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Air quality during COVID-19 lockdown: Blessing in disguise

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The world at present is facing a gravest health crisis due to the COVID-19 pandemic. To control its unimaginable transmission worldwide lockdown was implemented resulting in economic deterioration but on the other hand betterment of the environment took place. Therefore this study attempted to analyze the quality of air during the lockdown period and infer its outcome to environment and health. 15 empirical research articles, eight (54%), three (20%), two (13%) and two (13%) from Asia, Europe, South America and North America, respectively have been evaluated. From the studies it was inferred that during the lockdown period, in general, there was a trend of decrease in the level of concentrations of PM_{10}, $PM_{2.5}$, CO, NO, NO_2, NH_3, NO_x, SO_2 and increase in the concentration level of O_3 in comparison to either the pre-lockdown period or to the previous year(s) records. Marked decrease in the levels of NO, NO_2, NOx were noted. Also PM_{10}, $PM_{2.5}$, SO_2 and CO levels were seen to diminish significantly. The main reasons for such decrease were restricted movements of traffic and temporary closure of factories and industries. However, as the thermal power plants were functional during lockdown so improvement of air quality in those areas was not significant. Overall, significant improvement in the air quality was observed during the lockdown which led to better climatic conditions, lesser pollution and improved many seasonal ailments like asthma and other cardio-respiratory issues in people.

Keywords: Air pollutants, Air quality, COVID-19, Lockdown

The world at present is facing a gravest health crisis due to a virus. This has culminated into a pandemic, also known as "coronavirus pandemic", which until months ago were unknown to the scientists. Coronaviruses are a large family of RNA viruses that cause mainly respiratory diseases ranging from the common cold to more severe pneumonia in both mammals and birds. Viruses continue to emerge and challenge public health. According to the World Health Organisation (WHO) some of the lethal coronavirus varieties, found to affect global public health are SARS-CoV (Severe Acute Respiratory Syndrome corona virus) in 2002; MERS-CoV (Middle East Respiratory Syndrome corona virus) in 2012 and the newly emerged novel corona virus also known as SARS-CoV2 in 2019[1].This virus was named as COVID-19 by WHO after it became a pandemic threat. Coronaviruses are enveloped virus with a helical symmetry nucleocapsid and contains positive sense single stranded RNA genome of 26-32 kilobases, making it one of the largest RNA viruses[2,3]. They have a crown-like appearance under an electron microscope (*coronam* is the Latin term for crown) due to the presence of spike glycoproteins on the envelope[4]. Alcohols have distinct effects upon the structure of proteins and polypeptides like destruction of rigid native structure, induction of α-helix as well as dissolution of peptide aggregates[5,6]. Using this principle, under the preventive guidelines of WHO, hand-washing using alcohol based sanitizers are being recommended to prevent the entry of this life-threatening virus into the respiratory tract.

Since the first outbreak of COVID-19 was reported in Wuhan, China in December 2019[7], at present there are rarely any country that is unaffected with this global pandemic infection[8]. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes[9,10]. It affects adults more than the children through the infection of the respiratory tract epithelium[10]. The World Health Organisation recommended travel restrictions and nationwide lockdowns across the world to control its rapid community transmission.

COVID-19 may have a mammoth negative effect on human health and wealth. However, it has a

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significant positive effect on the environment. As there was sudden and worldwide impactful outburst of this virus the Director General-WHO declared it as a pandemic on March 11, 2020[11], the Governments of almost all the nations of the world implemented lockdown in their respective nations in order to control the level of transmission of the infection. From the end of March, 2020 till mid-May, 2020 almost the whole world was shut down. This demanded the temporary closure of the industries, factories, tourism, movement of vehicles, public organizations etc. and hence it led to a decrease in the emission of poisonous gases in the atmosphere, resulting in the decrease of the level of air pollution. The lockdown period improved the air and water quality in a short span of time due to very few human activities[12,13]. Therefore, the investigators of the present study attempted to evaluate the studies related to the empirical verifications of the quality improvement of air during the lockdown period and infer the nature of such improvement.

Methodology

Sample

15 numbers scientific research articles, authored by various authors from different countries of the world and published in reputed peer-reviewed journals, have been selected following the criteria mentioned below:

Inclusion criteria

Full-length empirical papers in the English language have been included. All experimental studies that, analyzed the data provided by the authorized air quality monitoring stations, have been included. Studies representing countries from different continents of the world have been included by giving priority to the prevalence of the number of coronavirus cases and ranking of the countries in reference to the level of air pollution[14].

Exclusion criteria

Abstracts were excluded due to a lack of detailed methodology and results.

Sampling technique

Purposive sampling technique has been followed in this investigation.

Method

The related empirical papers have been searched from Google Scholar and Open Athens, online search engines.

Delimitation of the study

The present study is delimited to the empirical studies related to the quality of air during the lockdown period. Only six primary air pollutants have been included in the study such as-Particulate Matter 10 micrometers (PM_{10}), Particulate Matter 2.5 micrometers ($PM_{2.5}$), Oxides of Carbon (COx), Oxides of Nitrogen (NOx), Oxides of Sulphur (SOx) and Ozone (O_3).

