VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"Jnana Sangama", Belgaum-590 014

A Dissertation Project Report on

"Impact of Environmental Factors On COVID-19 Transmission And Analysis Of Air Pollution During COVID-19 Lockdown Across Different Cities In India"

Submitted in partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING IN

CIVIL ENGINEERING

BY

BHARAT	**1CR16CV007**
RAHUL KARAGINI GN	**1CR16CV045**
RAJESH	**1CR16CV047**
RAKSHIT	**1CR16CV048**

Under the guidance of

Dr. Smaranika Panda

DEPARTMENT OF CIVIL ENGINEERING

CMR INSTITUTE OF TECHNOLOGY

ITPL MAIN ROAD BENGALURU-560 037

2020-2021

C.M.R. INSTITUTE OF TECHNOLOGY

(#32, AECS Layout, IT Park Road, Bengaluru-560 037)

Department of Civil Engineering

Certificate

This is to certify that the project work entitled **"Impact Of Environmental Factors On COVID-19 Transmission And Analysis Of Air Pollution During COVID-19 Lockdown Across Different Cities In India"** *has been successfully completed by Mr.Bharat* (USN 1CR16CV007), Mr. *Rahul Karagini* G N (USN *1CR16CV045), Mr.Rajesh (USN 1CR16CV047), Mr.Rakshit (1CR16cv048) bonafide students of CMR Institute of technology in partial fulfilment of the requirement for the award of degree of Bachelor of Engineering in Civil Engineering of the* ***"VISVESVARYA TECHNOLOGICAL UNIVERSITY",*** *Belgaum during the academic year 2020-21. It is certified that all corrections indicated for internal assessment has been incorporated in the Report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.*

Dr. Smaranika Panda	Dr. Asha M Nair	Dr. Sanjay Jain
(Assistant Professor)	HOD	Principal
	Department of Civil Engineering	CMR Institute of Technology
	CMR Institute of Technology	

Dr. Asha M Nair

(HOD)

Name of the Examiners	External Viva	Signature with date
1.		
2.		

C.M.R. INSTITUTE OF TECHNOLOGY
(#32, AECS Layout, IT Park Road, Bengaluru-560 037)

Department of Civil Engineering

DECLARATION

We, **Mr. Bharat , Mr.Rahul Karagini G N , Mr. Rajesh**, **Mr.Rakshit** bonafide students of CMR Institute of Technology, Bangalore, hereby declare that dissertation entitled **"Impact Of Environmental Factors On COVID-19 Transmission And Analysis Of Air Pollution During COVID-19 Lockdown Across Different Cities In India"** has been carried out by us under the guidance of **Dr.Smaranika Panda**, Department of Civil Engineering, CMR Institute of Technology, Bangalore, in partial fulfilment of the requirement for the award of degree of Bachelor of Engineering in **Civil Engineering** of the Visvesvaraya Technological University, Belgaum during the academic year 2020-21. The work done in this dissertation report is original and it has not been submitted for any other degree in any university.

Bharat (1CR16CV007)

Rahul Karagini GN (1CR16CV045)

Rajesh (1CR16CV047)

Rakshit (1CR16CV065)

ABSTRACT

The previous project "Particulate matter exposure of school children at different lands of Bengaluru" could not be continued due to pandemic coronavirus disease the lockdown has been put across the country.

Present work:

- *Air pollution is one of the major issues across world.*
- *Outdoor air pollution kills around 4.2 million people worldwide each year (WHO, 2018).*
- *However, the lockdown due to the Covid 19 pandemic has showed a drastic change in the atmospheric condition across the world as well as in India*
- *Clear blue skies across the world's megacities have become visible mark of the pandemic lockdown.*
- *Covid-19 may have some relation with the environmental factors and its transmission may vary accordingly. The climatic and geographical condition of India is quite different and in the present study we attempted to analyze various factors affecting Covid19*

ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without mentioning of the people who made it possible. Many responsible for the knowledge and experience gained during the work course.

