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ASSESSMENT OF AMBIENT AIR QUALITY OF ITARSI (M.P.)

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ABSTRACT :- Air quality assessment is often driven by the need to determine whether air quality standards or guidelines have been exceeded. However, it's important to recognize that another crucial objective of air quality assessment is to provide the necessary information for estimating how the population is exposed to air pollution and understanding its impact on public health. In this particular study, an analysis of various air pollutants such as PM10, PM2.5, SO_2, and NO_2 was conducted to evaluate the ambient air quality of Itarsi City. The findings revealed that PM10 and PM2.5 levels were within moderate ranges for residential areas, specifically Old Itarsi, but exceeded permissible limits at other monitoring stations. The study also observed a seasonal variation in PM10 and PM2.5 levels, with air quality worsening during winter due to lower temperatures and humidity, causing particulate matter to condense in the lower atmosphere. On the other hand, gaseous air pollutants like SO_2 and NOx were consistently below permissible limits across all sampling stations throughout the three-year study period. Seasonal variations in SO_2 and NO_2 also remained within acceptable limits at all stations and during all seasons

***KEYWORDS*:-** Air quality assessment, air quality, Itarsi, Old Itarsi, gaseous air pollutants, SO_2, NOx, PM2.5, PM10, seasons, ambient air, population.

INTRODUCTION:-

The assessment of ambient air quality is a critical endeavor that plays a pivotal role in safeguarding the well-being of our environment and public health. As urbanization and industrialization continue to expand worldwide, the quality of the air we breathe is becoming increasingly significant. Ambient air quality assessment serves as a comprehensive evaluation process that not only quantifies the concentration of various air pollutants but also examines their potential impact on ecosystems and human health.

This assessment entails the systematic measurement and analysis of a multitude of air pollutants, including particulate matter (PM10, PM2.5), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), volatile organic compounds (VOCs), and more. The data collected through this process aids in the identification of pollutant sources, the monitoring of pollutant trends, and the formulation of effective air quality management strategies.

Furthermore, the assessment of ambient air quality extends beyond simply adhering to regulatory standards and guidelines. It serves as a fundamental tool for understanding the dynamic relationship between environmental factors, pollution levels, and their potential repercussions on public health. As such, this assessment enables policymakers, environmental agencies, and researchers to make informed decisions aimed at mitigating pollution, reducing exposure risks, and promoting sustainable urban development.

In this context, this comprehensive exploration aims to delve into the multifaceted realm of ambient air quality assessment. It will elucidate the methodologies employed, the pollutants monitored, the implications for public health, and the broader environmental implications. By shedding light on the intricacies of this vital field, we aim to underscore its crucial role in our quest for cleaner air, healthier communities, and a more sustainable future.

LITERATURE REVIEW

Natarajan et al., (2022) presented an overview of the scientific attempts pertaining to the evaluation of impacts of air pollution and other meteorological changes on the historical monuments in India in the context of the global scenario. It is observed that seasonal fluctuations in the outdoor climate and increased human activities in the vicinity of the museums have plausible impacts on the immediate changes in the indoor air quality.

Mor et al., (2022) analyzed spatial variation of pollutants, ambient air quality data of 23 continuous ambient air quality monitoring stations were divided into three zones based on ecology and cropping pattern. The study could help to understand seasonal variation in ambient air quality and the influence of factors such as crop residue burning in the IGP region, which could help to formulate season-specific control measures to improve regional air quality.

Praveen et al., (2022) presented the variation in air pollutants (i.e., $PM_{2.5}$, PM_{10}, NO_2, and SO_2) profile between Christmas and new year celebrations in 2019, 2020, and 2021. It can be seen that the concentration of selected air pollutants shows a substantially higher concentration in celebration periods in all reported years. The results indicate that air pollutants values are always higher than permissible limits.

Sharma et al., (2022) presented the first comprehensive analysis of government air quality observations from 2015–2019 for PM_{10}, $PM_{2.5}$, SO_2, NO_2 and O_3 from the Central Pollution Control Board (CPCB) Continuous Ambient Air Quality Monitoring (CAAQM) network and the manual National Air Quality Monitoring Program (NAMP), as well as $PM_{2.5}$ from the US Air-Now network. We address inconsistencies and data gaps in datasets using a rigorous procedure to ensure data representativeness.

