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Assessment of Ambient Air Quality of Hoshangabad of M.P.

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ABSTRACT

Air quality assessment is frequently driven by the need to determine whether a standard or guideline has been exceeded. This overshadows another objective of air quality assessment: providing the information needed to estimate population exposure to air pollution and the effects on the health of the population. In this study analysis of air pollutants such as PM10, PM2.5, SO2, and NO2, were assessed to determine the ambient air quality of Hoshangabad City. The PM10 and PM2.5 were found moderate for all monitoring stations. Gaseous air pollutants SO2, and NOx were well below the permissible limit in all the sampling station in all three study years. Seasonal values for SO2; and NO2 were also found within the permissible limits at all the stations and in all the seasons.

KEYWORDS: *Air quality, air pollutants, PM10, PM2.5, humidity, temperature, NO2, Hoshangabad, Meenakshi-Chowk*

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1. INTRODUCTION

Ambient air monitoring is the systematic, long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air. Ambient air monitoring is an integral part of an effective air quality management system. Reasons to collect such data include to [1]:

- assess the extent of pollution;
- provide air pollution data to the general public in a timely manner;
- support implementation of air quality goals or standards;
- evaluate the effectiveness of emissions control strategies;
- provide information on air quality trends;
- provide data for the evaluation of air quality models; and
- support research (e.g., long-term studies of the health effects of air pollution).

There are different methods to measure any given pollutant. A developer of a monitoring strategy should examine the options to determine which methods are most appropriate, considering the main uses of the data, initial investment costs for equipment, operating costs, reliability of systems, and ease of operation. [2]

The locations for monitoring stations depend on the purpose of the monitoring. Most air quality monitoring networks are designed to support human health objectives, and monitoring stations are established in population centers. They may be near busy roads, in city centers, or at locations of particular concern (e.g., a school, hospital, particular emissions sources). Monitoring stations also may be established to determine background pollution levels, away from urban areas and emissions sources. Systems are needed to ensure that data are of acceptable quality, to record and store the data, and to analyze the data and present results. [3]

In India, Central Pollution Control Board initiated a nationwide network of National Ambient Air Quality Monitoring in the year 1984 with seven monitoring stations. Since then the number of monitoring stations have increased, steadily, over the period and now 290 stations covering 92 cities are in operation. The programme is being carried out with the help of State Pollution Control Bourds and some other agencies. The three criteria pollutants viz. sulphur dioxide (SO), oxides of nitrogen (NOx) and suspended particulate matter (SPM) are being monitored regularly at all the monitoring locations. [4] Besides this, in 10 metro-cities of the country, additional parameters such as respirable particulate matter (RPM), respirable lead & other toxic trace metals, hydrogen sulphide (HS), ammonia (NH) and polycyclic aromatic hydrocarbons (PAHs) are also being monitored. The monitoring of pollutants is carried out for 24 hours' averaging period (4-hourly sampling for gaseous pollutants & 8- hourly sampling for SPM) with a frequency of twice a week. [5]

Central Pollution Control Board laid down standards for ambient air quality with regard to various pollutants in respect of industrial, residential and sensitive areas. These standards provide the basis for protecting the public health, vegetation, animals and national heritage (monuments) from the adverse effects of air pollution within adequate margins of safety. This helps in continuous evaluation of air quality and deciding & taking appropriate actions for controlling the air pollution. [6]

2. LITERATURE REVIEW

Gokulet al.(2023)[7] presented PM2.5 prediction for Hyderabad city using various machine learning models viz. Multi-Linear Regression (MLR), decision tree (DT), K-Nearest Neighbors (KNN), Random Forest (RF), and XGBoost. A deep learning model, the Long Short-Term Memory (LSTM) model, was also used in this study. The results obtained were finally compared based on error and R2 value. The best model was selected based on its maximum R2 value and minimal error.

CM, Arun Muraliet al.(2023)[8]assessed and quantified the impact of meteorological, hydrological, and agricultural drought events from 2001 to 2017 over two large states of India (i.e., Maharashtra and Madhya Pradesh) using multi-temporal earth observation data at a finer resolution of 1 km.

Dangayachet al.(2023)[9]monitored the impact of COVID-19-induced lockdown and unlock down phases on the air quality of Jaipur city, Rajasthan, India by assessing the change in ambient air quality during pre-COVID-19 (January 2018–December 2019) and COVID-19 (January 2020–December 2021) phases by evaluating air quality parameters (PM10, PM2.5, NO2, O3, Benzene and o-Xylene) using ground station data.

