Air Quality Index (AQI) in Bangalore, Karnataka, during 21 days of COVID-19 lockdown period - a preliminary study

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Abstract : 'The National Air Quality Index' (AQI), a metric to report daily air quality as 'One Number- One Color-One Description' for the common man to judge the air quality, launched by the government of India as an trump card under 'Swachh Bharat Mission'. Bangalore is known as Silicon Valley of India. Bangalore has grown in size and population due to industrial development. This rapid industrial growth and related activities has a serious effect on air quality in the city. With respect to air pollution Bangalore is the second most polluted city in India. Coronavirus disease (COVID-19) is an infectious disease caused by a newly found virus. Thousands of suspected cases have been tested resulting in more than 13000 confirmed corona virus cases in India. Number of preventive measures has been taken to minimize the spreading of corona virus by the Indian government. India's Prime Minister has appealed to the nation to avoid mass gatherings and meetings. A 21-day lockdown across the country was imposed from 26th March, 2020 to 14th April, 2020 to curb the spread of the coronavirus pandemic. All factories, schools, colleges, offices and transportation services have been closed except essential services. The main objective of this study is to analyze the AQI trend in Bangalore during this first 21 days of lockdown period of COVID-19. Data has been obtained from Central Pollution Control Board (CPCB) website and used for analysis without any modification.

Index Terms - Quarantine, AQI, Pandemic, Corona virus disease, Lockdown period.

I. INTRODUCTION

During Preindustrial time the human activities have resulted in large increase in air pollution. Air pollutants are substances which are present in the atmosphere and adversely affect the human health, animals, plants, or microbial life; damage materials, or interfere with the normal activities of life (Thilagaraj et al. 2014). Air pollution is a major environmental issue with health problem affecting everyone in the world without any exception of low, middle, and high-income countries. Ambient (outdoor) air pollution in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide per year in 2016; this mortality is due to exposure to small particulate matter of 2.5 microns or less in diameter (PM 2.5), which cause cardiovascular and respiratory disease, and cancer disease+.

The latest reports have showed a significant role of air pollution in cardiovascular illness and death. World Health Organization (WHO) estimates that in 2016, 58% of outdoor air pollution-related to premature deaths due to heart disease and strokes, while 18% of deaths were due to chronic obstructive pulmonary disease and acute lower respiratory infections respectively, and 6% of deaths were due to lung cancer. Many deaths were attributed to more than one risk factor at the same time. A 2013 assessment by WHO International Agency for Research on Cancer (IARC) concluded that outdoor air pollution is carcinogenic to humans, with the particulate matter component of air pollution most closely associated with increased cancer incidence, especially lung cancer. An association also has been observed between outdoor air pollution and increase in cancer of the urinary tract [WHO 2014, Ravindra et al. 2012 and WHO 2001).

Discussing air pollution is a key to protecting public health. Major sources of outdoor air pollution are well beyond the control of individuals and demands action by local, national and regional level policy-makers working in sectors like transport, energy, waste management, urban planning, and agriculture.

On 31 December 2019, the WHO China Country Office informed with cases of pneumonia by unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China. From 31 December 2019 through 3 January 2020, a total of 44 case-patients with pneumonia of unknown etiology were reported to WHO by the national authorities in China. During this period it was reported that causal agent was not identified. After this incident it became pandemic as it covered the whole world and identified as Corona virus disease (COVID-19) which is an infectious disease caused by a newly discovered coronavirus. Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious health issues.

In the second week of April, 2020 thousands of suspected cases have been tested resulting 10023 confirmed corona virus cases in the country. The highest number of cases found in different states of India includes Maharashtra, Kerala, Delhi, Karnataka, Andhra Pradesh, Uttar Pradesh, Rajasthan and Tamil Nadu. First death due to coronavirus in India was reported in Karnataka on 12 March 2020 and by the end of second week of April, 2020 more than 339 deaths have been reported in the country. India has taken all necessary precautionary measures to avoid the community transmission phase of Covid-19 by extending the lockdown till 3rd May, 2020 (second stage of Lockdown of country) The south Indian city of Bangalore, the capital of Karnataka state, recognized as 11th ranked hotspot of COVID-19 affected area in India (as on 12th April,2020). (Mygov dashboard)