Kuldeep et al., (2022) assessed the air pollution scenario in the post lockdown phase in the seven major metropolises of Rajasthan, namely, Jodhpur, Alwar, Jaipur, Kota, Pali, Ajmer, and Udaipur, in the recent pandemic year 2020. The air pollution scenario is determined with the help of the Air Quality Index (AQI) and the concentration level of $PM_{2.5,}$ PM_{10}, NO_2, and SO_2. This study reveals that most cities of Rajasthan are violating India's national ambient air quality standards (NAAQS). It is found that Jodhpur is on rank first in terms of pollution levels, followed by Alwar, Jaipur, Pali, and Udaipur. The pollution level was higher before the lockdown period then reduced to a certain level due to restricted activities in lockdown. The pollution level is not rapidly increased after lockdown due to rainfall from the southwest monsoon. Winter season consists of higher concentration levels of pollutant and higher than before lockdown period.

Yadav et al., (2022) studied the impact of the judicial prohibition in Delhi to improve air quality, a comprehensive and comparative analysis was conducted over two consecutive years, namely 2015–2016 (when no significant regulations on the sale or usage of firecrackers were imposed) and 2017–2018 (when radically different regulations were implemented). Data on PM_{10}, $PM_{2.5}$, NO_x, and CO were analysed, and their trends and levels with various regulations in place were compared. In 2017, the concentrations of PM_{10}, $PM_{2.5}$, NO_x, and CO were reduced by 50%, 50%, 71%, and 64%, respectively, compared to 2016. However, in 2018, there was an increase of 32% in PM_{10} and $PM_{2.5}$ concentrations, as well as a 25% increase in CO concentrations, with the exception of NOx, which decreased to 25% on Diwali day. The data was also examined in conjunction with the entire timeline of the various court rulings and regulations imposed in Delhi.

Balamadeswaran et al., (2022) presented improvements of nitrogen dioxide (NO_2) during the COVID-19 lockdown in India. This research has been done using both the open source data sets taken from satellite and ground based for better analysis. For the satellite-based analysis, the Sentinel 5 Precauser's Tropospheric NO_2 from the European Space Agency and for the ground-based numeric data sets from Central Pollution Control Board (CPCB) has been used. During the COVID-19 disease, outbreak the world has set in quarantine and as an overcome air quality improved in Asian countries after national lockdown, the average NO_2 rates plummeted calculated by 40–50%. Similarly, it dramatically decreased in Asia during the COVID-19 pandemic quarantine period.

Markandeya et. al., (2021) investigated seasonal variations in air pollution levels in Lucknow and assess the ambient air quality of the city together with highlighting the health impacts of major pollutants like PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb, Ni and aerosols from 2010 to 2019. The maximum and minimum values of PM_{10}, $PM_{2.5}$, SO_2, NO_2, Pb and Ni were found to be 270.75 and

122.45 µg/m^3, 124.95 and 95.52 µg/m^3, 25.60 and 8.05 µg/m^3, 75.65 and 23.85 µg/m^3, 0.66 and 0.03 µg/m^3 and 0.07 and 0.01 ng/m^3, respectively.

Gautam et al., (2021) studied the differences in the air quality index (AQI) of Delhi (DTU, Okhla and Patparganj), Haryana (Jind, Palwal and Hisar) and Uttar Pradesh (Agra, Kanpur and Greater Noida) from 17 February 2020 to 4 May 2020. The AQI was calculated by combination of individual sub-indices of seven pollutants, namely $PM_{2.5}$, PM_{10}, NO_2, NH_3, SO_2, CO and O_3, collected from the Central Pollution Control Board website. The AQI has improved by up to 30–46.67% after lockdown.

Pandey et al., (2021) The present study deals with the impact of the pandemic outbreak of COVID-19 on the ambient air quality in the capital city of India. Real-time data were collected from eight continuous ambient air quality monitoring stations measuring important air quality parameters (NO_2, PM_{10} and $PM_{2.5}$). Results revealed that the city's air quality had improved significantly during the lockdown period due to COVID-19 outbreak.

METHODOLOGY:-

Itarsi is a city and municipality in Madhya Pradesh, India in Hoshangabad District.Itarsi is a key hub for agricultural goods and is the biggest railway junction in Madhya Pradesh. Rail services from all 4 major metropolitan cities of India namely Mumbai to Calcutta and Delhi to Chennai pass through Itarsi. Itarsi has large number of agro-based industries and warehouses . Itarsi got its name by "eeta(eent)", (literally means brick in Hindi) and "rassi", (literally means rope in Hindi). Bricks and ropes had been made earlier in itarsi. It has Ordnance Factory. The Bori Wildlife Sanctuary and Tawa Dam are nearby.