Sicardet al.(2023)[10]presented that Ground-level ozone (O3), fine particles (PM2.5), and nitrogen dioxide (NO2) are the most harmful urban air pollutants regarding human health effects. Here, we aimed at assessing trends in concurrent exposure of global urban population to O3, PM2.5, and NO2 between 2000 and 2019. PM2.5, NO2, and O3 mean concentrations and summertime mean of the daily maximum 8-h values (O3 MDA8) were analyzed (Mann-Kendall test) using data from a global reanalysis, covering 13,160 urban areas, and a ground-based monitoring network (Tropospheric Ozone Assessment Report), collating surface O3 observations at nearly 10,000 stations worldwide. At global scale, PM2.5 exposures declined slightly from 2000 to 2019 (on average, − 0.2 % year−1), with 65 % of cities showing rising levels. The highest O3 MDA8 increases (>3 % year−1) occurred in Equatorial Africa, South Korea, and India.

Badidaet al.(2023)[11] presented short term and long-term health impacts of ambient air pollutants focussed in LMICs. We evaluated Total Non-accidental mortality, Respiratory Mortality, Stroke Mortality, Cardio-vascular Mortality, Chronic Obstructive Pulmonary Disease (COPD), Ischemic Heart Disease (IHD) and Lung Cancer Mortality in LMICs particularly. Random Effects Model was utilised to derive overall risk estimate. Relative Risk (RR) estimates per 10 μg/m3 was used as input for model. We also found statistically significant positive associations between pollutants and Cardiorespiratory and Cardiovascular morbidity.

Ravindraet al.(2023)[12] examined the effect of air pollution on patient's hospital visits for respiratory diseases, particularly Acute Respiratory Infections (ARI). Outpatient hospital visits, air pollution and meteorological parameters were collected from March 2018 to October 2021. Eight machine learning algorithms (Random Forest model, K-Nearest Neighbors regression model, Linear regression model, LASSO regression model, Decision Tree Regressor, Support Vector Regression, X.G. Boost and Deep Neural Network with 5-layers) were applied for the analysis of daily air pollutants and outpatient visits for ARI. This study gives insight into developing machine learning programs for risk prediction that can be used to predict analytics for several other diseases apart from ARI, such as heart disease and other respiratory diseases.

Filonchyket al.(2023)[13]presented the effectiveness of government policies to reduce emissions. It was found that emission of pollutants from the country's energy sector has been steadily declining, with annual emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) decreasing from the US electric power sector between 1990 and 2020 by 93.4% and 84.8%, respectively, and carbon dioxide (CO2) by 37% between 2007 and 2020.

Aheret al.(2022)[14] quantified the changes in the pollutants level in the ambient air of Madhya Pradesh during COVID-19 induced 21 days lockdown. The data of 16 continuous ambient air quality monitoring stations (CAAQMS) for six pollutants, namely PM2.5, PM10, SO2, NOx, CO, and Ozone for pre-lockdown (1–21 March 2020) and lockdown (25 March-14 April 2020) period was compiled and appropriate statistical analysis was done.

Trushnaet al.(2022)[15]conducted environmental monitoring and health assessment in residential areas near viscose rayon and associated chemical manufacturing industries. Sociodemographic and anthropometric information, relevant medical and family history, and investigations including spirometry, electrocardiogram, neurobehavioral tests, and laboratory investigations (complete blood count, lipid profile and random blood glucose) will be conducted.

Sharmaet al.(2022)[16] Air Quality Index and concentration trends of six pollutants, i.e. PM2.5, PM10, NO2, SO2, CO, and O3 were analysed for National Capital Territory of Delhi, India for three periods in 2021 (pre-lockdown: 15 March to 16 April 2021, lockdown: 17 April to 31 May 2021 and post-lockdown: 01 June to 30 June). Data for corresponding periods in 2018–2020 was also analysed.

3. METHODOLOGY

3.1. Monitoring Area

Hoshangabad also known as Narmadapuram is a city and a municipality in Hoshangabad district in the Indian state of Madhya Pradesh. It serves as the headquarters of both Hoshangabad district and Narmadapurram division. It is located in central India, on the south bank of the Narmada River. Hoshangabad is 76.7km from the state capital Bhopal.

Hoshangabad is located at 22.75°N 77.72°E. It has an average elevation of 278 metres (912 feet). The climate of Hoshangabad district is typically that of Central India. Being close to the Tropic of Cancer, there is a hot, dry summer with maximum temperature of 40 - 42 degrees Celsius (April - June). This is followed by the monsoons with copious rainfall. The winters are dry and mild (November to February). An average height from the sea level is 331 m and average rainfall is 134 cm.

3.2.Sampling sites:

Four sampling sites have been selected for the proposed research work. The site selection is based on the representation of industrial area, commercial area, Residentiar area and other sensitive area.