To combat this kind of disease influenza pandemic of 1918 caused 50 million deaths worldwide, where isolation, quarantine, and total lockdown are recognized public health measures proved to be very effective in several European countries. Recently China also followed the same total lockdown measure to control this virus. Initially a 21-days lock-down imposed across the India from 25th March to 14th April, 2020 to curb the spread of the coronavirus pandemic. All factories, schools, colleges, offices and public transportation services have been closed except some essential services. Main objective of this study is to explore the

changes in air quality in terms of AQI during these 21 days of lockdown period in Bangalore, one of the most polluted cities in India.

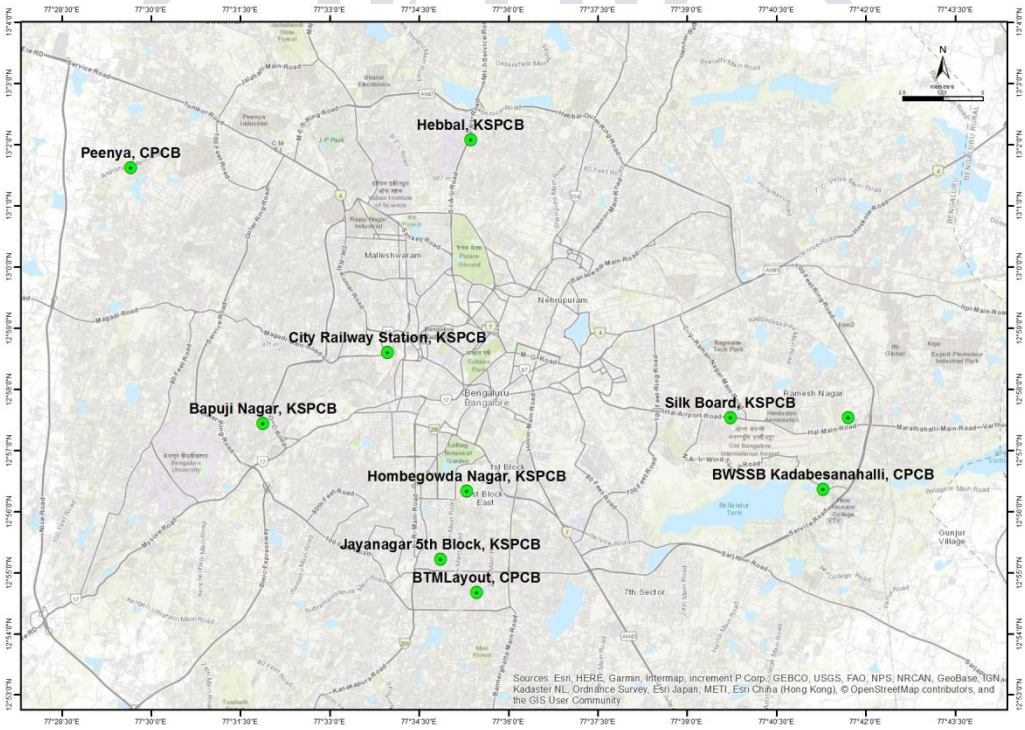
II. MATERIALS AND METHODS

2.1 Study Area –

Bangalore, the cultural, educational, industrial and administrative capital of Karnataka, India, is located between 12.9716° N and 77.5946° E longitudes and at an altitude of 920m above mean sea level. The summer temperature ranges from 18° C to 38° C, while the winter temperature ranges from 12° C to 25° C. Thus, Bangalore enjoys a good climate around the year. With its most parks and abundant greenery, it is also called as the "garden city" of India. The Bangalore landscape is located over ridges forming three watersheds. The undulating terrain in the region has facilitated the creation of a large number of interconnected lakes. Bangalore has grown by more than 10 times since 1951. The urban agglomeration had an overall population in 2011 of 8.4 million, including a workforce of 6.2 million, and a literacy rate of 87.6 percent according to the recent census. The information and technology (IT) sector is a major employer with 45 percent of the workforce. Bangalore is home to numerous high-tech knowledge hubs. Now Bangalore's identity has become from Garden city to an all important IT hub.