Results and Discussion

The literature obtained have been reviewed exhaustively and represented in the following (Table 1).

In this paper eight (54%), three (20%), two (13%) and two (13%) research articles have been included from Asia, Europe, South America and North America, respectively (Fig. 1).

Five (56%), two (22%), one (11%) and one (11%) countries are represented from Asia, Europe, South America and North America, respectively (Fig. 2).

Further, one (05%), one (05%), one (05%), one (05%), nine (45%), one (05%), two (10%), two (10%) and two (10%) places have been covered from China, South Korea, Japan, Kazakhstan, India, Italy, Spain, Brazil and USA, respectively (Fig. 3)

Therefore, the investigators attempted to include the scientific studies proportionately and by considering of the inclusion criteria.

After a thorough investigation it is noted that in most of the countries across the world total lockdown was implemented from a period between March 14 to 25, 2020, except in Wuhan (China) and Daegu (South Korea). In these two countries the total lockdown and self reflection was implemented from January 23, 2020 and February 23, 2020, respectively. It is for the reason that in Wuhan, China the first COVID-19 case was detected in December, 2019[7] and in South Korea on January 20, 2020[29]. Therefore, from the end of March, 2020 up to mid-May, 2020 movements were restricted in all aspects across the world. This seems to influence the air and water quality throughout the world[12].

Analyzing the data obtained from the papers that have been included in this study and computing the mean scores for all the respective data (Fig. 4) it may be inferred that during the lockdown period in general there was a trend of decrease in the level of concentrations of PM_{10}, $PM_{2.5}$, CO, NO, NO_2, NH_3, NOx, SO_2 and increase in the concentration level of O_3[11,15-28] in comparison to the records of either the

Table 1 — Analysis of the Scientific Research Articles

Author/s	Place of Study	Date of commencement of lockdown	Duration of the study	Interpretations of the data of the components of air pollution during the lockdown period						Inferences drawn from the studies
				PM_{10}%	$PM_{2.5}$%	COx%	NOx%	SOx%	O_3%	
ASIA										
(I) Ma C and Kang G (2020)[15]	(a)Wuhan, China (b)Daegu, South Korea (c)Tokyo, Japan	(a) Wuhan lockdown-January 23, 2020 (b)Daegu Self-reflection-February 23, 2020 (c) Tokyo-self-reflection-March 25, 2020	January 9 to April 29, 2020 (112 days)	One month pre-lockdown/self-refection *vs* lockdown period						(i) Decrease in the concentration of $PM_{2.5}$ delayed the allergic airway inflammation in 10 year old children (subject of the study) in all the three cities in ratio to the percentage of reduction of the concentration of $PM_{2.5}$ in that city. Hence health hazards due to air pollution decreased during the period of lock-down/ self-reflection[15] (ii) Decrease in the concentration level of NO_2 also improved the health of the people, especially the Wuhan citizens[15]
				Nil	(a) Wuhan (-29.9) (b) Daegu (-20.9) (c) Tokyo (-3.6)	Nil	NO_2: (a)Wuhan (-53.2) (b) Daegu (-19.0) (c) Tokyo (-10.4)	Nil	Nil	
(II) Kerimay A *et.al*. (2020)[16]	Almaty, Kazakhstan	March 19, 2020	March, 19-April 14, 2020 (27 days)	March, 19-April 14, 2019 *vs* March, 19-April 14, 2020		Pre-lockdown period *vs* lockdown period				(i) Decrease in the concentration of air pollutants maybe due to the absence of road traffic during the lock-down, along with the seasonal changes in the temperature and precipitation, during that period[16] (ii)However, the result was affected by the coal combustion in power plants[16] (iii)Increase in the level of O_3 may be due to the higher levels of solar activity[9]
				Nil	(-21)	CO: (-49)	NO_2: (-35)	Nil	(+15)	
(III) Lokhand wala S and Gautam P (2020)[11]	Ghaziabad City, Northern India	March 25, 2020 (midnight)	March25 to April 14, 2020 (21 days)	January 14, 2020 *vs* lockdown period						(i) Lockdown has significant impact on the concentration of the primary components of air pollution[11] (ii) Improved the water quality of the rivers of Ganga, Yamuna, Cauvery and others[11]
				(-50.8)	(-85.1)	Nil	NO_2: (-48.7)	SO_2: (-14.3)	Nil	
(IV) Mandal I and Pal S (2020)[17]	Stone quarrying and crushing site of Dwarka river basin of Mayurakshi, Eastern India	March 25, 2020 (midnight)	March25 to April 14,2020 (21 days)	Pre-lockdown period *vs* lockdown period						(i) Due to lock-down significant decrease in- (a) PM_{10} concentration (b) Land surface temperature (c) noise level[17] (ii) Improvement of river water quality[17]
				(-23.56) (approx)	Nil	Nil	Nil	Nil	Nil	

(*Contd.*)