1. **SPM-** SPM is an area on Rasuliya road, Hoshangabad. It's an industrial area. There is a paper mill in this area. The paper mill may harm the quality of air in the area. There is also a bus route passing through theis area.
2. **Bus station**- Hoshangabad is a junction of road transport. The buses move in different direction from here. This are is also full of activities. Hundreds of people move in different direction from here. It is also situated in the center of the city. So, the area must be air quality affected.
3. **Meenkeshi chowk**- This area of meenakashi chowk situsated the centre of the town. This is a place full of activity. This is a main commercial area of the city.
4. **Rasuliya- Rasuliya-** is a part of Hoshangabad. Different routes of buses pass through this area. Railway track also passes through this area. The burning agriculture f a residues is also generally found in the area.

Table 3.1 Selected Air Quality Monitoring Stations

S. no	Area code	Selected Area	Area Type
1	I-2	SPM	Industrial
2	C-2	Bus station	Commercial
3	R-2	Meenkeshi chowk	Residential
4	S-2	Rasuliya	Sensitive

3.3. Parameters:

For the study of air quality of the study area following four air quality parameters have been selected:

1. PM 10
2. PM 2.5
3. NO_X
4. SO_2

The Ambient air quality is monitored at four locations in Hoshangabad area. Ambient air is drawn through a size-selective inlet of the dust sampler Envirotech APM-460 BL and APM 540 equipments. The sample collection and analysis was carried out as per standard methods specified in National Ambient Air Quality Standards (NAAQS), Central Pollution Control Board.

3.4. Sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method)

Sampling and analysis of particulate matter (PM10) in ambient air using the gravimetric method involves collecting airborne particles on a filter medium and then measuring the mass of the collected particles. Particulate Matter (PM10) in ambient air is drawn through a size-selective inlet of the dust sampler Envirotech APM-460 BL equipment. This consists of 20.3 X 23.4 cm (8 X 10in) filter with a flow rate of 0.5 /min. Usually glass fibre filter for PM10 is used. Particles with aerodynamic diameter less than the cut-point of the inlet are only collected by these filters. The mass of the collected particles is determined by the difference in the filter paper weights prior to and after sampling. The concentrations of the particles in the designated size range are calculated by dividing the weight gain of the filter by the volume of air sampled. The system is designed to operate at an air flow of 1 LPM and the sampling period is set to 24 hrs.

Fig3. 1 Respirable dust samplers

3.5. Sampling and analysis of PM2.5 in ambient air (Gravimetric Method)

Particulate Matter (PM2.5) in ambient air is drawn through a size-selective inlet of the dust sampler Envirotech APM 550 MFC equipment. Usually 37 mm and 47 mm glass fibre filter for is used for PM2.5 sampling. Particles with aerodynamic diameter less than the cut-point of the inlet are only collected by these filters. The mass of the collected particles is determined by the difference in the filter paper weights prior to and after sampling. The concentrations of the particles in the designated size range are calculated by dividing the weight gain of the filter by the volume of air sampled.

Fig3.2 Filter Paper

3.6. Sampling and analysis of Nitrogen dioxide in ambient air (Modified Jacob and Hochheiser Method)

Oxides of Nitrogen gases in ambient air are collected by bubbling ambient air through a sodium hydroxide–sodium arsenate solution to form a stable solution of sodium nitrite. The absorbing reagent is mixed with phosphoric acid and sulphanilamide (Diazotizing reagent) and N-1 (Napthyl) – ethylenediamine dihydrochloride (NEEDA) (Coupling reagent) an azo- dye is formed. The intensity of the dye colour is estimated spectrophotometrically

3.7. Sampling and Analysis of sulphur dioxide in ambient air (Improved West and Gaeke method)

SO_2 gas in ambient air is absorbed from the ambient air into the absorbing solution sodium or potassium tetra chloro mercurate taken into the impingers. A stable di-chloro sulphite mercurate complex is formed which is then treated with bleached pararosaniline solution and HCl to form intensely colored (red purple) rosaniline methanol sulphonic acid. The concentration of the color is then determined spectrophotometrically

4. RESULT AND DISCUSSION

4.1. ZONE SPM HOSHANGABAD –

4.1.1. PM10 CONCENTRATION

Concentration (µg/m³) = (Collected Mass in µg) / (Sampled Volume in m³) * (Reference Time / Sampled Time)

PM10 (**µg/m³**) = (FINAL weight – INITIAL weight) x 10^6/((8 X60) X 1.25)

The results are shown below

	INI (Wi)	FINAL (Wf)	Concentration (Wi-Wf)	PM10
Apr-20	2.7916	2.839546	0.047946	79.91
Apr-20	2.707852	2.756482	0.04863	81.05
Apr-20	2.626616	2.676218	0.049602	82.67