2.2 Air Quality Sampling Stations–

The monitoring of the ambient Air quality at 10 different monitoring stations (Figure 1) located at Bangalore is being carried out with the help of Central Pollution Control Board; Karnataka State Pollution Control Board; Pollution Control Committees; National Environmental Engineering Research Institute (NEERI), Nagpur. CPCB co-ordinates with these agencies to ensure the uniformity, consistency of air quality data and provides technical and financial support to them for operating the monitoring stations. The AQI is determined on the basis of concentration of 8 pollutants, including Particulate Matter (PM 2.5, PM 10), Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Carbon monoxide (CO), Ozone (O_3), Ammonia (NH_3) and Lead (Pb). The monitoring of pollutants is carried out for 24 hours.



Ambient Air Quality Monitoring Station 1	BTM Layout, Bangalore – CPCB
Ambient Air Quality Monitoring Station 2	BWSSB Kadabesanahalli, Bangalore – CPCB
Ambient Air Quality Monitoring Station 3	Bapuji Nagar, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 4	City Railway Station, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 5	Hebbal, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 6	Hombegowda Nagar, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 7	Jayanagar 5th Block, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 8	Peenya, Bangalore – CPCB
Ambient Air Quality Monitoring Station 9	Sanegurava Halli, Bangalore – KSPCB
Ambient Air Quality Monitoring Station 10	Silk Board, Bangalore – KSPCB

Source: Central Pollution Control Board (CPCB) Note: Map not to scale

Figure 1: Locations of air quality monitoring stations at Bangalore, Karnataka

2.3 The National Air Quality Index (AQI) –

Air quality indices (AQI) are commonly used to indicate the level of severity of air pollution to the public. A number of methods were developed in the past by various researchers/environmental agencies for the calculation of AQI, but there is no universally accepted method, appropriate for all situations (Monteiroet al. 2017 and Angathaet al. 2019). In India, 'The National Air Quality Index' (AQI), a metric to report daily air quality as 'One Number- One Colour-One Description' for the common man to judge the air quality, launched by the Government of India as an initiative under 'Swachh Bharat Mission'. Air pollution concerned with mainly environmental and health related issues, particularly in urban areas. Central Pollution Control Board along with State Pollution Control Boards has been operating National Air Monitoring Program (NAMP) covering most of the cities in the country. In addition, continuous monitoring systems that provide data on near real-time basis are also installed in major cities (WHO 2020 and WHO 2014).

The Central Pollution Control Board (CPCB) has released National Air Quality Indices (AQI) for 24 cities across India in the month of January 2016. The National AQI is published for every month by CPCB along with a numerical value and a colour code, which helps in comparing air pollution levels in different cities. It is determined on the basis of concentration of 8 pollutants, including Particulate Matter (PM 2.5, PM 10), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), ammonia (NH_3) and lead (Pb).

The colour categories are classified into 6 categories depending upon numerical value as Good (0-50), satisfactory (51-100), moderately polluted (101-200), poor (201-300), very poor (301-400) and severe (401-500). Based on the measured ambient concentrations, corresponding standards and likely health impact, a sub-index is calculated for each of these pollutants. The worst sub-index reflects overall AQI. Associated likely health impacts for different AQI categories and pollutants have been also been suggested, with primary inputs from the medical expert members of the group. The AQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as in Figure 2.

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 - 1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

AQI	Remark	Color Code	Possible Health Impacts
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to sensitive people
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases
201-300	Poor		Breathing discomfort to most people on prolonged exposure
301-400	Very Poor		Respiratory illness on prolonged exposure
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases

*One hourly monitoring (for mathematical calculations only) Source: Central Pollution Control Board (CPCB)