Table 1 — Analysis of the Scientific Research Articles

(V) Selvam S *et.al*. (2020)[18]	Gujarat, Western India	March 25, 2020 (midnight)	March24 to April 20, 2020 (28 days)	January1 to March 23, 2020 (Pre lockdown period) *vs* March 24 to April 20, 2020 (lockdown period)							(i) Also the overall Air Quality Index improved by 58% for during the months from January to April, 2020, in comparison to the same period in 2019[18]
				(-44)	(-39)	CO: (-25)	NO_2: (-59)	SO_2: (-40)	(+58)		
(VI) Jain S and Sharma T (2020)[19]	(a) Delhi (b) Mumbai (c) Chennai (d) Kolkata (e) Bangalore, India	March 25, 2020 (midnight)	March 10 to april6, 2020 (27 days)	(A) Pre lockdown period *vs* post lockdown period							(i)Spatiotemporal variations depict that significant decrease in the level concentration of all the air 12 pollutants, except ozone[19] (ii) However, in Bangalore there is decrease in the concentration of O_3[19]
				(a) Delhi (-52) (b) Mumbai (-47) (c)Chennai Nil (d)Kolkata (-34) (e)Bangalore (-34)	(a)Delhi (-41) (b)Mumbai (-33) (c)Chennai (-14) (d)Kolkata (-23) (e)Bangalore (-22)	CO: (a)Delhi(-29) (b)Mumbai (- 46) (c)Chennai (-25) (d)Kolkata (-29) (e)Bangalore (-16)	NO_2: (a)Delhi (-50) (b)Mumbai (-75) (c)Chennai (-32) (d)Kolkata (-60) (e)Bangalore (- 60)	Nil	(a) Delhi (+7) (b) Mumbai (+8) (c) Chennai (+3) (d) Kolkata (+17) (e) Bangalore (–11)		
				(B) March-April 2019 *vs* March-April 2020							
				(a) Delhi (-34) (b)Mumbai Nil (c)Chennai Nil (d)Kolkata (- 32) (e)Bangalore (-40)	(a) Delhi (-32) (b)Mumbai Nil (c)Chennai (-39) (d)Kolkata (-27) (e)Bangalore (-47)	(a) Delhi (-27) (b)Mumbai Nil (c)Chennai (-23) (d)Kolkata (-16) (e)Bangalore (-15)	(a) Delhi (-48) (b)Mumbai- Nil (c)Chennai (-43) (d)Kolkata (-66) (e)Bangalore (-56)	Nil	(a) Delhi (-14) (b)Mumbai Nil (c)Chennai (+73) (d)Kolkata (+ 87) (e)Bangalore (-21)		
(VII) Mahato S, Pal S and Ghosh K G (2020)[20]	Delhi, India	March 25, 2020 (midnight)	March 25 to April 14, 2020 (21 days)	(A) Pre lockdown period *vs* post lockdown period							(i) 54%, 49%, 43%, 37% and 31% reduction air pollution in central, eastern, southern, western and northern parts of Delhi of was recorded by NAQI within four days of commencement of the lock-down[20] (ii) Increase in the concentration level of O_3 may be negligible and insignificant, but the increase in the level of O_3 was recorded in the industrial and traffic dominated areas, maybe due to decrease in NO level[20]

(*Contd.*)

Table 1 — Analysis of the Scientific Research Articles

				(-51.84)	(-53.11) [i] Traffic background station: (-62.61) [ii] Industries background station: (-59.74)	CO: (-30.35) [i] Traffic background station: (-36.84) [ii] Industries background station: (-21.43)	NO_2: (-52.68) [i] Traffic background station: (-50.61) [ii] Industries background station: (-45.99) NH_3: (-12.33)	SO_2: (-17.97)	O_3: (+0.78)
				(B) March-April 2019 *vs* March-April 2020					
				(-60)	(-39)	Nil	Nil	Nil	Nil
(VIII) Kumari P and Toshniwal D (2020)[21]	(a) Delhi-northern India (b) Mumbai-western India (c) Singrauli-Eastern India	March 25, 2020 (midnight)	March1 to April 15, 2020 (46 days)	Pre lockdown period *vs* post lockdown period					
				(a)Delhi (-55.01) (b)Mumbai (-44.61) (c)Singrauli (+58.85)	(a) Delhi (-49.34) (b)Mumbai (-37.35) (c) Singrauli (+15.27)	Nil	NO_2 : (a) Delhi (-60.11) (b)Mumbai (-78.12) (c)Singrauli (-12.5)	SO_2 : (a)Delhi (-19.51) (b) Mumbai (-39.01) (c) Singrauli (+11.82)	O_3: (a) Delhi (+37.35) (b) Mumbai (+20.65) (c) Singrauli (+35.07)
EUROPE									
(IX) Collivignarelli M C *et.al.* (2020)[22]	Milan, Italy	(A) March 9, 2020-Partial Lock-down (B) March 23, 2020-Total Lock-down	February 7, 2020 to April 5, 2020 (58 days)	(A) Pre-lockdown period *vs* partial lockdown period					
				(-48)	(-47.4)	CO: (-57.6)	(a) NO_2: (-61.4) (b) NOx: (-74.5)	SO_2: (-25.4)	(+252.3)
				(B) Partial lockdown period *vs* total lockdown period					
				(-14.1)	(-16.3)	CO: (-22)	(a) NO_2: (-32.1) (b) NOx: (-36.6)	SO_2: (-68)	(+30.5)