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. **Kheda**- It is an area on Hoshangabad Road in Itarsi it is an industrial area. In this area there are some small scale industries like Soya plant cement pipe factory and oil factory These Industries may affect the quality of air.
2. **Railway station**- Itarsi is a junction of Railways. Around 200 trains come to this station every day. One can go in any direction from the station. It is an area in the centre of the city. The area is full of activities. Thousands of people come and go from this station.
3. **Old Itarsi** - It is a big Residential area of the city Itarsi . The high way NH-69 passes through this area. The traditional means of cooking are used in this area. These things may affect the air quality.
4. **Kandai**- It is a small village near Itarsi. The reason behind the selection of this area is that there are brickkilns in this area. Burning of residues is also found in this area.

Table 3. 1 Selected Air Quality Monitoring Stations

S.No	Area code	Selected Area	Area Type
1	I-1	Kheda	Industrial
2	C-1	Railway station	Commercial
3	R-1	Old Itarsi	Residential
4	S-1	Kandai	Sensitive

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 Itarsi 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.

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

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.

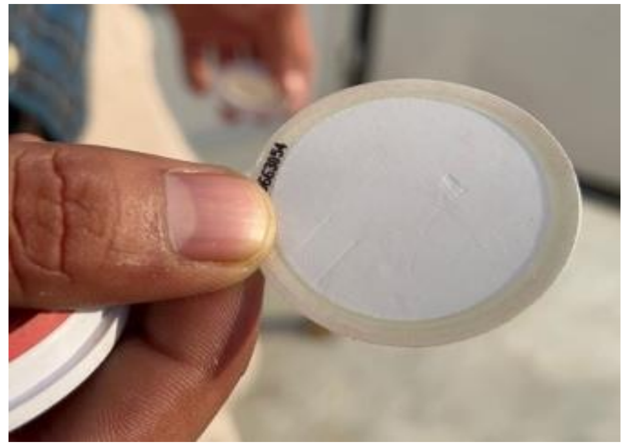

Fig3. 2 Filter Paper

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

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.

RESULT AND DISCUSSION:-
ZONE KHEDA-
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	2.8342	0.0426	71
Apr-21	2.707852	2.752252	0.0444	74
Apr-22	2.626616	2.672534	0.045918	76.53

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	0.778886	0.77808	32.42
Apr-21	0.000782	0.020984	0.020202	33.67
Apr-22	0.000758	0.02174	0.020982	34.97

SO_2 CONCENTRATION
Concentration (ppm or µg/m³) = (Measurement Value) / (Calibration Factor)
C (SO_2 µg/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

SO_2=(As - Ab) X 0.382 X 2615.44 / 240

	As	Ab	As-Ab	SO_2
Apr-20	0.015	3.223757	3.208757	13.42
Apr-21	0.01455	3.472625	0.876905	14.456
Apr-22	0.014114	3.766655	1.248806	15.68

NO_X 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**	**NO_X**
Apr-20	0.03	1.42791	1.39791	17.758
Apr-21	0.0291	1.512763	1.483663	18.84735
Apr-22	0.028227	1.560512	1.532285	19.465

Similarly, concentrations are calculated for other zones as well.

ZONE OLD ITARSI-
The results are shown below

	INI (Wi)	**FINAL(Wf)**	**Concentration (Wi-Wf)**	**PM10**
Oct-20	2.6916	2.7234	0.0318	53.0264
Oct-21	2.7796	2.8128	0.0332	55.2669
Oct-22	2.6962	2.7305	0.0343	57.1564

PM2.5 CONCENTRATION

	INI (Wi)	**FINAL(Wf)**	**Concentration (Wi-Wf)**	**PM2.5**
Oct-20	0.0008	0.0153	0.0145	24.2129
Oct-21	0.0008	0.0159	0.0151	25.1464
Oct-22	0.0008	0.0164	0.0157	26.1173

SO_2 CONCENTRATION

	As	**Ab**	**As-Ab**	**SO_2**
Oct-20	0.0154	1.6639	1.6485	6.9267
Oct-21	0.0149	1.7924	1.7775	7.4615
Oct-22	0.0145	1.9442	1.9297	8.0932

NO_X CONCENTRATION

	As	**Ab**	**As-Ab**	**NOX**
Oct-20	0.0291	0.7506	0.7215	9.1658
Oct-21	0.0299	0.7957	0.7658	9.7281
Oct-22	0.0290	0.8199	0.7909	10.0469

ZONE RAILWAY STATION ITARSI-
PM10 CONCENTRATION

PM10 refers to particulate matter with a diameter of 10 micrometers or smaller, which can have adverse health effects when inhaled. To calculate PM10 levels, specialized equipment Respirable Dust sampler is used. The general steps involved in calculating PM10 concentrations are outlined below:

1. **Sampling**: Using a PM10 sampler to collect air samples over a specific time period. These samplers are designed to capture particles with diameters of 10 micrometers or smaller.
2. **Weighing**: After the sampling period, the filter is carefully removed from the sampler and was handled in a controlled environment to avoid contamination. Then the filter before and after sampling is Weighed using a microbalance. The difference in weight (post-sampling weight minus pre-sampling weight) represents the mass of the collected particulate matter.
3. **Calculation**: Dividing the mass of the collected particulate matter by the volume of air sampled to calculate the concentration of PM10.The system is designed to operate at an air flow of 1 LPM and the sampling period is set to 8 hrs. The formula is:

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
Dec-20	2.4986	2.5386	0.0400	66.7400
Dec-21	2.6630	2.7047	0.0417	69.5600
Dec-22	2.6630	2.7062	0.0432	71.9382

PM2.5 CONCENTRATION

- Particulate Matter (PM2.5) in ambient air is drawn through a size-selective inlet of the dust sampler Envirotech APM 550 MFC equipment.
- The mass of the collected particles is determined by the difference in the filter paper weights prior to and after sampling.

Calculating Sampled Volume: The same steps as in the PM10 calculation are used to calculate the sampled volume (in cubic meters) based on the flow rate of the sampler and the sampling duration.

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

	INI (Wi)	FINAL(Wf)	Concentration (Wi-Wf)	PM2.5
Dec-20	0.0008	0.0191	0.0183	30.4748
Dec-21	0.0008	0.0198	0.0190	31.6498
Dec-22	0.0008	0.0205	0.0197	32.8718

4.3.3 SO_2 CONCENTRATION

1. Sulfur dioxide reacts with the reactive substance on the filter to form a compound that can be measured. This might involve a color change or a change in the properties of the reactive substance.
2. **Calibration**: Before or after sampling, measurement system is calibrated using a known concentration of sulfur dioxide. This calibration helps establish a relationship between the reaction product and the concentration of SO2.
3. **Measurement**: The change in measured the reactive substance on the filter after sampling. This measurement is usually done using colorimetric or titration techniques.
4. **Calculating Concentration**: calibration curve obtained from the calibration step is used to to convert the measurement to SO2 concentration. The formula is:

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

C (SO_2 µg/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

SO_2=(As - Ab) X 0.382 X 2615.44 / 240

	As	**Ab**	**As-Ab**	**SO_2**
Dec-20	0.0152	2.3856	2.3704	9.9308
Dec-21	0.0147	2.5697	2.5550	10.6974
Dec-22	0.0143	2.7873	2.7730	11.6032

NO_X CONCENTRATION

1. **Sampling**: Air samples are collected using Modified Jacob and Hochheiser Methoddesigned to capture nitrogen dioxide (NO2) and nitric oxide (NO).
2. **Calibration**: measurement system is Calibratedusing known concentrations of NOx gases. Calibration establishes a relationship between the measurement signal and the actual concentration of NOx.
3. **Measurement**: The change in the reaction caused by the presence of NOx gases in the sample is measured.
4. **Calculating Concentration**: Using the calibration curve obtained from the calibration step the measurement is converted to NOx concentration. The calibration curve relates the measurement signal to known concentrations of NOx.

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**	**NO_X**
Dec-20	0.0304	1.0648	1.0345	13.1409
Dec-21	0.0295	1.1274	1.0979	13.9470
Dec-22	0.0286	1.1625	1.1339	14.4041

ZONE KANDAI-

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	2.5696	0.0496	82.7150
Feb-22	2.7336	2.7853	0.0517	86.2100
Feb-23	2.7336	2.7871	0.0535	89.1575

PM2.5 CONCENTRATION

	INI (Wi)	**FINAL(Wf)**	**Concentration (Wi-Wf)**	**PM2.5**
Feb-21	0.0008	0.0235	0.0227	37.7693
Feb-22	0.0008	0.0244	0.0235	39.2256
Feb-23	0.0008	0.0252	0.0244	40.7401

SO_2 CONCENTRATION

	As	**Ab**	**As-Ab**	**SO_2**
Feb-21	0.0159	3.7557	3.7398	15.6343
Feb-22	0.0154	4.0456	4.0302	16.8412
Feb-23	0.0149	4.3882	4.3732	18.2672

NO_X CONCENTRATION

	As	**Ab**	**As-Ab**	**NO_X**
Feb-21	0.0312	1.6598	1.6286	20.6881
Feb-22	0.0308	1.7593	1.7285	21.9572
Feb-23	0.0299	1.8150	1.7851	22.6767