Figure 2: AQI Category, Pollutants and Health Breakpoints

III. Results and Discussion

The very purpose of this study is to analyze AQI trend in Bangalore during first phase of lockdown period of India. The entire country has been put under a 21-days historical lockdown as a measure to curb the spread of the coronavirus. With a few vehicles on the street, and no factories running, the air quality of Bangalore has significantly improved within 24 hours of the lockdown. The data obtained directly from the Central Pollution Control Board (CPCB) website and used for analysis without further modification. The air quality of Bangalore turned 'better' from 'hazardous' within 24 hours after imposing lockdown. Air Quality Index (AQI) of Bangalore has seen the sharp drop to 'Satisfactory' levels (Table 1 and Figure 3). Earlier AQI was 'Moderate' with a possibility of causing breathing discomfort, asthma and heart diseases (Figure 2). The nationwide lockdown imposed to combat Covid-19 impacted positively on the air quality. The Real-Time Air Quality Index obtained from the System of Air Quality Weather Forecasting and Research (SAFAR) and the Central Pollution Control Board (CPCB) showed relatively safer levels of AQI. The analysis of past five years average AQI and five days before the lockdown period in comparison with the 21 days of lockdown period also indicated the same pattern of drastic improvement of air quality (Figure 3, 4 &5). European Public Health Alliance (EPHA) reported higher death rates for Covid-19 to illnesses caused by air pollution such as high blood pressure,

diabetes and certain respiratory illnesses. Researchers of Italy recently reported that, a possible relationship of air pollution limits and the number of cases of COVID-19 infections.

Table -1 AQI on the days of lockdown (21 days) in comparison with same days of previous years.

		AQI		
NO DAYS	**LOCKDOWN PERIOD**	**2018**	**2019**	**2020**
1	**March 25**	**111**	**98**	**57**
2	**March 26**	**95**	**115**	**58**
3	**March 27**	**95**	**121**	**54**
4	**March 28**	**118**	**140**	**53**
5	**March 29**	**138**	**158**	**57**
6	**March 30**	**130**	**134**	**63**
7	**March 31**	**117**	**139**	**55**
8	**April 1**	**112**	**126**	**52**
9	**April 2**	**92**	**151**	**59**
10	**April 3**	**97**	**122**	**69**
11	**April 4**	**106**	**120**	**64**
12	**April 5**	**138**	**158**	**57**
13	**April 6**	**130**	**134**	**63**
14	**April 7**	**117**	**139**	**55**
15	**April 8**	**112**	**126**	**52**
16	**April 9**	**92**	**151**	**59**
17	**April 10**	**97**	**122**	**69**
18	**April 11**	**106**	**120**	**64**
19	**April 12**	**118**	**113**	**64**
20	**April 13**	**116**	**120**	**58**
21	**April 14**	**128**	**120**	**48**
Based on Number of Monitoring Stations		**3**	**7**	**8**
Prominent pollutants		**PM10, PM2.5,**	**PM10, PM2.5, Ozone**	**PM10, PM2.5, CO**
Average AQI		**101**	**122**	**56**