(VIII) Kumari P and Toshniwal D (2020)[21]	(i)Less reduction in the level of SO_2 as the power plants were functional during lock-down[21]. (ii) Increase in the concentration level of O_3maybe due to: [1] less combustion of NOx and VOCs [2] Increase in atmospheric temperature during that period[21]. (iii) In Singrauli the concentration levels of all the pollutants, except NO_2 increased during the lock-down phase at the Vindyachal Super Thermal Power Station, located in Singrauliwas functional during the lock-down[21]
(IX) Collivignarelli M C *et.al.* (2020)[22]	(i) Significant reduction in the concentration of all pollutants due to vehicular traffic restriction, temporary closure of industries[22] (ii) Marked increase in the concentration level of O_3 due to higher solar radiation during spring and summer. Also due to significant decrease of the concentration of NO in the air[22]

(*Contd.*)

Table 1 — Analysis of the Scientific Research Articles

(X) Tobías A *et.al*. (2020)[23]	Barcelona, Spain	March 14, 2020	March 14 to March 30, 2020	Pre lockdown period *vs* post lockdown period						(i) Decrease in the concentration of NO_2 may be due to decrease in the combustion of fuels during the lock-down[23] (ii)Concentration of PM_{10} is influenced by the regional-background –origin of Saharan dust episodes, dust re-suspension along with other causes related to industrialization and traffic[23] (iii) Decrease in the concentration of SO_2 due to the reduction of emissions by the cruises[23] (iv) Increase in the level of O_3 due to: [a] decrease of NOx in VOCs limited environment [b] Decrease of NO [c] Increase of isolation and temperature during that period[23]
				[i] Urban Bacground Station (-27.8) [ii] Traffic Station (-31.0)	Nil	Nil	NO_2: [i] Urban Bacground Station (-47) [ii] Traffic Station (-51.4)	SO_2: [i] Urban BacgroundStatio (-91.4) [ii] Traffic Station (+ 1.8)	[i] Urban Bacground Station (+28.5) [ii] Traffic Station (+57.7)	
(XI) Baldsano J M (2020)[24]	(a) Madrid, Spain (b) Barcelona, Spian	March 14, 2020	March, 2020 (31 days)	March 2019 *vs* March 2020						(i) Higher reduction values between 2019 and 2018 maybe due to meteorological differences between both the years. 2019 had stable weather but poor air quality whereas, 2018 had unstable weather with more dispersion of pollution[24]
				Nil	Nil	Nil	NO_2: (a) Madrid (56) (b)Barcelona (-59)	Nil	Nil	
				March 2018 *vs* March 2020						
				Nil	Nil	Nil	NO_2: (a) Madrid (46) (b)Barcelona (-55)	Nil	Nil	
SOUTH AMERICA										
(XII) Dantas G *et. al*. (2020)[25]	Rio de Janeiro, Brazil: AQ monitoring stations (a) Irajá (b)Bangu (c) Tijuca	March 23, 2020 partial lock-down in Rio de Janerio	March2 to April 16, 2020 (45days)	Pre lockdown period *vs* post lockdown period						(i) Partial lock-down improved the air quality of the city[25] (ii) Increase in the level of O_3 may be due to high solar radiation and high temperature[25]
				(a) Irajá (-21.4) (b)Bangu (-17.5) (c) Tijuca (-33.3)	Nil	CO: (a) Irajá Nil (b)Bangu (-41.3) (c) Tijuca (-48.5)	NO_2: (a) Irajá (-53.9) (b)Bangu (-32.2) (c) Tijuca Nil	Nil	(a) Irajá (+31.1) (b)Bangu (+22.5) (c)Tijuca (+63)	

(*Contd.*)

Table 1 — Analysis of the Scientific Research Articles

(XIII) Nakada LYK and Urban RG (2020)[26]	São Paulo, Brazil	March 24, 2020 partial lock-down in São Paulo	March 24 to April 26, 2020 (approx) (33 days)	Partial lockdown *vs* five-year monthly mean							(i) Significant decrease in the concentration levels of NO, NO_2 and CO in urban areas during partial lock-down period in comparison with the five-year mean value[26] (ii) Significant increase in O_3 concentration during the same period in urban areas[26] (iii) Even tough Brazil is located in the southern hemisphere with relevant meteorological differences when compared with Asia and Europe significant air quality improvements were noticed[26]
				up to (-22.8)	up to (-29.8)	CO: up to (-64.8)	NO: up to (-77.3) NO_2: up to (-54.3) NOx: up to (-65.4)	SO_2: (-32.7)	(+31.5)		
				Four-week partial lock-down *vs* four-week before lock-down							
				No significant decrease was noticed.	No significant decrease was noticed.	up to (-29.8)	NO: up to (-40.4) NO_2: up to (-29.3) NOx: up to (-31.7)	No significant decrease was noticed.	(+13.4)		
NORTH AMERICA											
(XIV) Jia C *et. al*. (2020)[27]	Memphis, USA	March 25, 2020	March 25 to May 4, 2020 (40 days)	lockdown period *vs* prior month							(i) In-significant impact of lock-down on air quality was observed in Memphis[27]
				Nil	up to (+ 23)	Nil	NO_2: No change in the concentration	Nil	up to (+36)		
(XV) Zangari S (2020)[28]	New York, USA	March 20, 202 in New York	March 20 to First week of May, 2020 (45 days approx)	First week of May *vs* First week of January							(i) Six-year trend shows that the concentration of $PM_{2.5}$ and NO_2 decreases gradually from first week of January to first week of May[28] (ii) No significant change in the air quality was observed[28]
				Nil	(-36)	Nil	NO_2: (-51)	Nil	Nil		