We would like to express my deep sense of gratitude to our principal Dr. **SANJAY JAIN**, **CMR INSTITUTE OF TECHNOLOGY COLLEGE, BANGALORE** for his motivation and for creating an inspiring atmosphere in the college by providing state of art facilities for preparation and delivery of report.

Our sincere thanks to **Mrs. ASHA M NAIR** , Head of Department Civil Engineering CMRIT, Bangalore who shared her opinions and experiences through which we received the required information crucial for the project.

We consider it a privilege and honour to express our sincere gratitude to our internal guides **Mr. Nagendra v**, Department of Civil Engineering for their valuable guidance throughout the tenure of this project work.

Bharat

Rahul Karagini G N

Rajesh

Rakshit

INTRODUCTION

- The old project could not be completed due to the pandemic covid-19.
- It was carried out for 15 days before the lockdown.
- The monitoring started on 1st march 2020, before placing the instrument we had to take permission of the school authorities as the project was related to school children.
- The project was carried out for 10 days and we have the samples/filter papers of each sampling
- "The evidence we have is pretty clear that people who have been living in places that are more polluted over time, that they are more likely to die from coronavirus," says Aaron Bernstein, the director of the Center for Climate, Health, and Global Environment at Harvard University.

Sampling site:

Fig: : Sampling location and instrument

Fig : Filter paper overview of day-1 to day-10 after 8 hours of sampling

INTRODUCTION

- Covid-19/ SARS-CoV-2 originated from Wuhan city of china, after it spread across the world WHO has declared it as pandemic disease.
- It is highly contagious with a mortality rate of 6.4 %. However, the rate varies in different countries.
- This virus has made the world shut down and several countries had declared lockdown to maintain social distancing and it prevent the spread of virus.
- India reported its first case on 30th of January 2020. as it took places of different parts of India, the government has declared lockdown on 25th march 2020.
- Covid-19 is an acute respiratory illness which comes with minor symptoms to difficulty in breathing, kidney failure and death.

Need for the study

- Covid19 pandemic has brought the world to stand still which resulted in significant changes in the climatic conditions
- The carbon emission reduced drastically- (WHO, 2020)
- The size of ozone hole reduced (NASA, 2020)
- Green algae was observed in the Polar regions
- Air quality improved across the world
- Keeping this in view , **there is a requirement to study the impact of Covid 19 in Indian scenario**.
- The **climate variability has shown significant effect on infectious diseases** in the **past research** across different cities which are polluted to a large extent.
- Hence an attempt was made to find if there exist a correlation with **air pollutants and meteorological conditions with Covid 19** by considering 4 contrasting cities of India.

Scope and Objective:

SCOPE: To study the impact of environmental factors on covid-19 transmission and to analyse the air pollution data during the coronavirus lockdown across different cities in India.

OBJECTIVE: The climate variability has shown significant effect on infectious diseases in the past research across different cities which are polluted to a large extent.

