Assessment of Air Quality in Bangalore Before, During & After Covid-19 Lockdown

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Abstract—**Air pollution is the presence of any solid, liquid or gaseous substances in the atmosphere in such a concentration as may be or tend to be injurious to human beings or other living being or creature or plants or property or environment". The major air pollutants are particulate matter (PM$_{10}$, PM$_{2.5}$ etc.), Oxides of nitrogen and Sulphur (NO$_X$, SO$_X$) and Ozone. A machine containing filters is used to collect dust sample at various locations around Bangalore. The samples are then sent to a laboratory to be tested for PM$_{10}$, PM$_{2.5}$, SO$_X$ and NO$_X$. The test results are then used to calculate the Air Quality Index for respective locations. The data for various phases of lockdown was requested from Central Pollution Control Board. As per Indian National Air Quality Standards, average value is 60 for PM$_{2.5}$, 100 for PM$_{10}$, 80 for NO$_2$ and 80 for SO$_2$. The values are expressed in µg/m^3. From the tests results it was found that the air pollution had significantly decreased during the lockdown and there was an increase before and after the lockdown. The air around residential areas showed significantly less pollution compared to commercial and industrial area during Lockdown period.**

Keywords—Air pollution; particulate matter; covid-19; lockdown; air quality index.
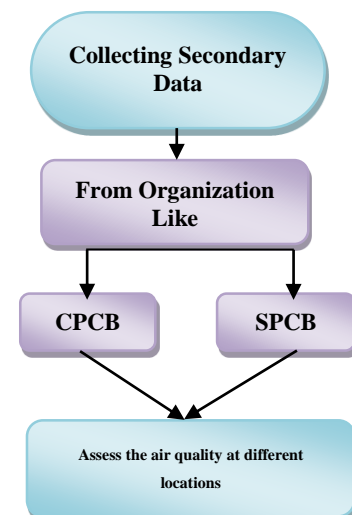
I.   INTRODUCTION

According to World health Organization (WHO), Air pollution occurs due to, release of toxic Pollutants into the atmosphere beyond such concentration which can cause harm to human health and the planet. Every year, Air Pollution causes approximately 7 million deaths all around the world. Currently, Nine out of ten human beings are breath air which exceeds the WHO's standards.

In case of developing and under developed countries the air quality is considered as crucial. Air pollution is a serious threat to the human being, on account not only of its impact on public and individual health due to increasing illness. According to Rana et al. (2021), the effect of covid-19 lockdowns on pollutant concentrations in chaina was examined by synthesizing the reported evidence. The covid-19 was seriously affected public health worldwide and caused millions of infections and deaths, especially among the elderly. To prevent the spread of this infectious disease, the Chinese government took a nationwide contingency plan to restrict human activities. During lockdown, economic activities were reduced dramatically and people were isolated in their homes. Lockdown measures resulted in the improvement in air quality, as air pollutants such as particulate matter or less (PM$_{10}$), less (PM$_{2.5}$), SO$_2$, CO, NO$_2$ decreased significantly. To reduce or stop the spreading of the virus, the

Indian government has announced complete lockdown except emergency services, pharmacies, medical shops etc, in that phase various transport was fully shut (except emergency services)during that time there was much more decrease was there in air pollution, they came up with a result which is the decrease of air pollution between the phases, it was examined by Chaudhary et al.(2021), in New Delhi, This research work was done by Chinnaswamy et al.(2016) in Bangalore one of the fastest growing and fastest development city in India, They have done a Time Series Analysis of 2006-2013, The have don't the critical analysis from 6 stations, and the air was assessed for 48 hours in a week, and they have come with an result that Bangalore has or is experiencing various levels of pollution with some areas having either high or critical levels of one or more pollutants. Researchers like, Jaeja et al. (2020), Coker et al. (2020), Malmqvist et al. (2018), Saud and Pandel (2018), Singh and Chauhan (2021), Selvam et al. (2020), Dasgupta and Srikanth (2020), Sekhara Rao Kolluru et al. (2020), Srivastava and Kumar (2019), Munappy (2018), Haque and Singh (2017), Gope et al. (2021), Chinnaswamy et al. (2016) conducted various studies to monitor air quality index in various parts of the world including Bangalore. Most of these researches shows that, PM$_{25}$, PM$_{10}$, NO$_2$& CO particular related to industrial activates & traffic, indicate a reduction during covid -19 outbreak.