Legends:
Nil: Data not included in the study/ data missing
(-): Decrease in the level of concentration of the air pollutant
(+): Increase in the level of concentration of the air pollutant

pre-lockdown period or the previous year(s). All studies reported, it to be significant[11,15-26], except those that were conducted to study the effect in the USA. In Memphis, USA insignificant effect of lockdown on air pollution was observed[27]. Also Zangari (2020)[28], who compared the level of concentration of $PM_{2.5}$ and NO_2in the first week of May, 2020 with first week of January, 2020 opined, though the results show that the concentration of $PM_{2.5}$ and NO_2 have decreased during the lockdown period but the six-year trend shows that the concentration of $PM_{2.5}$ and NO_2 decreases gradually from the first week of January to the first week of May[28] in New York, USA. In each empirical study as

the data were collected from different locations in each of the major cities at different times by different techniques so some of the cities have more than one observation about each pollutant. To nullify the difference in collection methods and concise the resultant effect of the air pollutants in each of the studied cities, the mean value has been considered to meet the objective of this current investigation.

The studies that have been examined show that the empirical verifications of the air quality during the lockdown period were done either by comparing the lockdown/post lockdown[20,23]/self-reflection[15]/stay-at-home[27] period with the pre-lockdown period or by comparing with the previous year(s) records on air quality of the respective places. (Fig. 5) represents the comparison of the mean values of the air pollutants during lockdown with pre lockdown period and previous years(s) record.

From the figure it may be inferred that during the lockdown period concentration of all the air pollutants decreased except O_3. Probable cause for this increase maybe due to the decrease in the level of concentration of NO in the air[22], especially in industrial and traffic dominated areas[20,26], less combustion of NOx and VOCs[21,23]. Other probable reasons for the increase in the level of O_3 in the air maybe due to the solar radiation[16,25] and an increase in atmospheric temperature[21,25]. Increase in the level of concentration of O_3 facilitated to overcome the problem of the 'Ozone Hole' to some extent.

However, few studies observed that due to the combustion of coal in power plants, which were functional even during the lockdown period affected the air quality of those places[16,21].

Marked decrease in the concentration levels of NO, NO_2 and NOx were noticed, especially when the data have been compared with the previous year(s) records. A decrease in the level of NO_2 may be due to a decrease in the combustion of fuels during the lockdown[23]. It improved the health of the people[15]. Ma C and Kang G (2020)[15] noted that it had significantly improved the health of the Wuhan citizens. As data for NH_3 was available from only one source so evaluation of the level of concentration of NH_3 was not possible in the present study.

Significant decreases in the levels of concentration of PM_{10}, $PM_{2.5}$, SO_2 and CO have also been observed during the lockdown period due to restricted movements of traffic and temporary closure of factories and industries[11,17,23]. The decrease in the concentration of $PM_{2.5}$ delayed the allergic airway inflammation in 10 years old children in Wuhan, Daegu and Tokyo[15]. In Slovenia 71% to 78% decrease in paediatric asthma admissions and 51% to 68% decrease in admissions for acute respiratory tract infections were reported in comparison to the last three years, *i.e.* 2017, 2018 and 2019, during the period from March 16 to April 20, 2020[30]. Also Picano (2020)[31] observed that due to the reduction of fine particulate matter, NO_2 and increase of O_3 in the air led to a reduction in acute cardiovascular admissions and acute environmental cardiovascular mortality during the lockdown period.