RESULT ANALYSIS

Table 4. 1 Annual value of PM10 2020-2023

Month	**Stations**			
	I-1	**R-1**	**C-1**	**S-1**
Apr-20-Mar 21	71	53.03	66.74	82.72
Apr-21-Mar 22	74	55.27	69.56	86.21
Apr-22-Mar 23	76.53	57.16	71.94	89.16
Average	**73.84**	**55.15**	**69.41**	**86.03**
SD	**2.26**	**1.69**	**2.12**	**2.63**
Min	**71**	**53.03**	**66.74**	**82.72**
Max	**76.53**	**57.16**	**71.94**	**89.16**

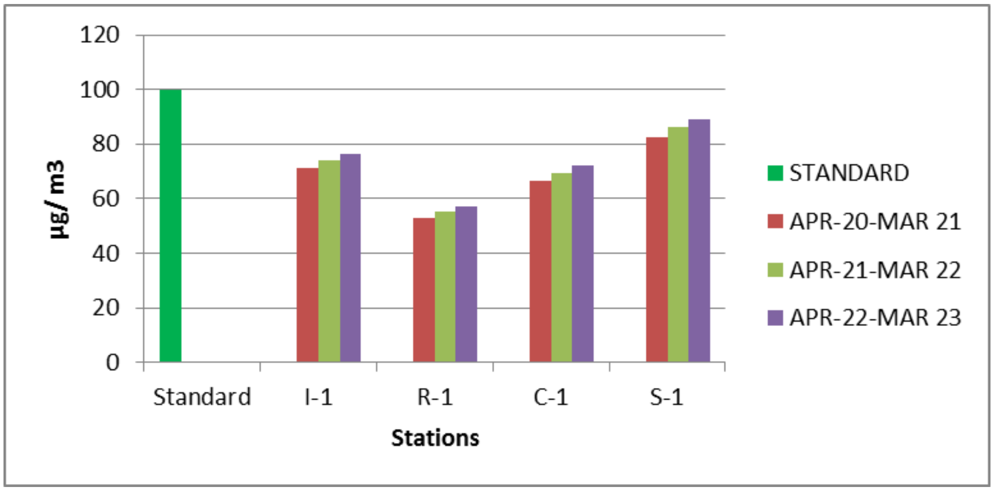

Fig 4. 1 Showing PM10 in 2020-2023

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).

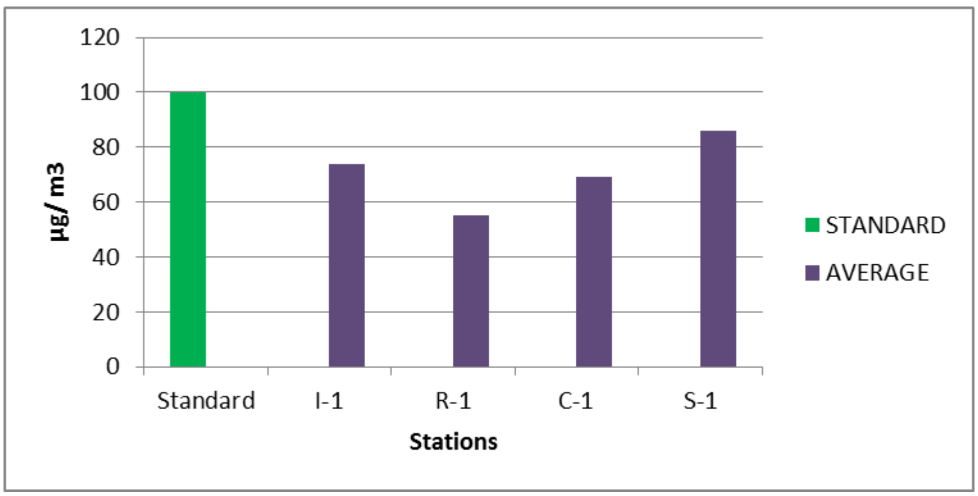

Fig 4. 2 Average Value of PM10 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zones, specially in Kandai village Itarsi, while lowest at residential zone old Itarsi.

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

Month	Stations			
	I-1	**R-1**	**C-1**	**S-1**
Apr-20-Mar 21	32.42	24.21	30.47	37.77
Apr-21-Mar 22	33.67	25.15	31.65	39.23
Apr-22-Mar 23	34.97	26.12	32.87	40.74
Average	**33.69**	**25.16**	**31.67**	**39.24**
SD	**1.04**	**0.78**	**0.98**	**1.21**
Min	**32.42**	**24.21**	**30.47**	**37.77**
Max	**34.97**	**26.12**	**32.87**	**40.74**