4.1.2. PM2.5CONCENTRATION

Concentration (µg/m³) = (Collected Mass of PM2.5 in µg) / (Sampled Volume in m³)

	INI (Wi)	FINAL (Wf)	Concentration (Wi-Wf)	PM2.5
Apr-20	0.000806	0.718406	0.7176	29.90
Apr-20	0.000782	0.019384	0.018602	31.00
Apr-20	0.000758	0.019988	0.01923	32.05

4.1.3. SO2 CONCENTRATION

Concentration (ppm or µg/m³) = (Measurement Value) / (Calibration Factor)

$$C\ (SO_2\ \mu g/m\ ) = (As - Ab\ )\ x\ CF\ x\ Vs\ /\ Va\ x\ Vt$$

Where,
C SO_2 = Concentration of Sulphur dioxide, µg/m
As = Absorbance of sample
Ab = Absorbance of reagent blank
Cs = Calibration factor F
Vs = Volume of air sampled, m
Va = Volume of sample, ml
Vt = Volume of aliquot taken for analysis, ml

SO2 = (As - Ab) X 0.382 X 2615.44 / 240

	As	Ab	As-Ab	SO2
Apr-20	0.015	2.582369	2.567369	10.75
Apr-20	0.01455	2.652032	2.637482	11.04
Apr-20	0.014114	2.885046	2.870933	12.01

4.1.4. NOX CONCENTRATION.

C (NO µg/m) = (As - Ab) x CF x Vs / Va x Vt x 0.82

Where,
C NO = Concentration of Nitrogen dioxide, µg/ m^3
As = Absorbance of sample
Ab = Absorbance of reagent blank
CF = Calibration factor
Vs = Volume of air sampled, m^3
Va = Volume of sample, ml
Vt = Volume of aliquot taken for analysis, ml
0.82 = Sampling efficiency

C (NO µg/m) = (As - Ab) x 2.5 / (0.82 x 240)

	As	Ab	As-Ab	NOX
Apr-20	0.03	1.228906	1.198906	15.23
Apr-20	0.0291	1.355532	1.326432	16.85
Apr-20	0.028227	1.367254	1.339027	17.01

Similarly, concentrations are calculated for other zones as well.

4.2. ZONE MEENKESHI CHOWK

4.2.1. PM10 CONCENTRATION

The results are shown below

	INI (Wi)	FINAL (Wf)	Concentration (Wi-Wf)	PM10
Oct-20	2.6916	2.7331	0.0415	69.1861
Oct-21	2.7796	2.8217	0.0421	70.1731
Oct-22	2.6962	2.7392	0.0429	71.5757

4.2.2. PM2.5 CONCENTRATION

	INI (Wi)	FINAL (Wf)	Concentration (Wi-Wf)	PM2.5
Oct-20	0.0008	0.0163	0.0155	25.8874
Oct-21	0.0008	0.0169	0.0161	26.8433
Oct-22	0.0008	0.0174	0.0166	27.7489

4.2.3. SO2 CONCENTRATION

	As	Ab	As-Ab	SO2
Oct-20	0.0154	2.0304	2.0150	8.4522
Oct-21	0.0149	2.0852	2.0702	8.6802
Oct-22	0.0145	2.2684	2.2539	9.4429

4.2.4. NOX CONCENTRATION

	As	Ab	As-Ab	NOX
Oct-20	0.0291	0.9717	0.9426	11.9746
Oct-21	0.0299	1.0728	1.0429	13.2483
Oct-22	0.0290	1.0818	1.0528	13.3741

4.3. ZONE BUS STATION HOSHANGABAD –

4.3.1. PM10 CONCENTRATION

The results are shown below

	INI (Wi)	FINAL(Wf)	Concentration (Wi-Wf)	PM10
Dec-20	2.4986	2.5511	0.0525	87.5066
Dec-21	2.6630	2.7163	0.0533	88.7549
Dec-22	2.6630	2.7173	0.0543	90.5289

4.3.2. PM2.5 CONCENTRATION

	INI (Wi)	FINAL(Wf)	Concentration (Wi-Wf)	PM2.5
Dec-20	0.0008	0.0205	0.0196	32.7424
Dec-21	0.0008	0.0212	0.0204	33.9514
Dec-22	0.0008	0.0218	0.0211	35.0968

4.3.3. SO2 CONCENTRATION

	As	Ab	As-Ab	SO2
Dec-20	0.0152	2.5680	2.5528	10.6903
Dec-21	0.0147	2.6373	2.6226	10.9787
Dec-22	0.0143	2.8690	2.8547	11.9433