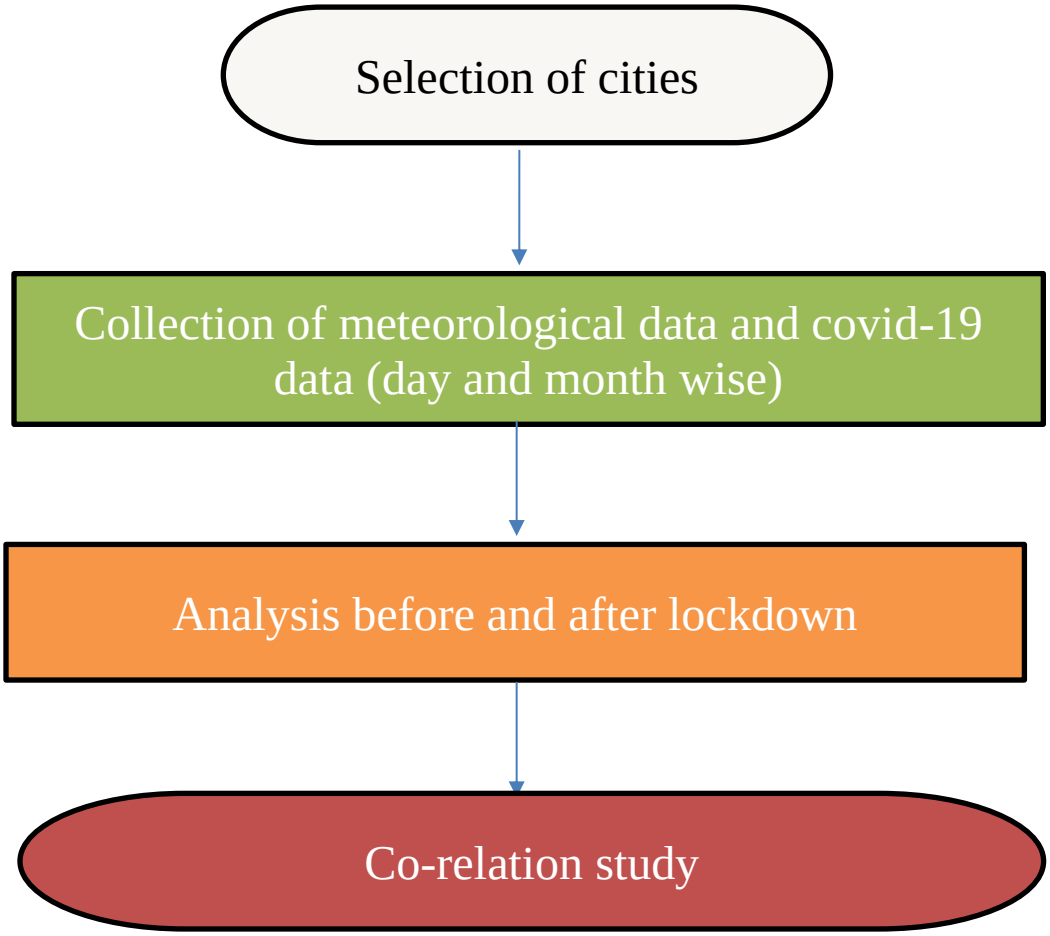
1. Air pollution is a major problem in developed and developing countries. In this covid-19 lockdown it is necessary to know the reduction in air pollution and pollutants causing health risks.
2. Some researchers have shown a relative data between meteorological factors and covid-19. hence it is evident that there must be some relation between these factors and covid-19. To collect the meteorological data before and after covid-19 and to analyze the same across different cities of India.
3. Establishing the correlation between Covid 19 and meteorological parameters such as wind speed, Relative humidity and temperature

LITERATURE REVIEW

AUTHORS	YEAR	REVIEW
Asmi Anwar, Sajid Anwar, et. al	2019	There is a long run co-integrating relationship among climate change, socio-economic factors and prevalence of infectious diseases. Climate change, as measured by the temperature, is contributing to the spread of infectious diseases. This is the first study giving evidence of the impact of climate change on incidence of infectious diseases as can be seen from highly vulnerable countries to climate change.
Mao wang, ali jiang, et.al		The lgN rose as the average temperature went up to a peak of 8.72℃ and then slowly declined. The apexes of the minimum temperature and the maximum temperature were 6.70℃ and 12.42℃ respectively. The curves shared similar shapes. Under the circumstance of lower temperature, every 1℃ increase in average, minimum and maximum temperatures led to an increase of the cumulative number of cases by 0.83, 0.82 and 0.83 respectively.
Yongjian zhu, jingui xie, Fengming huang, Liqing cao.	2020	In this paper, they generalized additive model to explore the relationship between ambient air pollutants and daily COVID-19 confirmed cases. they found significantly positive associations of $PM_{2.5}$, PM_{10}, CO, NO_2 and O_3 with COVID-19 confirmed cases, while SO_2 was negatively associated with the number of daily confirmed cases. These findings could provide evidence that air pollution is an important factor in COVID-19 infection.