II.   METHODOLOGY

The study was carried out by following the methodology as described below;

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Secondary data collection

- Secondary data means data that are already available i.e., they refer to the data which have already been collected and studied by somebody else. When the researcher uses secondary data, then he has to look into various sources from where he can obtain them.
- Secondary data is collected from government & various organizations such as SPCB (State Pollution Control Board) CPCB (Central Pollution Control Board) and other organizations.
- These data will be assessed and used to find AQI of various locations.

III.   RESULTS AND DISCUSSION

The limits of Air Quality Index value for for PM2.5 is 40 , PM10 is 60, SO2 is 50 , and NO2 is 50, and the AQI value for all is 67. The data collected from the field with the use of various filters. With an interval of 15 days, AQI values are calculates for the following locations:

- ✓ Jayanagar
- ✓ Hombegowda Nagar
- ✓ Central Silk Boar (CSB)
- ✓ Peenya

The selection of the locations are based on the fact that, they fall under our required category that is one being Residential, the other being Commercial, and Industrial as well and compared them with each other to see the differences in air quality.

Table:1 Limited value of PM10, PM2.5, SO2, NO2

Parameters	Standard value	AQI
PM2.5	40	
PM10	60	67
SO2	50	
NO2	50	

15 Days Data of all the 4 station i.e Central Silk Board(CSB), Peenya, Jayanagar, HomebayGowda are submitted as below

A. Jayanagar(1/09/201-1/02/2022)

1. Pre-Lockdown(1/09/2019- 29/02/2020)

EXAMPLE Table:2 Showing air quality index during pre-lockdown period from 1/09/2019-16/09/2019

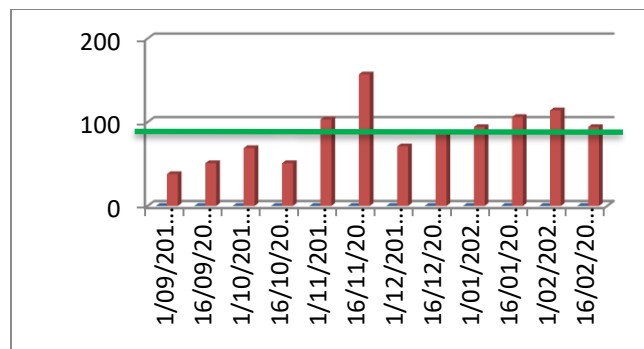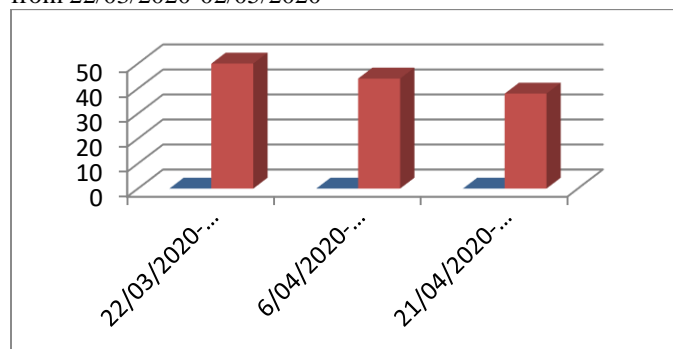| Sl	Parameters	Duration (Date)	∑of all parameter	Average	AQI
1	PM 2.5	1/09/2019-16/09/2019	191.48	12.76	38
2	PM10		563.5	37.56	
3	SO2		49.71	3.31	
4	NO2		269.93	17.99	

Fig. 1 Showing Air Quality Index from 1/09/2019-29/02/2020

2.   1st Lockdown(22/03/2020- 2/05/2020)

Example Table:3 Showing air quality index during pre-lockdown period from 22/03/2020-6/04/2020