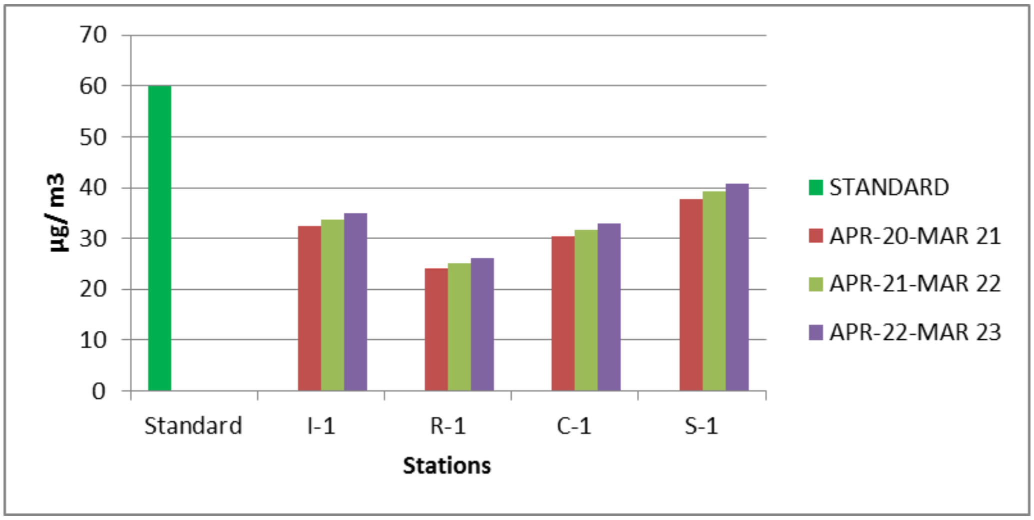

Fig 4. 3 Showing PM2.5 in 2020-2023

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).

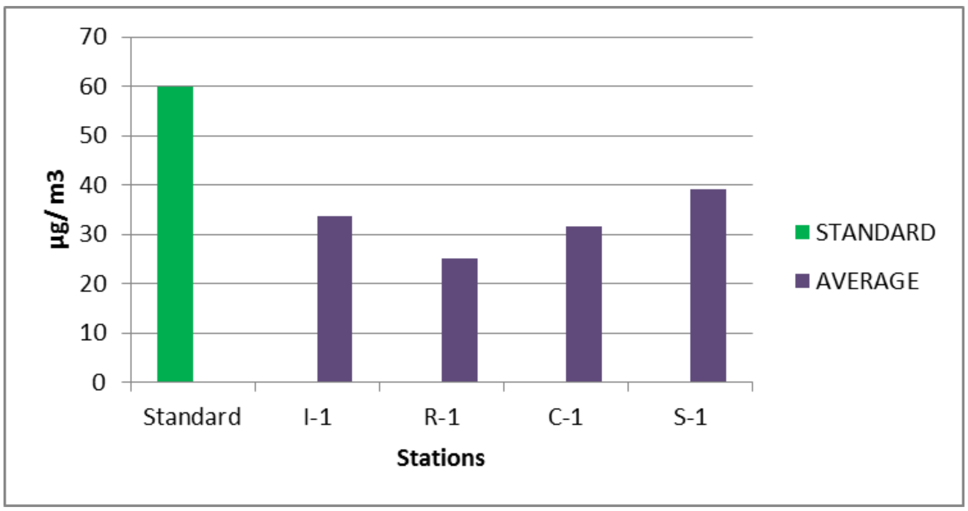

Fig 4. 4 Average Value of PM2.5 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zones, specially in Kandai village Itarsi, while lowest at residential zone old Itarsi.

Table 4. 3 Annual value of SO_2 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**