Franklin amuakwa, George marbuah, Mwenya mubanga	2017	They have examined the effect of climate variability on the incidence of infectious diseases using panel data for the period 1998–2013 for all 21 Swedish counties. temperature generally has a linear negative effect on the number of patients. However, the relationship between winter temperature and the number of patients is non-linear.
Jiangtou liu, Ji zhou, Jinxi yao, xiuxia zhang, Lanyu li, et. al	2020	Their results indicated that COVID-19 transmission may be affected by meteorological factors, and a weather with low temperature, mild diurnal temperature range and low humidity likely favor its transmission. Our findings on the impact of meteorological conditions over the transmission of COVID-19 are consistent with previous studies on the transmission of SARS or other infectious diseases
Jianguo tan, lina mu, jiaxin huang, et. al	2005	Current knowledge based on case studies of the SARS outbreak in the four cities suggested that the SARS outbreaks were significantly associated with the temperature and its variations. However, because the fallacy and the uncontrolled confounding effects might have biased the results, the possibility of other meteorological factors having an affect on the SARS outbreaks deserves further investigation.

Methodology:



Study area description

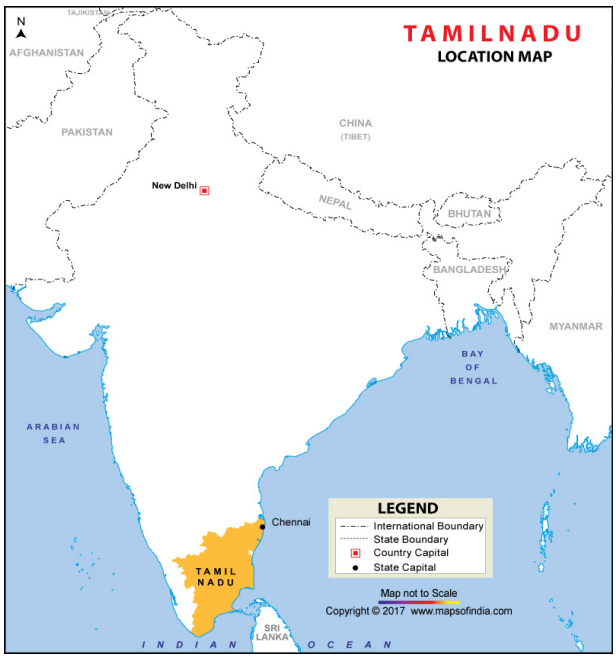
Selection of site: Sites are chosen based contrasting geographic locations such as coastal and non-coastal area etc.

Indore:

It is middle portion of India
Indore is at high elevation i.e. 550 m height from mean sea level (MSL).
Humidity is relatively dry. It is in the range of 25- 85%
High temperature reaching 40 ^{o} c during summer and as low as 5 ^{o}C during winter
Population of the city: 1,994,397
Population Density: 3800/km2

Chennai:

This is located in the southern part of India
It is a coastal city
It experiences high temperature though out the year
It is a highly humid region due to close proximity to sea
The height of Chennai is 6m from MSL
Population of the city: 7,088,000
Population Density: 17,000/km2



Ahmedabad:

This is located in the Western part of India
The highest temperature recorded this year is 40 ^{o} c in the month of April.
Annual Relative humidity of the city is 54% and during summer 34%.
The height of city from MSL is 54m.
The population of Ahmedabad is 55.7 l.
The population density is 12000/sq km.

Delhi :

Delhi is located in north part of our country.
Delhi is the capital of India.
Delhi is the most polluted city in India.
The temperature in Delhi varies from 30-40 ^{o} c during summer.
The relative humidity of city is 35%
The population of city is 2,64,54000
The population density is 11312/ sq km.

Data collection

- Meteorological data was collected from the Central pollution Control Board
- The data is available for hourly basis and was averaged to find the 24-hr average
- Air pollution data was collected from the CAAQMS (Continuous Ambient Air Quality Monitoring Stations) of the cities. Central pollution and State pollution Control boards operate the CAAQMS. The data was collected and outliers were removed and analyzed to find daily average
- Covid19 data for city level was collected from the official bulletin. The district level daily data is not readily available, Only state level data are available in various platform.