Sl	Parameters	Duration(Date)	∑ of all parameter	Average	AQI
1	PM 2.5	22/03/2020-6/04/2020	429.33	28.62	50
2	PM10		745.19	49.67	
3	SO2		3.08	1.54	
4	NO2		247.03	16.46	

Fig. 2 Showing air quality index during 1st lockdown period from 22/03/2020-02/05/2020

3.   2nd Lockdown 27/04/2021- 21/06/2021

Example Table 4 Showing air quality index during 2nd lockdown period from 27/04/2021-12/05/2021

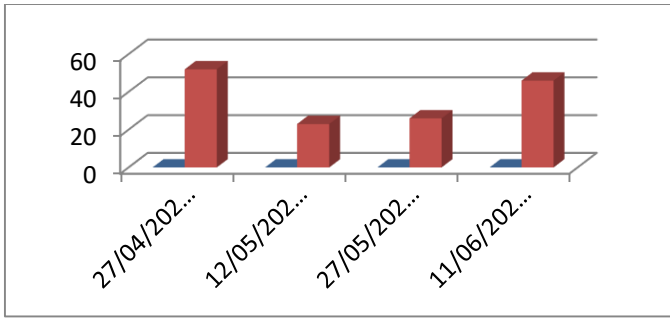| Sl	Parameters	Duration (Date)	∑ of all parameter	Average	AQI
1	PM 2.5	27/04/2021-12/05/2021	463.99	30.93	52
2	PM10		769.12	51.27	
3	SO2		84.7	5.64	
4	NO2		370.43	24.69	

Fig. 3 Showing air quality index during 2nd lockdown period
from27/04/2021-21/062021

4. Post-Lockdown (1/08/2021-1/02/2022)

Example Table 5 Showing air quality index during Post-lockdown period from 1/08/2021-16/08/2021

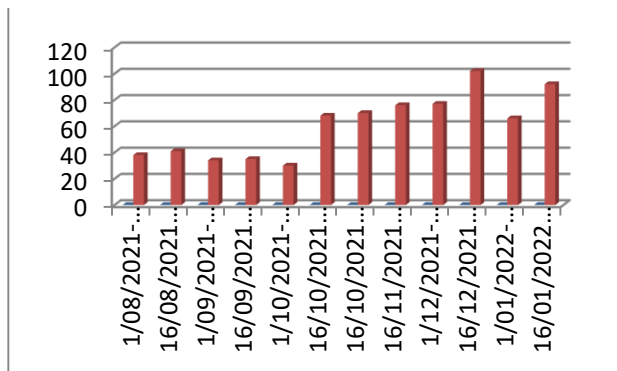| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/08/2021-16/08/2021	300.71	20.04	38
2	PM10		574.25	38.28	
3	SO2		88.78	5.91	
4	NO2		448.32	29.88	

Fig.4 Showing air quality index during post-lockdown period from 01/08/2021-01/02/2022

B. Hombegowda Nagar

1. Pre Lockdown(1/9/2019- 29/2/2020)

Example Table 6 Showing air quality index during Pre-lockdown period from 1/9/2019-16/9/2019

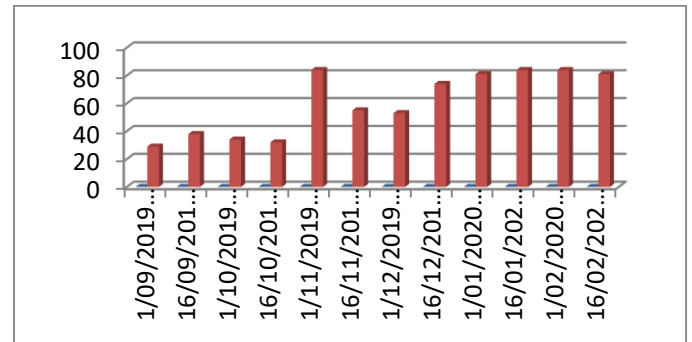| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/9/2019-16/9/2019	109.93	7.32	29
2	PM10		434.84	28.98	
3	SO2		159.65	10.64	
4	NO2		107.59	7.17	