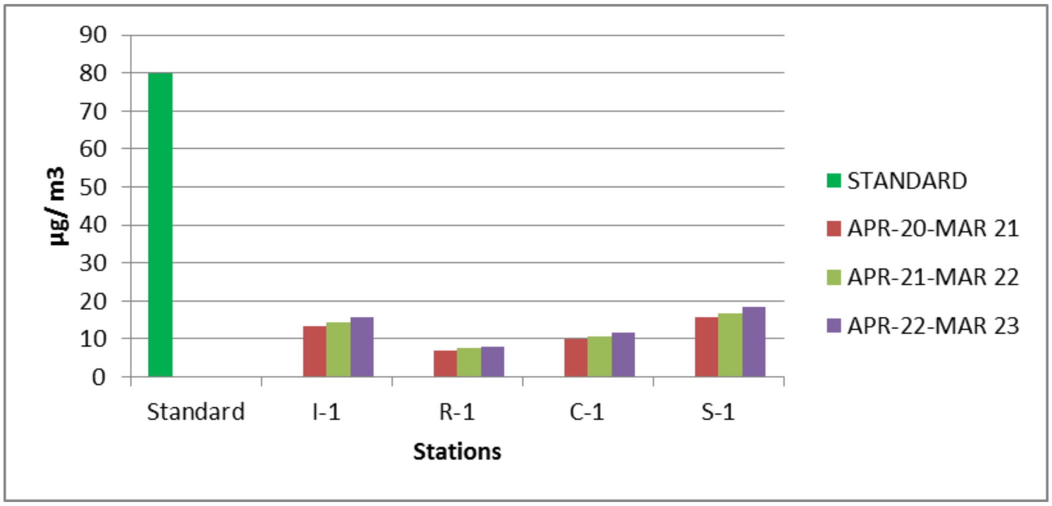

Fig 4. 5 Showing SO_2 in 2020-2023

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).

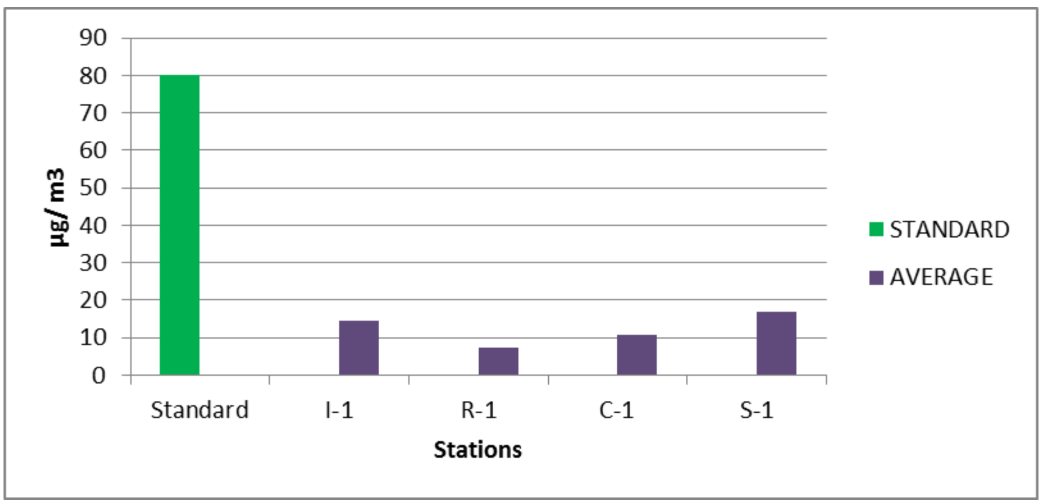

Fig 4. 6 Average Value of SO_2 for 2020-2023

From the above graphs we can see that the PM10 values are highest at sensitive zones, specially in Kandai village Itarsi, while lowest at residential zone old Itarsi.

Table 4. 4 Annual value of NO_X 2020-2023

Month	**Stations**			
	I-1	**R-1**	**C-1**	**S-1**
Apr-20-Mar 21	17.76	9.17	13.14	20.69
Apr-21-Mar 22	18.85	9.73	13.95	21.96
Apr-22-Mar 23	19.47	10.05	14.4	22.68
Average	**18.69**	**9.65**	**13.83**	**21.77**
SD	**0.71**	**0.36**	**0.52**	**0.82**
Min	**17.76**	**9.17**	**13.14**	**20.69**
Max	**19.47**	**10.05**	**14.4**	**22.68**