Results & Discussion

Outdoor Air Quality Characterization: Indore

Table:1 Statistical distribution of pollutants **before lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	1.1	0.2366	1.58	0.51
Ozone(µm/m3)	34.79	2.965	42.71	22.83
NO2(µm/m3)	69.14	19.618	138.12	39.81
SO2(µm/m3)	10.97	3.736	26.1	4.56
PM2.5(µm/m3)	63.42	7.473	117.77	25.21

Table: Statistical distribution of pollutants **after lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.59	0.2629	0.97	0.21
Ozone(µm/m3)	35.2290	1.6602	37.75	32.04
NO2(µm/m3)	51.0195	15.4358	57.46	16.41
SO2(µm/m3)	8.8203	3.7283	14.57	2.77
PM2.5(µm/m3	38.0220	19.0035	95.55	11.5

Table: Statistical distribution of meteorological parameters **before lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	1.2753	0.3082	1.96	0.68
Temperature(0 C)	20.7388	2.3335	26.68	14.29
Relative humidity(%)	58.4346	9.6997	90.23	30.38

Table: Statistical distribution of meteorological parameters **after lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	1.2969	0.3839	2.2	0.69
Temperature(0 C)	29.3386	1.8761	34.67	29.14
Relative humidity(%)	34.0725	7.1324	78.1	27.5

Indore city: Air pollution before and after lockdown

- Percentage reduction in Co was observed to be 46.36%
- Percentage reduction in Ozone was observed to be 0%
- Percentage reduction in NO2 was observed to be 26.20%
- Percentage reduction inSO2 was observed to be 19.59%
- Percentage reduction in PM2.5 was observed to be 40%

Outdoor Air Quality Characterization : Chennai

Table: Statistical distribution of pollutants **before lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.5736	0.223	0.93	0.35
Ozone(µm/m3)	24.646	8.4090	45.7	6.78
NO2(µm/m3)	20.6226	5.1761	29.14	8.69
SO2(µm/m3)	5.3008	2.3062	18.43	1.64
PM2.5(µm/m3)	43.054	14.0819	118.35	5.87

Table: Statistical distribution of pollutants **after lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.40	0.1191	1.01	0.29
Ozone(µm/m3)	16.901	5.9783	50.34	8.58
NO2(µm/m3)	10.925	6.5651	27.67	0.43
SO2(µm/m3)	4.3001	1.6395	8.53	1.29
PM2.5(µm/m3	22.715	10.704	63.22	1.49

Table: Statistical distribution **of meteorological** parameters **before lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	0.7282	0.3416	2.07	0.14
Temperature(0 C)	26.023	0.7466	27.64	23.34
Relative humidity(%)	74.787	5.3646	96.8	59.59

Table**:** Statistical distribution **of meteorological** parameters **after lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	0.6007	0.1620	1.05	0.32
Temperature(0 C)	28.89	0.6570	31.09	26.89
Relative humidity(%)	71.14	2.9049	82.778	65.043

Chennai: Air pollution before and after lockdown

- Percentage reduction in Co was observed to be 29.82%
- Percentage reduction in Ozone was observed to be 31.42%
- Percentage reduction in NO2 was observed to be 47%
- Percentage reduction inSO2 was observed to be 18.86%
- Percentage reduction in PM2.5 was observed to be 47.24%

Outdoor Air Quality Characterization: Delhi

Table**:** Statistical distribution of pollutants **before lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	1.4656	0.581	3.92	0.35
Ozone(µm/m 3)	38.136	14.416	123.6	10.42
NO2(µm/m3)	49.936	20.3566	163.5	19.14
SO2(µm/m3)	5.7436	2.571	14.95	2.71
PM2.5(µm/m3)	183.766	66.156	353.1	47.1

Table**:** Statistical distribution of pollutants **after lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.417	0.180	0.93	0.13
Ozone(µm/m 3)	65.705	13.015	110.6	32.79
NO2(µm/m3)	23.115	11.0725	61.09	4.38
SO2(µm/m3)	9.991	2.2286	13.31	4.65
PM2.5(µm/m3	63.675	22.705	127.9	25.57

Table: Statistical distribution of meteorological parameters **before lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	0.6226	0.142	1.85	0.43
Temperature(0 C)	13.53	2.372	19.98	6.49
Relative humidity(%)	77.78	7.571	95.13	59.61