Fig 5 Showing air quality index during Pre-lockdown period
from 01/09/2019-29/02/2020

2. 1st Lockdown (22/3/2020- 2/5/2020)

Example Table 7 Showing air quality index during 1st lockdown period from 22/3/2020-6/4/2020

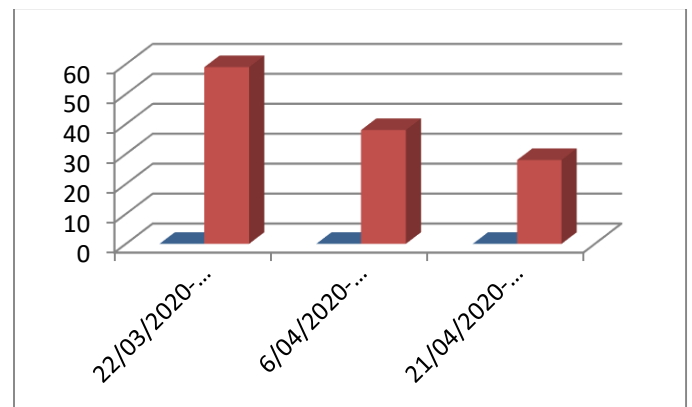| Sl	Parameters	Duration(Date)	Sum of all parameter	Average	AQI
1	PM 2.5	22/3/2020-6/4/2020	456.25	30.41	59
2	PM10		882.76	58.85	
3	SO2		171.14	11.4	
4	NO2		112.06	7.47	

Fig 6 Showing air quality index during 1st lockdown period from 22/03/2020-02/05/2020

3. 2nd Lockdown 27/4/2021- 21/6/2021)

Example Table 8 Showing air quality index during 2nd lockdown period from 27/4/2021-12/5/2021

Sl	Parameters	Duration(Date)	Sum of all parameter	Average	AQI
1	PM 2.5	27/4/2021-12/5/2021	275.09	22.92	61
2	PM10		728.34	60.69	
3	SO2		84.62	7.05	
4	NO2		144.36	12.03	

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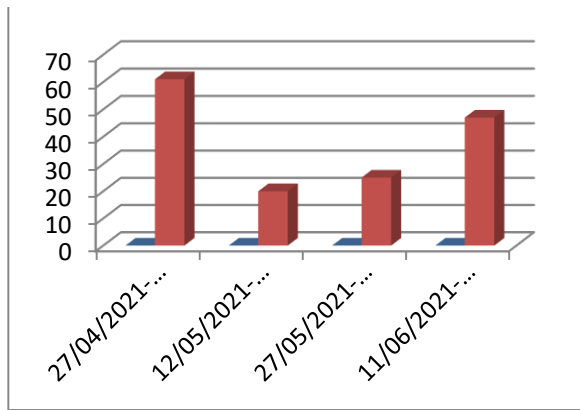**ISSN: 2278-0181**
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Fig. 7 Showing air quality index during 2nd lockdown period from 27/04/2021-21/06/2021

4.   Post Lockdown(1/8/2021- 2/2/2022)

Example Table 9 Showing air quality index during Post-lockdown period from 1/8/2021-16/8/2021

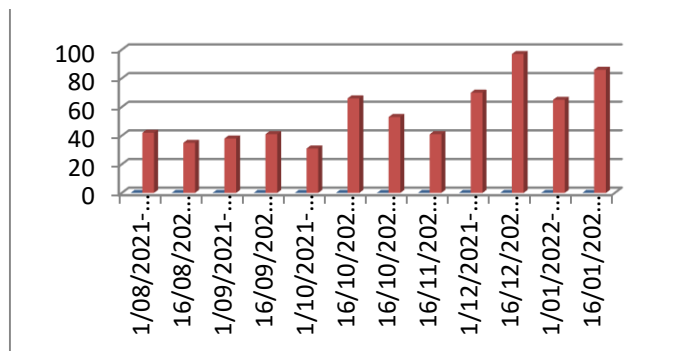| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/8/2021-16/8/2021	321.72	21.44	42
2	PM10		627.01	41.8	
3	SO2		103.8	6.92	
4	NO2		189.17	12.61	