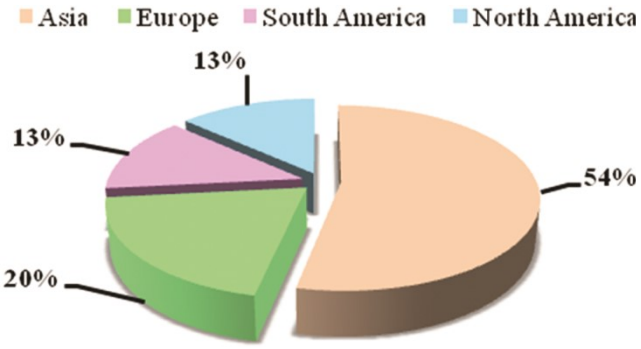


Fig. 1 — Percentage of studies obtained from different continents

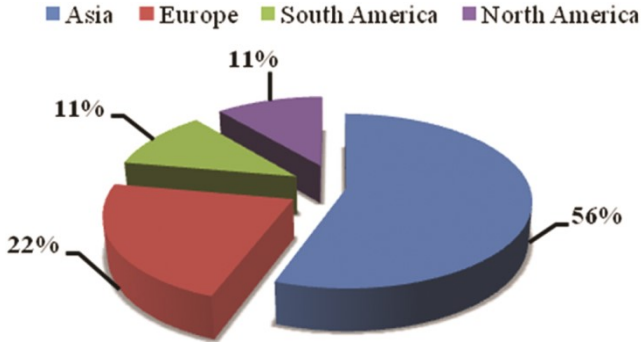


Fig. 2 — Percentage of countries covered in each continent

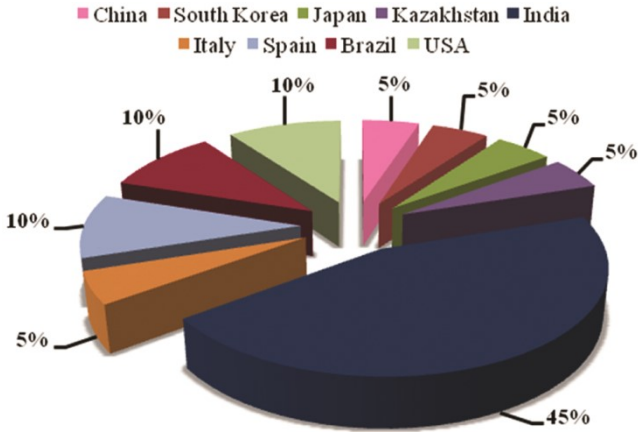
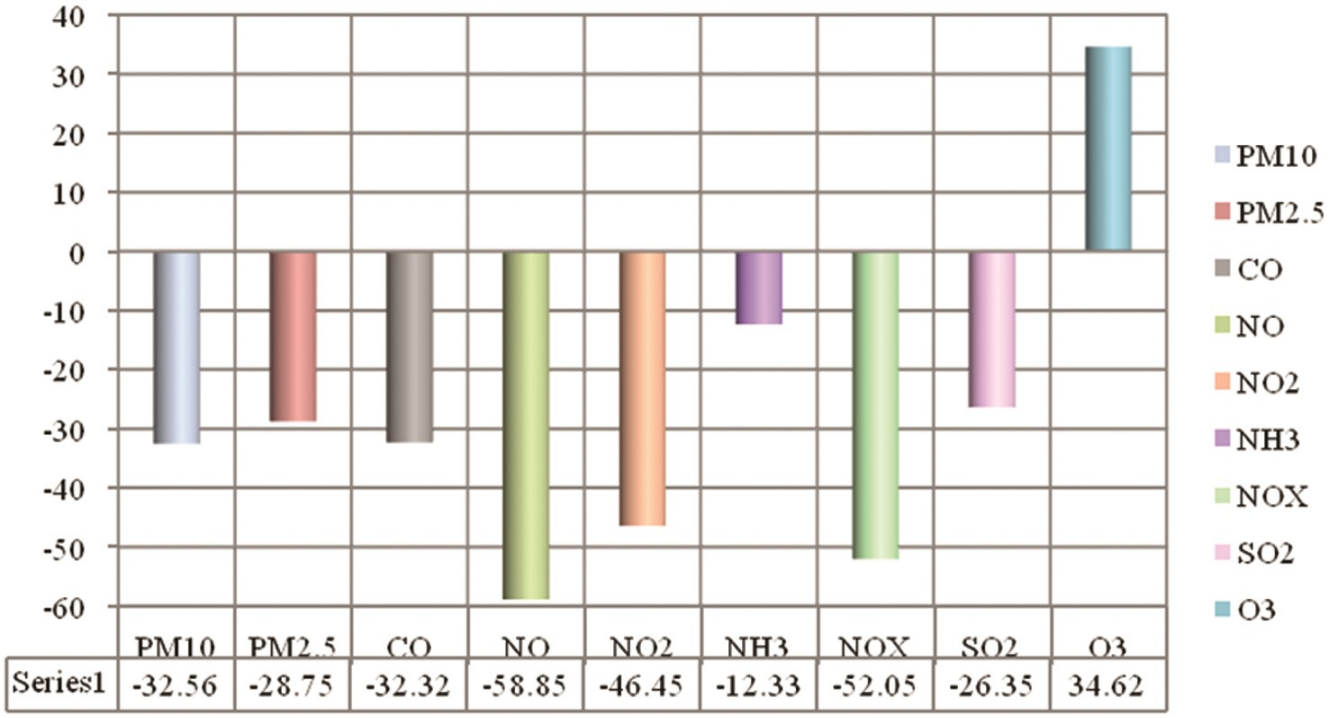
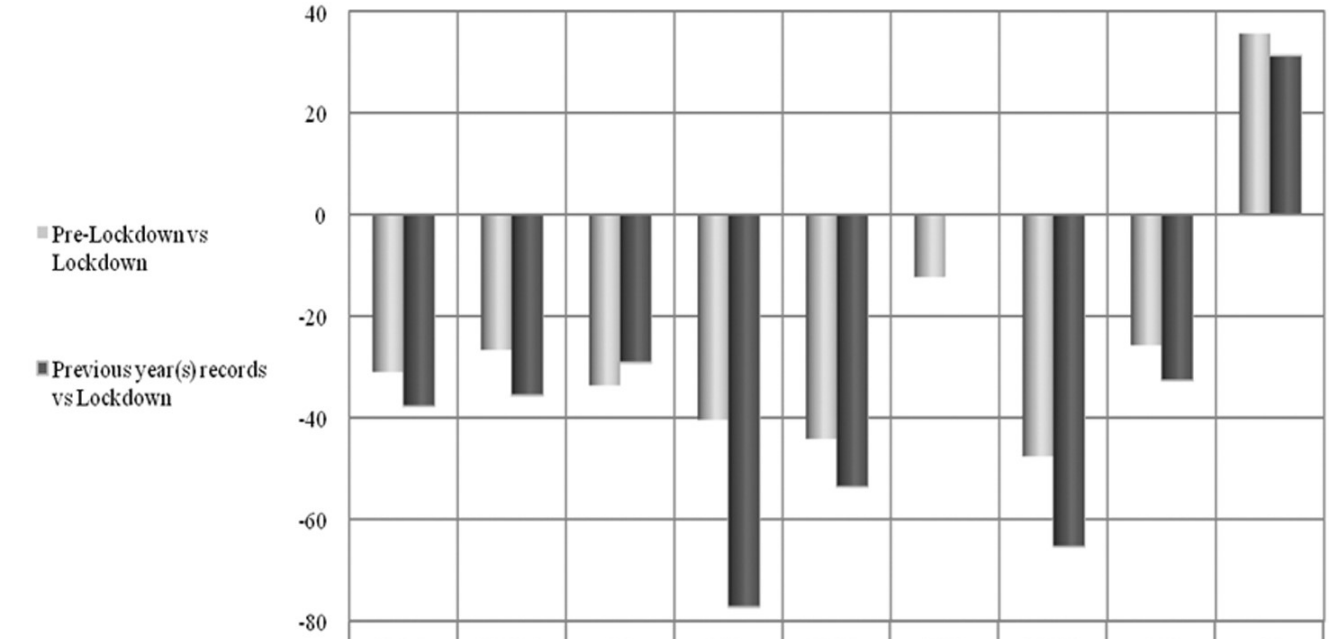