Table: Statistical distribution of meteorological parameters **after lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	0.6825	0.169	1.34	0.51
Temperature(0 C)	24.06	2.950	31.15	13.53
Relative humidity(%)	58.095	6.858	86.88	35.13

Delhi: Air pollution before and after lockdown

- Percentage reduction in Co was observed to be 71.54%
- Percentage reduction in Ozone was observed to be 0%
- Percentage reduction in NO2 was observed to be 53.71%
- Percentage reduction inSO2 was observed to be 0%
- Percentage reduction in PM2.5 was observed to be 65.35%

Outdoor Air Quality Characterization : Ahmedabad

Table: Statistical distribution of pollutants **before lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.7837	0.3157	2.41	0.03
Ozone(µm/m3)	34.8	11.33	75.25	5.04
NO2(µm/m3)	40.532	16.4752	122.12	11.21
SO2(µm/m3)	54.5326	25.074	135.6	10.26
PM2.5(µm/m3)	63.9883	18.0656	135.92	17.83

Table: Statistical distribution of pollutants **after lockdown**

Parameter	Average	Std Deviation	Maximum	Minimum
Co(mg/m3)	0.4883	0.189	1.24	0.27
Ozone(µm/m3)	44.629	10.3752	76.75	16.61
NO2(µm/m3)	28.289	9.7565	62.97	13.42
SO2(µm/m3)	34.2335	14.133	113.75	9.03
PM2.5(µm/m3	38.1055	11.4245	99.72	19.57

Table: Statistical distribution of meteorological parameters **before lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	3.1560	1.1233	7.4	0.4
Temperature(0 C)	20.4973	2.3441	26.979	15.313
Relative humidity(%)	46.5113	7.4382	71.38	27.54

Table: Statistical distribution of meteorological parameters **after lockdown**

Parameter	Average	Std deviation	Maximum	Minimum
Wind speed(m/s)	4.7918	1.5580	7.94	1.81
Temperature(0 C)	29.8315	2.3739	37.063	21.188
Relative humidity(%)	34.887	10.548	66.72	18.57

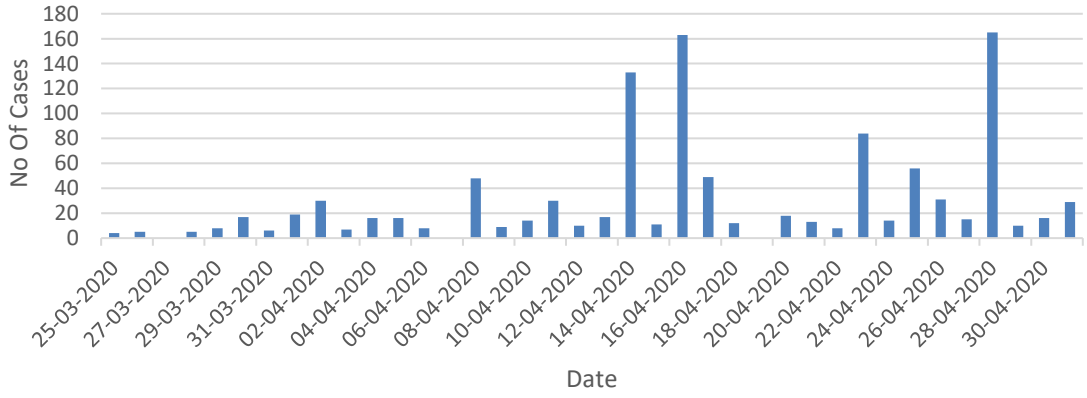
Ahmadabad: Air pollution before and after lockdown

- ► Percentage reduction in Co was observed to be 37.43%
- ► Percentage reduction in Ozone was observed to be
- ► Percentage reduction in NO2 was observed to be 30.20%
- ► Percentage reduction inSO2 was observed to be 37.22%
- ► Percentage reduction in PM2.5 was observed to be 40.44%