Fig. 8 Showing air quality index during Post-lockdown period from 1/08/2021-01/02/2022

C. CSB(1/9/2019- 29/2/2020)

1.   Pre Lockdown

Exampke Table 10 Showing air quality index during Pre-lockdown period from 1/9/2019-16/9/2019

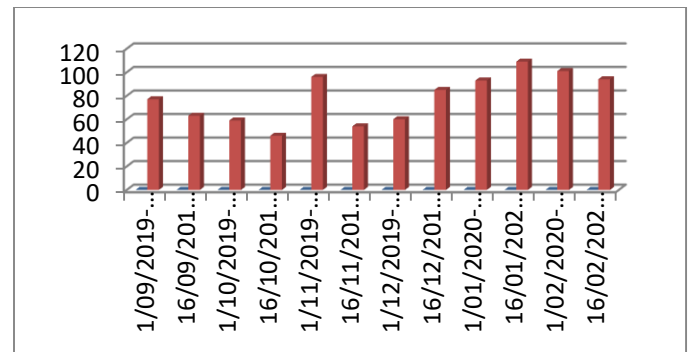| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/9/2019-16/9/2019	270.96	18.06	77
2	PM10		1150.7	76.71	
3	SO2		23.99	1.59	
4	NO2		454.7	30.31	

Fig 9 Showing air quality index during Pre-lockdown period from 01/09/2019-29/02/2020

2.   1st Lockdown(22/3/2020- 2/5/2020)

Example Table 11 Showing air quality index during 1st lockdown period from 22/3/2020-6/4/2020

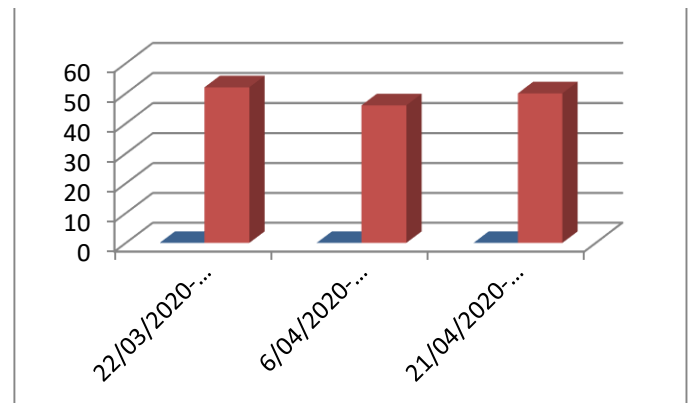| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	22/3/2020-6/4/2020	375.34	25.02	52
2	PM10		774.84	51.65	
3	SO2		35.41	2.36	
4	NO2		110.68	7.37	

Fig 10 Showing air quality index during 1st lockdown period from 22/03/2020-02/05/2020

3.   2nd Lockdown (27/4/2021- 21/6/2021)

Example Table 12 Showing air quality index during 2nd lockdown period from 27/4/2021-12/5/2021

Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	27/4/2021-12/5/2021	291.43	22.41	56
2	PM10		726.85	55.91	
3	SO2		40.97	3.15	
4	NO2		265.82	20.44	

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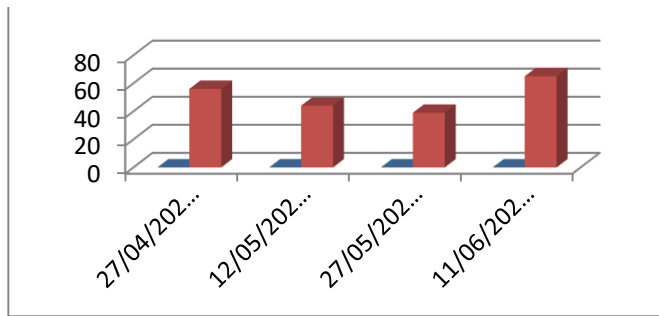**ISSN: 2278-0181**
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Fig 11 Showing air quality index during 2nd lockdown period
from 27/04/2021-21/06/2021