Fig. 3 — Percentage of places covered in each continent



	PM10	PM2.5	CO	NO	NO2	NH3	NOX	SO2	O3
Series1	-32.56	-28.75	-32.32	-58.85	-46.45	-12.33	-52.05	-26.35	34.62

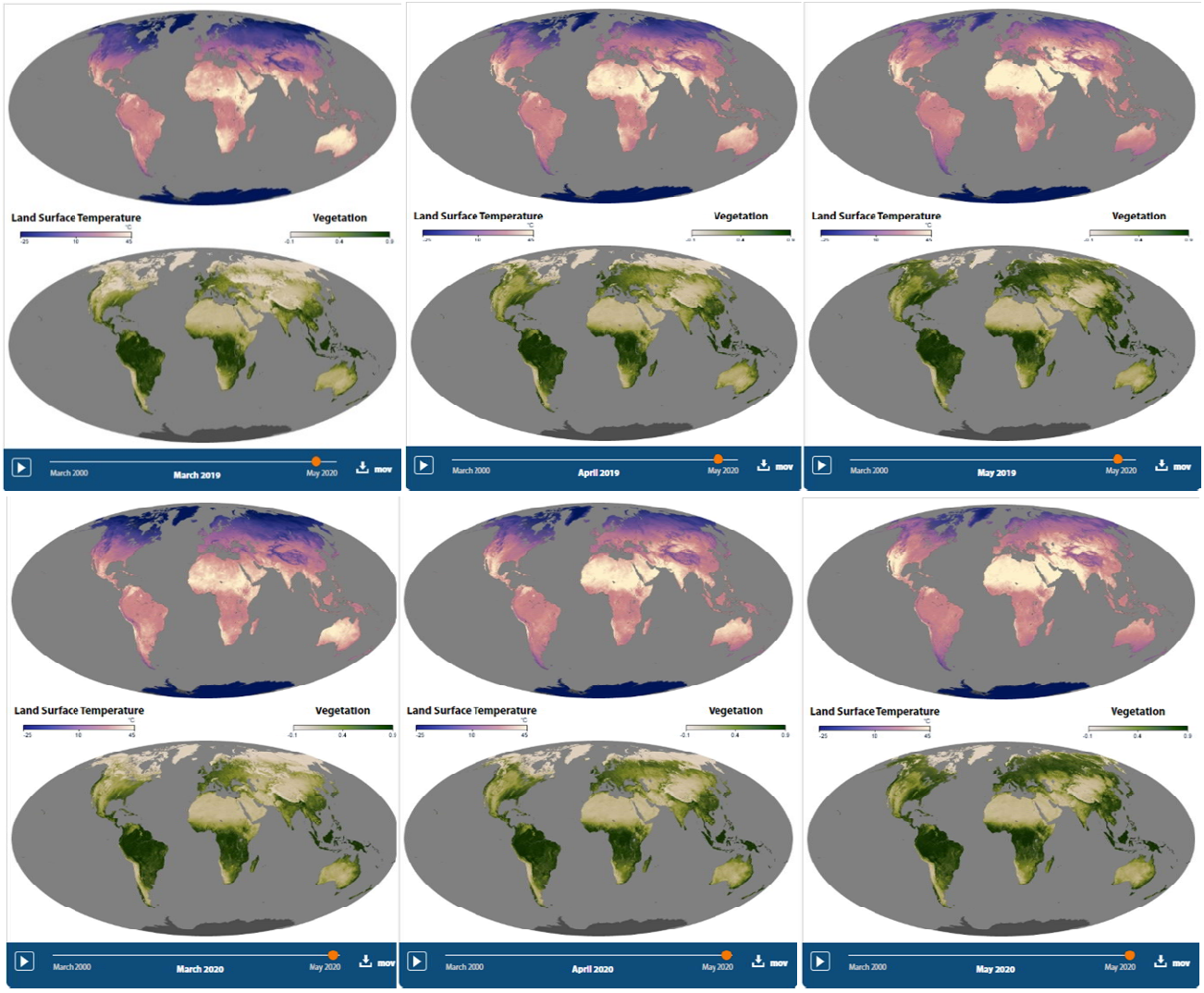
Fig. 4 — Mean values of the air pollutants during lockdown period