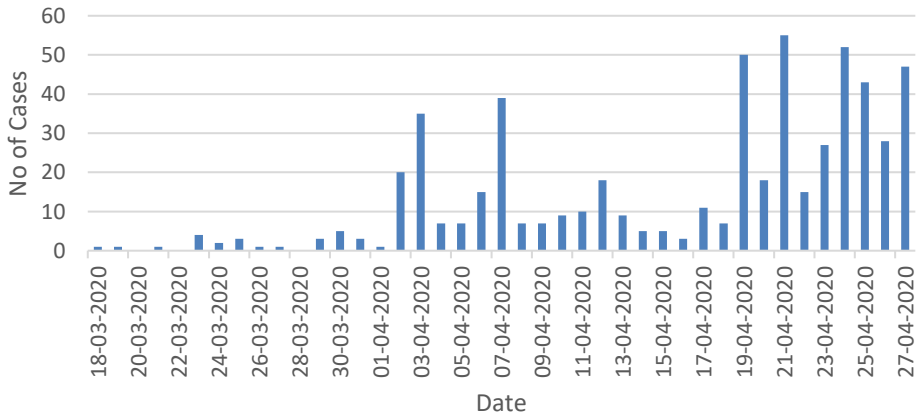
In Objective 2

City wise data Covid19 data collection is completed
Various correlation studies will be carried out.