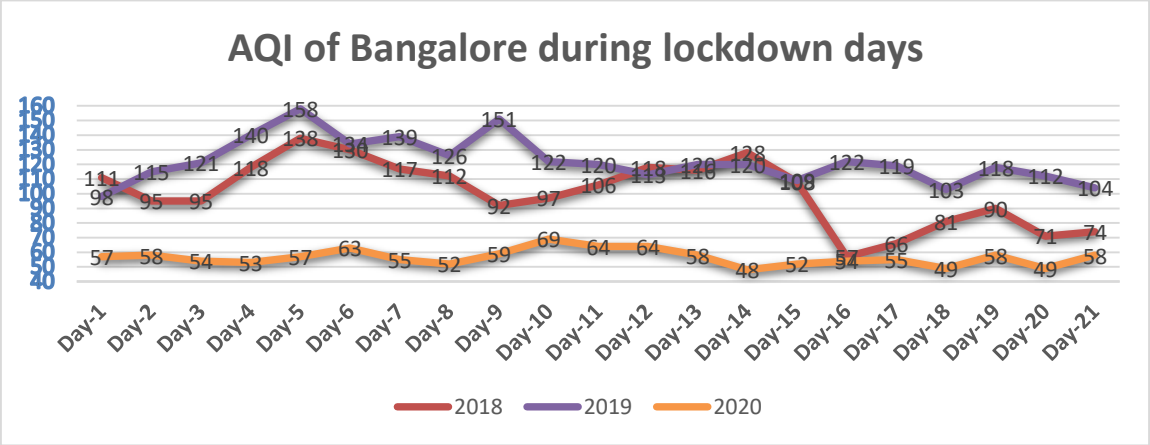
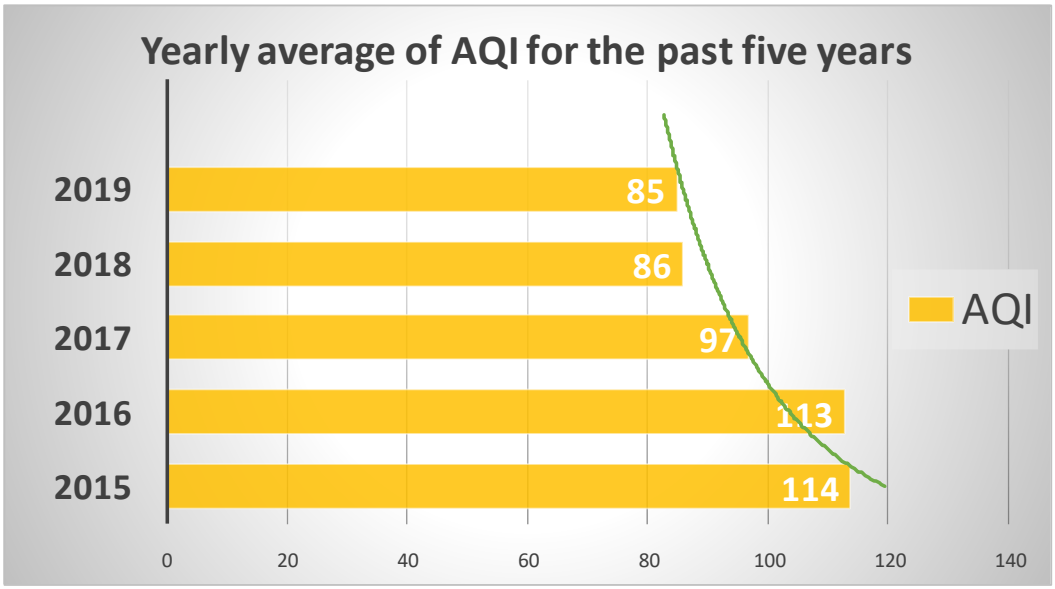
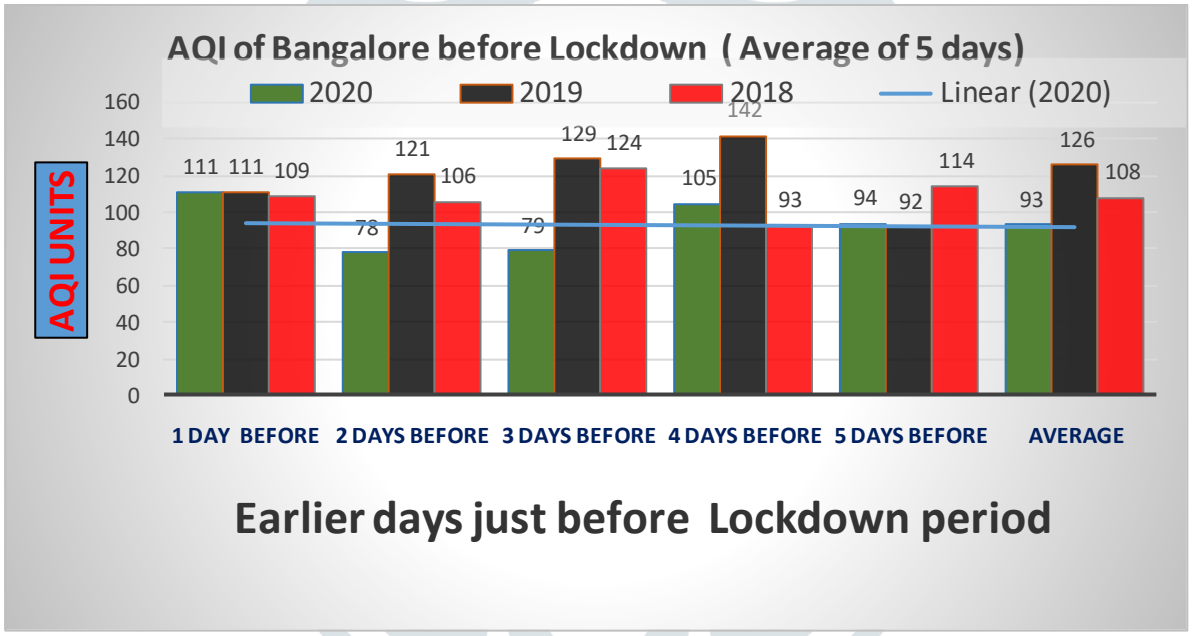