4.3.4. NOX CONCENTRATION

	As	Ab	As-Ab	NOX
Dec-20	0.0304	1.2226	1.1923	15.1455
Dec-21	0.0295	1.3486	1.3191	16.7565
Dec-22	0.0286	1.3602	1.3316	16.9156

4.4. ZONE RASULIYA HOSHANGABAD-

4.4.1. PM10 CONCENTRATION

Concentration (µg/m³) = (Collected Mass in µg) / (Sampled Volume in m³)* (Reference Time / Sampled Time)

PM10 (**µg/m³**) = (FINAL weight – INITIAL weight) x 10^6/ (8 X60) X 1.25)

The results are shown below

	INI (Wi)	FINAL(Wf)	Concentration (Wi-Wf)	PM10
Feb-21	2.5200	2.5588	0.0388	64.6744
Feb-22	2.7336	2.7729	0.0394	65.5970
Feb-23	2.7336	2.7737	0.0401	66.9081

4.4.2. PM2.5 CONCENTRATION

	INI (Wi)	FINAL(Wf)	Concentration (Wi-Wf)	PM2.5
Feb-21	0.0008	0.0154	0.0145	24.1993
Feb-22	0.0008	0.0159	0.0151	25.0928
Feb-23	0.0008	0.0164	0.0156	25.9393

4.4.3. SO2 CONCENTRATION

	As	Ab	As-Ab	SO2
Feb-21	0.0159	2.0900	2.0741	8.7004
Feb-22	0.0154	2.1464	2.1310	8.9351
Feb-23	0.0149	2.3350	2.3200	9.7202

4.4.4. NOXCONCENTRATION

	As	Ab	As-Ab	NOX
Feb-21	0.0312	1.0015	0.9703	12.3262
Feb-22	0.0308	1.1043	1.0735	13.6374
Feb-23	0.0299	1.1136	1.0837	13.7669

4.5. RESULT ANALYSIS

Table 4. 1 Annual value of PM10 2020-2023

Month	Stations			
	I-2	R-2	C-2	S-2
Apr-20-Mar 21	79.91	69.19	87.51	64.67
Apr-21-Mar 22	81.05	70.17	88.75	65.60
Apr-22-Mar 23	82.67	71.58	90.53	66.91
Average	81.21	70.31	88.93	65.73
SD	1.132431	0.980459	1.240084	0.916522
Min	79.91	69.19	87.51	64.67
Max	82.67	71.58	90.53	66.91

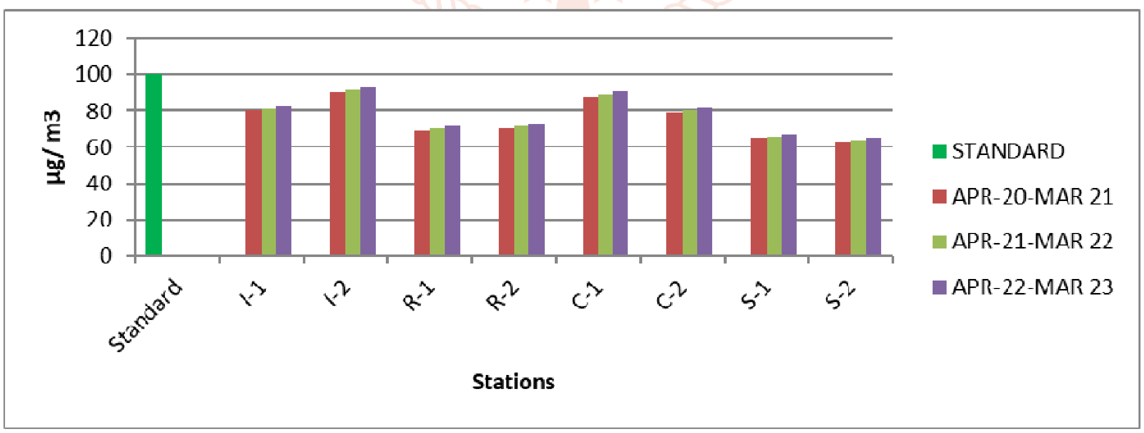

Fig 4. 1 Showing PM10 in 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zones, and maximum in the year 2022-2023, while lowest at residential zones in year 2020-2021 i.e (lockdown period).