4. Post Lockdown (1/8/2021- 1/2/2022)

Example Table 13 Showing air quality index during Post lockdown period from 1/8/2021-16/8/2021

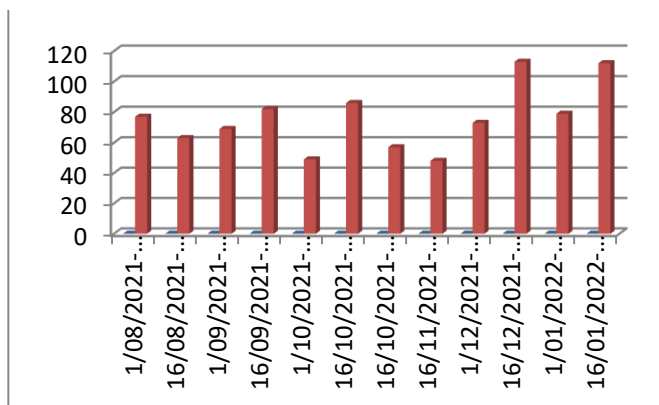| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/8/2021-16/8/2021	216.57	14.43	77
2	PM10		1159.7	77.31	
3	SO2		75.96	5.06	
4	NO2		682.5	45.5	

Fig 12 Showing air quality index during Post lockdown period from 1/08/2021-01/02/2022

D. Peenya (1/09/2019- 29/2/2020)

1. Pre Lockdown

Example Table 14 Showing air quality index during Pre lockdown period from 1/09/2019-16/9/2019

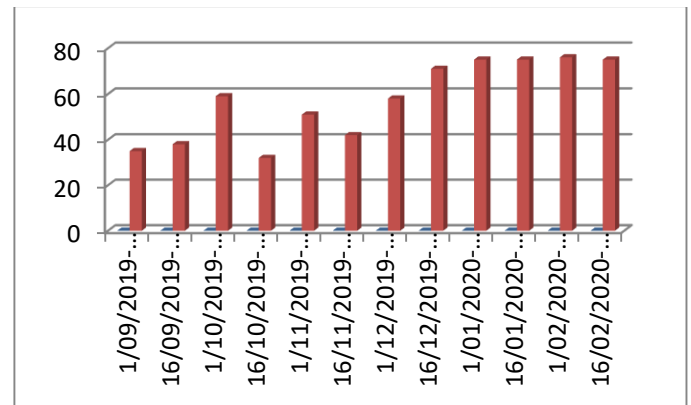| Sl	Parameters	Duration (Date)	∑of all parameter	Average	AQI
1	PM 2.5	1/09/2019-16/9/2019	190.08	21.12	35
2	PM10		0	0	
3	SO2		24.95	3.56	
4	NO2		244.79	27.19	

Fig 13 Showing air quality index during Pre lockdown period from 1/09/2019-29/02/2020

2. 1st Lockdown(22/3/2020- 2/5/2020)

Example Table 15 Showing air quality index during 1st lockdown period from 22/3/2020-6/4/2020

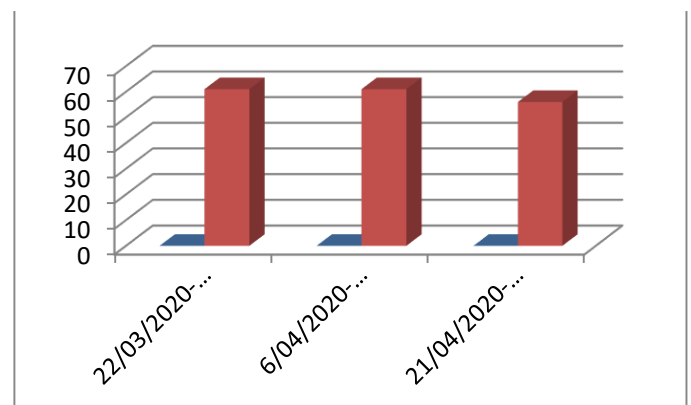| Sl	Parameters	Duration (Date)	∑ of all parameter	Average	AQI
1	PM 2.5	22/3/2020-6/4/2020	573.75	38.25	61
2	PM10		0	0	
3	SO2		49.7	3.31	
4	NO2		109.66	7.31	