Figure 3: AQI of Bangalore during Lockdown days



Source: AQI-Bulletin Published by CPCB (everyday @ 4 PM (Average of 24 hours)



Source: AQI-Bulletin Published by CPCB (everyday @ 4 PM (Average of 24 hours)
Figure 4: AQI on the days earlier to lockdown in comparison with same days of previous years

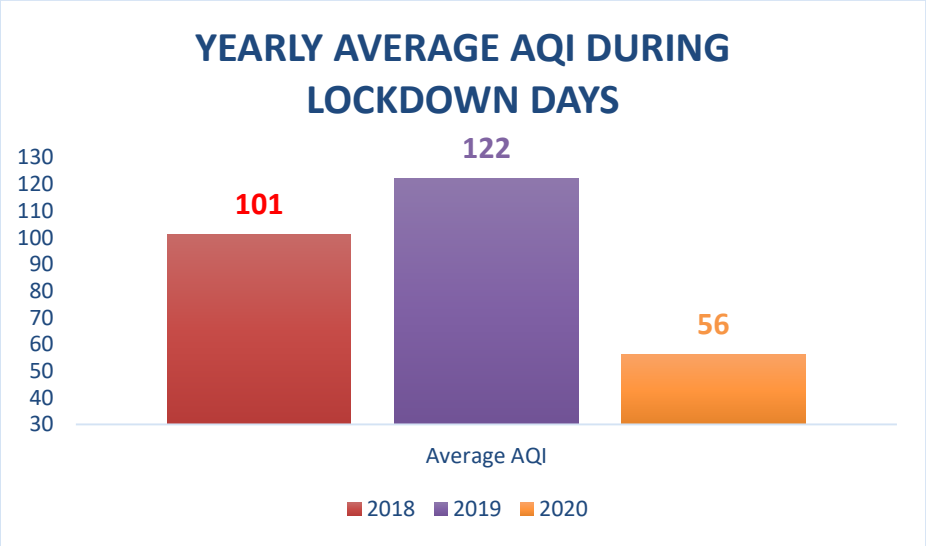


Figure 5: Yearly average AQI during Lockdown days

IV.CONCLUSION

The AQI provides communities with information on the current air quality in areas where monitoring stations are located. Many pollutants included in the AQI comes primarily from automobiles, domestic fuel consumption or long range transport, none of which can be subject to immediate control. The latest reports have reflected the role of air pollution in cardiovascular illness and death. More and more, evidences demonstrated the linkages between ambient air pollution and the cardiovascular diseases. The countrywide lockdown in a bid to slow down the spread of Covid-19, the Real-Time Air Quality Index (AQI) of Bangalore have begun to significantly decrease to 'satisfactory' level from 'moderate'. But, the damage has already been done to human health and people's ability to fight against infectious diseases like COVID-19. Governments should have acted on this air pollution long ago, but have prioritised the economy over health by being liberal to industrialists. 'Late better than never', we need to rethink about this instead of wasting money to establish modern health facility to public. It is evident from our past history that epidemics like COVID-19 will occur repeatedly in future also. Analysis by the Italian Society of Environmental Medicine (SIMA) and the Universities of Bari and Bologna has found particulate matter concentrations between 10th & 29th February, 2020 coincided with the contagion of COVID-19 up to March 3. Atmospheric particulate matter can act as a carrier for viruses but also allows contaminants to remain in the air for a certain time. The nationwide lockdown imposed to fight Covid-19 seems to have many hidden positive impacts on environment along with human values among public in the manner significant improvement in the quality of Bangalore during this crucial lockdown period.

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