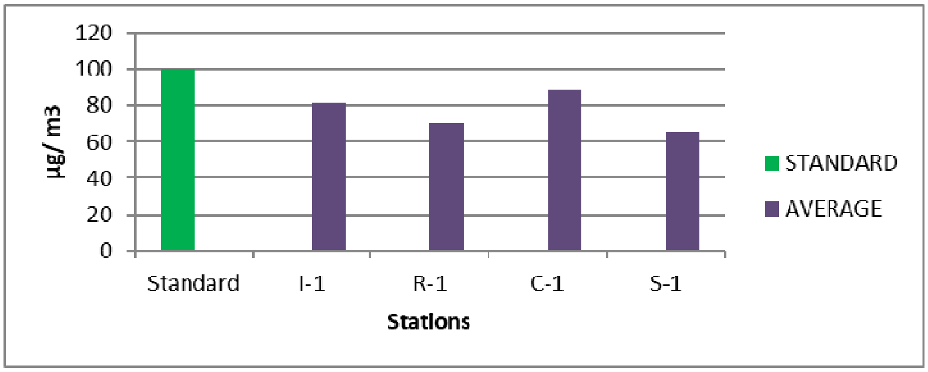

Fig 4. 2 Average Value of PM10 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zone, Rasuliya, Hoshangabad, while lowest at residential zone Meenakshi Chowk.

Table 4. 2 Annual value of PM2.5 2020-2023

Month	Stations			
	I-2	R-2	C-2	S-2
Apr-20-Mar 21	29.90	25.89	32.74	24.20
Apr-21-Mar 22	31.00	26.84	33.95	25.09
Apr-22-Mar 23	32.05	27.75	35.10	25.94
Average	31.53	27.30	34.52	25.52
SD	0.523	0.452813	0.572718	0.423285
Min	31.00	26.84	33.95	25.09
Max	32.05	27.75	35.10	25.94

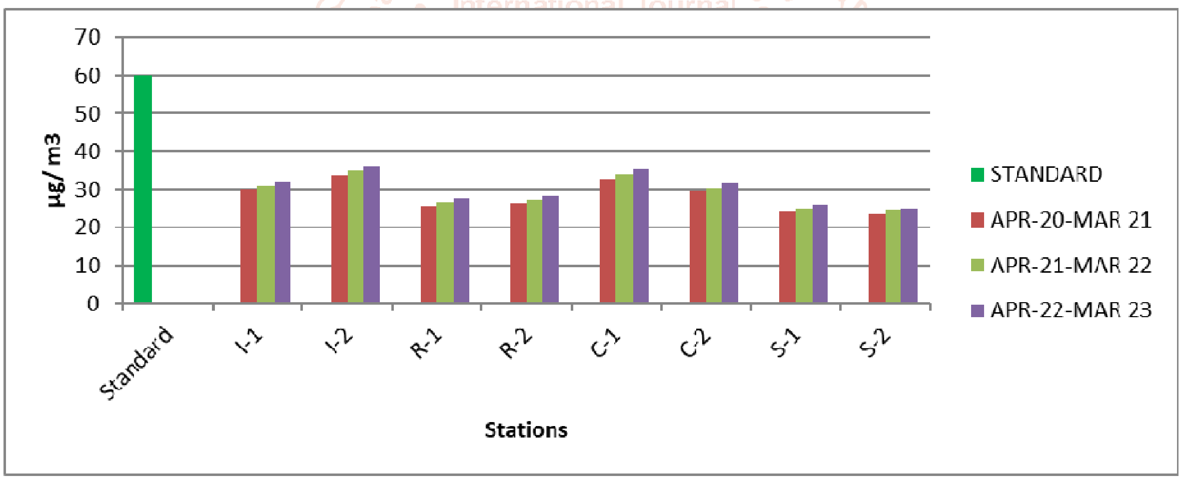

Fig 4. 3 Showing PM2.5 in 2020-2023

From the above graphs we can see that the PM2.5 values are highest at sensitive zones, and maximum in the year 2022-2023, while lowest at residential zones in year 2020-2021 i.e (lockdown period).

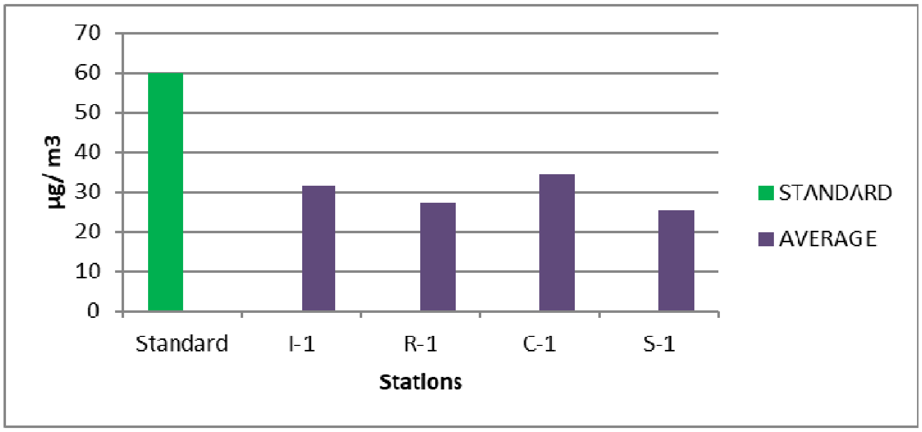

Fig 4. 4 Average Value of PM2.5 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zone, Rasuliya, Hoshangabad, while lowest at residential zone Meenakshi Chowk.