Fig 14 Showing air quality index during 1st lockdown period from 22/03/2020-2/05/2020

3. 2nd Lockdown (27/4/2021- 21/6/2021)

Example Table 16 Showing air quality index during 2nd lockdown period from 27/4/2021-12/5/2021

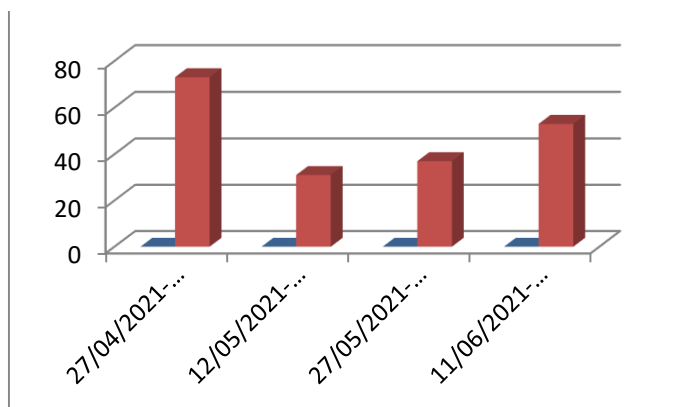| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	27/4/2021-12/5/2021	629.54	41.96	73
2	PM10		1088.3	72.55	
3	SO2		85.12	5.67	
4	NO2		256.4	17.09	

Fig 15 Showing air quality index during 2nd lockdown period
from 27/04/2021-21/06/2021

4. Post Lockdown (1/8/2021- 1/2/2022)

Example Table 17 Showing air quality index during Post
lockdown period from 1/8/2021-16/8/2021

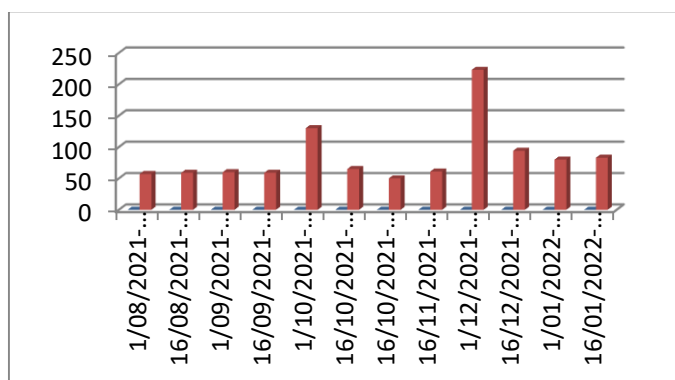| Sl	Parameters	Duration (Date)	Sum of all parameter	Average	AQI
1	PM 2.5	1/8/2021- 16/8/2021	453.11	32.36	57
2	PM10		804.05	57.43	
3	SO2		27.64	1.84	
4	NO2		221.81	14.78	

Fig 16 Showing air quality index during Post lockdown period
from 1/08/2021-1/02/2022

CONCLUSION

The air quality index across the selected monitoring stations
has shown reduced values during the lock down period. The
AQI in residential area is very much less when compared to
the commercial area and traffic junction during the lock down
period. There is difference in AQI of pre Covid and during
COVID, as most of the anthropogenic activities were stopped
due to imposition of lock down by the State of Karnataka,
especially the stoppage of vehicular movement within the city
area. The AQI analysis indicates that there is a reduction of 26
to 65% in air pollutants at selected places of study spread
across the study period. The post COVID AQI analysis reveals
that, there is slight increase in the air pollutant concentration,
especially concentration of PM_{10} and $PM_{2.5}$ across different
locations of study area. The Pre covid scenario on air pollutant
concentration reveals that, the PM10 and PM 2.5 are higher
than SO2 and NO2.

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