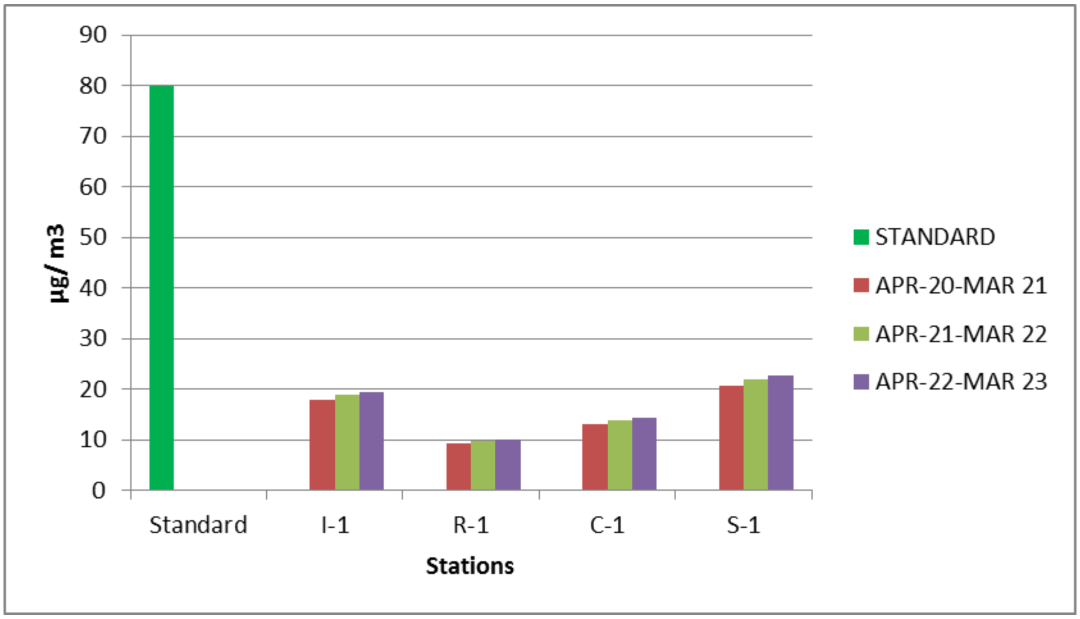

Fig 4. 7 Showing NO_X **in 2020-2023**

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).

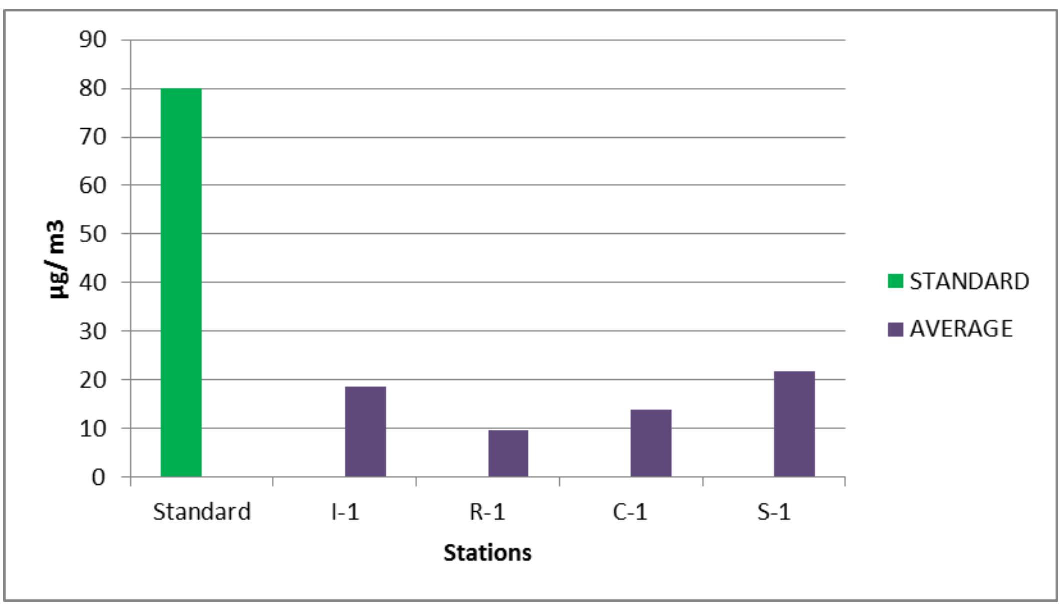

Fig 4. 8 Average Value of NO_X **for 2020-2023**

From the above graphs we can see that the PM10 values are highest at sensitive zones, specially in Kandai village Itarsi, while lowest at residential zone old Itarsi.

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-2	KHEDA	71	MODERATE	Air quality is acceptable, but there may be a moderate health concern
R-2	OLD ITARSI	57.15	MODERATE	Air quality is acceptable, but there may be a moderate health concern
C-2	RAILWAY STATION	71.93	MODERATE	Air quality is acceptable, but there may be a moderate health concern
S-2	KANDAI	89.15	MODERATE	Air quality is acceptable, but there may be a moderate health concern

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CONCLUSION:-

In this study analysis of air pollutants such as PM10, PM2.5, SO_2,and NO_2, were assessed to determine the ambient air quality of Itarsi City. The PM10 and PM2.5 were found moderate for residential areas i.e. Old Itarsi and higher than the permissible limit for other monitoring stations. Seasonal variation of PM10 and PM2.5 showed that in winter air quality becomes worst due to low temperature and humidity particulate matter condenses in lower atmosphere.

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 SO_2; and NO_2 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 commercial station were with less AQI but industrial and sensitive 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 Itarsi. city was found in Moderate category which is acceptable, but there may be a moderate health concern. The vehicle fleet in Itarsi is growing rapidly and it may cause responsible for the increasing air pollution in city. From the study, it was observed that pollution by particulates is mainly responsible for ambient air pollution in Itarsi city.

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