bikaner

This data represents the concentration of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in µg/m³ of Regional Office, RSPCB, Bikaner. The data taken monthly wise throughout the year. The data shows that concentration of PM₁₀ in November month is maximum and in may month it is minimum. The concentration of SO₂ in January month is maximum and in September month it is minimum. The concentration of NO₂ in December month is maximum and in September month it is minimum.

4.2. RSMML Office, 02 Gandhi Scheme, Bikaner

This data represents the concentration of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in µg/m³ of. The data taken RSMML Office, 02 Gandhi Scheme, Bikaner monthly wise throughout the year. The data shows that concentration of PM₁₀ in November month is maximum and in March month it is minimum. The concentration of SO₂ in May month is maximum and in March month it is minimum. The concentration of

NO₂ in December month is maximum and in March month it is minimum.

4.3. AEN PHED PDR, Sub Division IV, Laxami Nathji Ghati Road, Hammalon Ki Badi, Bikaner

This data represents the concentration of Particulate Matter (PM₁₀), Sulphur Di-oxide (SO₂) and Nitrogen Di-oxide (NO₂) in µg/m³ of. The data taken AEN PHED, Sub division IV, Laxami Nathji Ghati Road, Hammalon Ki Badi, Bikaner monthly wise throughout the year. The data shows that concentration of PM₁₀ in November month is maximum and in March month it is minimum. The concentration of SO₂ in June month is maximum and in November month it is minimum. The concentration of NO₂ in December month is maximum and in April month it is minimum.

The yearly average Data of Particulate Matter (PM₁₀) is 158.89 µg/m³. The monthly minimum average is 127.27 µg/m³ and monthly maximum average is 258.95 µg/m³. Yearly Sulphur Di-oxide (SO₂) is 5.30 µg/m³. the monthly minimum average is 5.17 µg/m³ and monthly maximum average is 5.5 µg/m³ and yearly Nitrogen Di-oxide (NO₂) is 25.66 µg/m³ the monthly minimum average is 22.95 µg/m³ and monthly maximum average is 33.53 µg/m³ in Bikaner City.

5. Conclusion

Air pollution and control act passed in 1981 and amended in 1987 to ensure prevention, control and abatement of air pollution in India. Supreme Court has taken air pollution prevention seriously by taking several initiatives [12] like making use of compresses natural gas in public services mandatory due to which cumulative percentage of pollution has decreased. Increasing of cities have also great role in increase the air pollution rates as use of personal vehicles and in Bikaner especially the contribution of SPM due have increase in dust devils to larger extent. In most of cities in India a provision for vehicles is made in which vehicles is certified as “pollution under control” with validity of three months after proper testing under norms of Bharat Stage 2nd or higher emission norms, along with pollution control board present in every state perform ambient air quality monitoring at work-stations present all over states across the country to keep continuous tract about air pollution levels and applying corrective actions wherever necessary [13]. Many organizations have been established that work in hand with government to make necessary efforts to reduce air pollution for example Energy and resource institute, and Indian association for air pollution control, society of Indian automobile manufacturers etc are actively involved in prevention of air pollution [14].

6. Recommendation

As the present discourse reveals that air pollution is one of major problem in Bikaner city despite than other pollution too, as the city is expanding at large pace with their population and other infrastructural facilities due to Indira Gandhi canal and large deposition of non ferrous minerals in adjoining area contribute the pollution at greater extent therefore it is having urgent need to monitoring the air quality on regular basis, stringent action shall undertaken for mining activities and public awareness are main component to address aforesaid problem.

Abbreviations

SPM	Suspended Particulate Matter
GPS	Global Positioning Satellite
QGIS	Quantum Geographical Information System
NAQI	National Ambient Air Quality Index
SOX	Sulphur Oxide
NOX	Nitrogen Oxide
CO	Carbon Monoxide
PM	Particulate Matter
NAMP	National Air Quality Programme
RSPCB	Rajasthan State Pollution Control Board
RSMML	Rajasthan State Mines and Mineral Limited

CPCB	Central Pollution Control Board
AEN, PHED	Assist Engineer, Public Health Engineering Department

Conflicts of Interest

The authors declare no conflicts of interest.

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