Table 4. 3 Annual value of SO2 2020-2023

Month	Stations			
	I-2	R-2	C-2	S-2
Apr-20-Mar 21	13.42	6.93	9.93	15.63
Apr-21-Mar 22	14.46	7.46	10.7	16.84
Apr-22-Mar 23	15.68	8.09	11.6	18.27
Average	**14.52**	**7.49**	**10.74**	**16.91**
SD	**0.92**	**0.48**	**0.68**	**1.08**
Min	**13.42**	**6.93**	**9.93**	**15.63**
Max	**15.68**	**8.09**	**11.6**	**18.27**

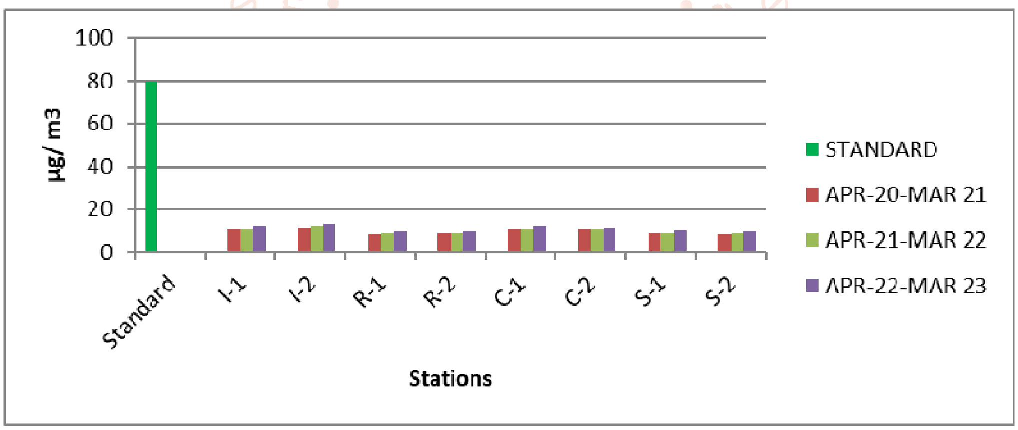

Fig 4.5 Showing SO2 in 2020-2023

From the above graphs we can see that the SO2 values are highest at sensitive zones, and maximum in the year 2022-2023, while lowest at residential zones in year 2020-2021 i.e (lockdown period).

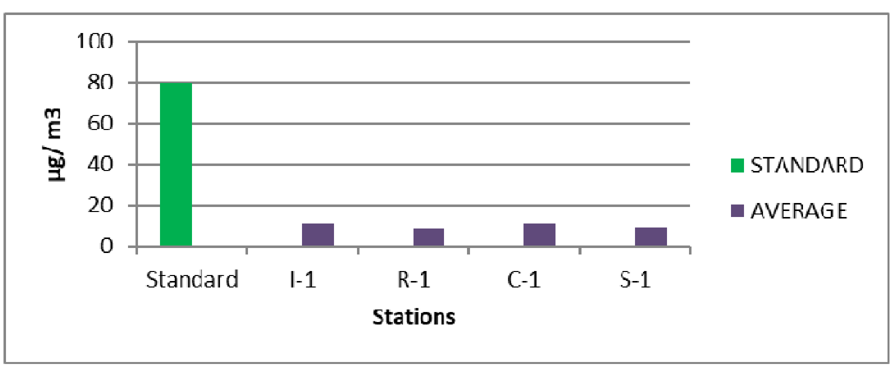

Fig 4. 6 Average Value of SO2 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zone, Rasuliya, Hoshangabad, while lowest at residential zone Meenakshi Chowk.

Table 4.4 Annual value of NOX 2020-2023

Month	Stations			
	I-2	R-2	C-2	S-2
Apr-20-Mar 21	15.23	11.97	15.15	12.33
Apr-21-Mar 22	16.85	13.25	16.76	13.64
Apr-22-Mar 23	17.01	13.37	16.92	13.77
Average	16.93	13.31	16.84	13.70
SD	0.08	0.0629	0.079556	0.064747
Min	16.85	13.25	16.76	13.64
Max	17.01	13.37	16.92	13.77