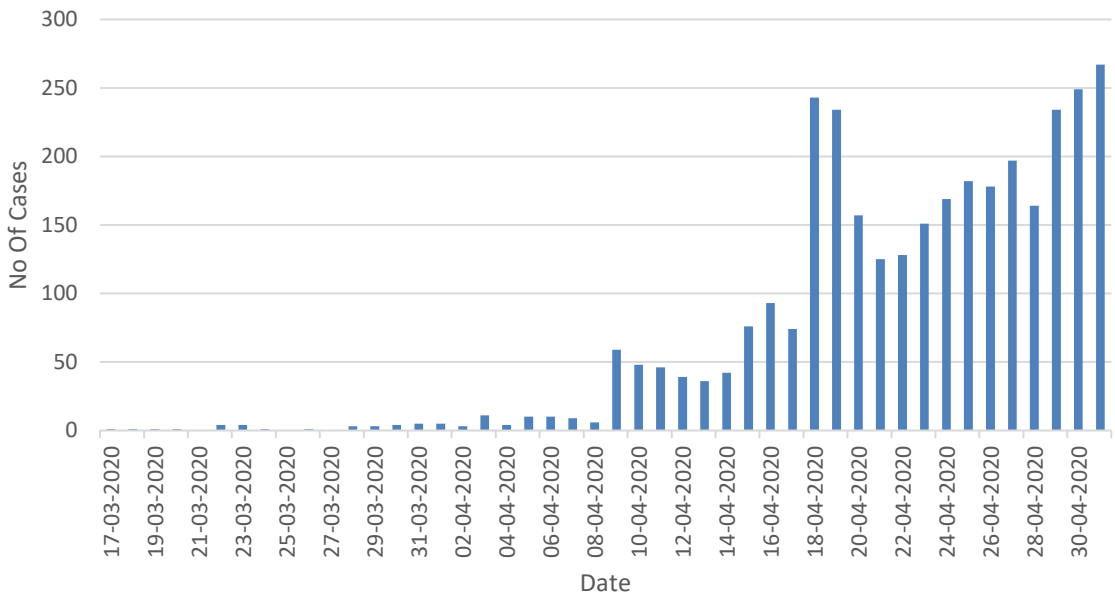
Indore: Covid 19 cases



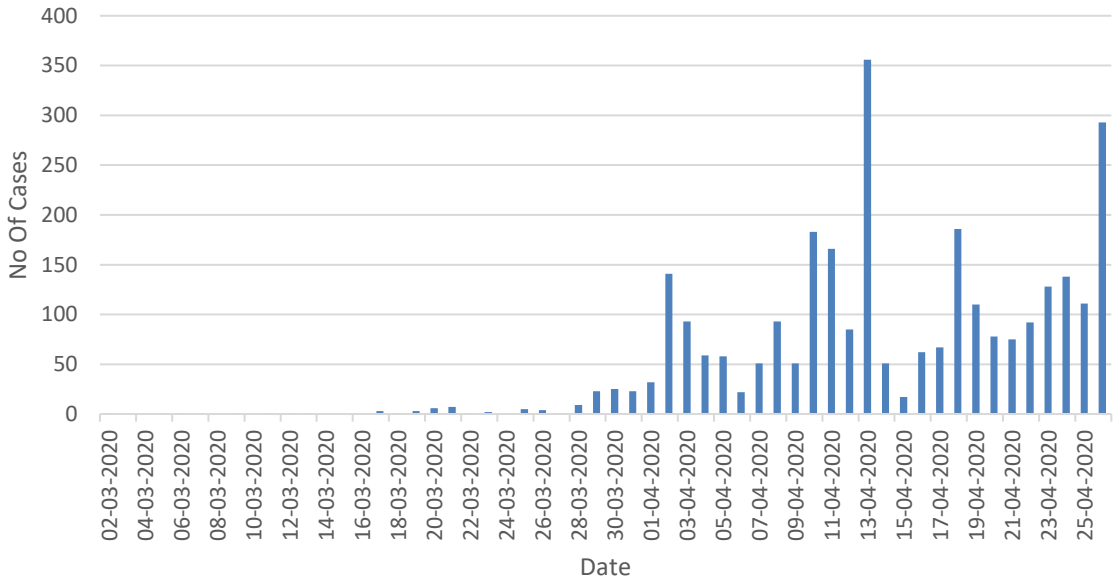
Chennai: Covid 19 cases



Ahmadabad: Covid 19 cases



Delhi: Covid 19 cases



CONCLUSION

Objective 1:

- In every city we can observe there has been reduction in pollutants after lockdown.
- Indore the CO concentration has reduced to 50%, while NO2 and SO2 particles are reduced by 10-20% and PM2.5 particles reduced by 30%.
- Chennai a coastal city has shown 50% reduction in NO2 and PM2.5 concentration, other pollutants are reduced by 20%.
- Delhi being a most polluted city has shown some miracles as each and every pollutant is reduced by 50%.
- Ahmedabad has shown 40% reduction in CO and PM2.5 concentration, other pollutants are reduced by 20% minimum.

Time line:

Activities	May	June 15th
Literature review		
Collection of data and monitoring	Completed	
Scenario analysis (before and after study)	Completed	
Covid19 correlation study with outdoor concentration and meteorology		
Documentation		

Acknowledgement

We would like to acknowledge Mr. Nilesh for his help during data collection
We acknowledge the software developers of the online site (Covid19.org.in) for helping in city wise data collection process

REFERENCES

- Climate change and infectious diseases: evidence from highly vulnerable countries Iran. J. Public Health Iran J Public Health, 48 (12) (2019), pp. 2187-2195.
- Climate changes, environment and infection: facts, scenarios and growing awareness from the public health community within Europe Anaerobe, 17 (6) (2011), pp. 337-340, 10.1016/j.anaerobe.2011.05.016
- Analysis of spatiotemporal characteristics of pandemic SARS spread in mainland China Biomed. Res. Int. Biomed Res Int, 2016 (2016), Article 7247983, 10.1155/2016/7247983
- Influenza virus transmission is dependent on relative humidity and temperature PLoS Pathog.PLoS pathogens, 3 (10) (2007), pp. 1470-1476, 10.1371/journal.ppat.0030151.
- Role of Temperature and humidity in the modulation of the Doubling Time of COVID-19 Cases. Medrxiv (2020), 10.1101/2020.03.05.20031872 2020.2003.2005.20031872.
- Temperature significant change COVID-19 transmission in 429 cities medrxiv (2020), Article 2020.2002.2022.20025791, 10.1101/2020.02.22.20025791.
- G. Beig, S.K. Sahu (Eds.), SAFAR-High Resolution Emission Inventory of Mega City Delhi -2018, MoES, New Delhi (2018).
- Effect of restricted emissions during COVID-19 on air quality in India Shubham sharma delhi 2020.