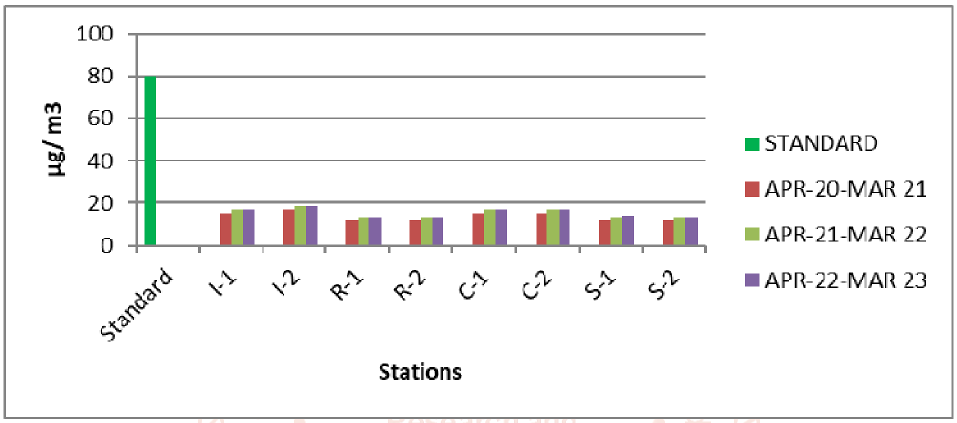

Fig 4. 7 Showing NOX in 2020-2023

From the above graphs we can see that the NOX values are highest at sensitive zones, and maximum in the year 2022-2023, while lowest at residential zones in year 2020-2021 i.e (lockdown period).

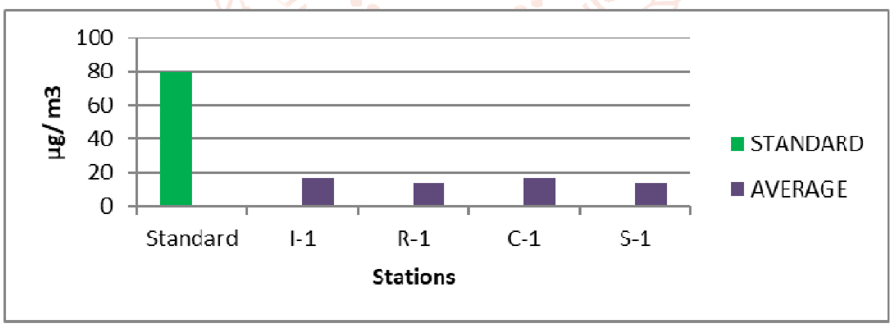

Fig 4. 8 Average Value of NOX for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zone, Rasuliya, Hoshangabad, while lowest at residential zone Meenakshi Chowk.

4.10. AIR QUALITY INDEX

The Air Quality Index (AQI) is a standardized measure used to provide information about the quality of air in a particular location. The AQI takes into account several pollutants, including ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide.

To calculate the AQI, we need to know the concentration of each pollutant in the air. The concentration values are typically measured in micrograms per cubic meter (µg/m³) for particulate matter and parts per million (ppm) for gaseous pollutants.

AQI for all other zones are listed below

I-1	SPM	81.21	MODERATE	Air quality is acceptable, but there may be a moderate health concern
R-1	MEENAKSHI CHOWK	70.31	MODERATE	Air quality is acceptable, but there may be a moderate health concern
C-1	BUS STATION	88.93	MODERATE	Air quality is acceptable, but there may be a moderate health concern
S-1	MALAKHEDI	65.73	MODERATE	Air quality is acceptable, but there may be a moderate health concern

5. CONCLUSION

In this study analysis of air pollutants such as PM10, PM2.5, SO2, and NO2, were assessed to determine the ambient air quality of Hoshangabad City. The PM10 and PM2.5 were found moderate for all monitoring stations. Seasonal variation of PM10 and PM2.5 showed that in summer air quality becomes worst since higher temperatures can lead to the formation of ground-level ozone and other pollutants through reactions involving sunlight and emissions from vehicles and industrial sources.

Source of PM10 is road dust industrial activity, agriculture activity, vehicles population, unpaved road mining operation etc. A great deal of attention has focused on particulate matter pollution due to their severe health effects especially fine particles Several epidemiological studies have indicated a strongly association between elevated concentration of particulate matter and increased mortality. Gaseous air pollutants SO2, and NOx were well below the permissible limit in all the sampling station in all three study years. Seasonal values for SO2; and NO2 were also found within the permissible limits at all the stations and in all the seasons.

Air Quality Index (AQI) was calculated. It was observed that residential and sensible station were with less AQI but industrial and commercial station were comparatively more polluted.

.In Sensitive and Industrial station were observed high AQI. It is indicating that in comparison to 2021 the air quality deteriorated in 2022 and 2023. Overall air Quality of Hoshangabad.city was found in Moderate category which is acceptable, but there may be a moderate health concern.

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