	PM10	PM2.5	CO	NO	NO2	NH3	NOX	SO2	O3
Pre-Lockdown vs Lockdown	-31.03	-26.69	-33.64	-40.4	-44.17	-12.33	-47.6	-25.72	35.59
Previous year(s) records vs Lockdown	-37.76	-35.63	-29.16	-77.3	-53.61	0	-65.4	-32.7	31.3

Fig. 5 — Comparison of the mean values of the Air Pollutants

Further, keen observation of the images and measurements taken by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite during the periods from March-May 2019 and from March-May 2020, makes it evident that improvement in the quality of air affected the worldwide land surface temperature during lockdown as well, which in turn had positive effect on the vegetation. These maps show daytime land temperatures as measured from space. Temperatures range from –25 degrees Celsius (deep blue) to 45 degrees Celsius (pinkish yellow). Vegetation is pictured as a scale, or index, of greenness. In places where foliage is dense and plants are growing quickly, the index is high, represented in dark green. Regions where few plants grow have a low vegetation index, shown in tan[32] (Fig. 6).



Source: https://earthobservatory.nasa.gov/global-maps/MOD_LSTD_M/MOD_NDVI_M

Fig. 6 — Images of world land surface temperature and vegetation

Limitation of the study

No relevant studies from the continents of Africa, Oceania and Antarctica were found.

Conclusion

It may be inferred from this analysis that the lockdown did improve the air quality of the world significantly. This report may be concluded with a note that as a coin has two sides similarly amidst all the negative impact on the health of mankind inflicted by COVID-19, healing of the earth and its resources took place. The air quality drastically improved that led to better climatic conditions which too affected the health in a positive way.

Conflict of Interest

All authors declare no conflict of interest.

References

1 WHO, Module A, Unit 2: emerging respiratory viruses, including novel coronavirus (COVID-19). [Cited 2020 April 6]. Available from:https://openwho.org/courses/introduction-to-ncov.

2 Cherry J, Demmler H, Gail J, Kaplan SL, Steinbach WJ & Hotez PJ, *Feigin and Cherry's textbook of Pediatric Infectious Diseases*. Elsevier Health Sciences, ISBN 978-0-323-39281-5, PT6615.

3 Woo PC, Huang Y, Lau SK & Yuen KY, Coronavirus genomics and bioinformatics analysis. *Viruses*, 2 (2010) 1804.

4 Cascella M, Rajnik M, Cuomo A, Dulebohn SC & Napoli RD, *Features, Evaluation and Treatment Coronavirus* (COVID-19). Stat Pearls [Internet]. [Cited 2020 June 28]. Available from: http://creativecommons.org/licenses/by/4.0/.

5 Kumari NKP & Jagannadham MV, Organic solvent induced refolding of acid denatured heynein: Evidence of domains in the molecular structure of the protein and their sequential unfolding. *J Proteins Proteomics*, 2 (2011) 11.

6 Kumari NKP & Jagannadham MV, SDS induced molten globule state of heynein; a new thiol protease: Evidence of domains and their sequential unfolding. *Colloids Surf B Biointerfaces*, 82 (2011) 609.

7 Ali I & Alharbi OML, COVID-19: Disease, management, treatment, and social impact. *Sci Tot Environ*, 728 (2020) 138861.

8 Pathak M, COVID-19 research in India: A quantitative analysis. *Indian J Biochem Biophys*, 57 (2020) 351.

9 WHO, *Coronavirus Disease* (COVID-19) Dashboard [Internet]. [Cited 2020 June 30]. Available from: https://www.who.int/health-topics/coronavirus#tab=tab_1.

10 Pandit K, Gupta S & Sharma AG, Clinico-Pathogenesis of COVID-19 in children. *Indian J Biochem Biophys*, 57 (2020) 264.

11 Lokhandwala S & Gautam P, Indirect impact of COVID-19 on environment: A brief study in Indian context. *Environ Res*, 188 (2020) 109807.

12 Gautam S, The influence of COVID-19 on air quality in India: A boon or inutile. *Bull Environ Contam Toxicol*, 104 (2020) 724.

13 Srivastava S, Kumar A, Bauddh K, Gautam AS & Kumar S, 21-Day lockdown in India dramatically reduced air pollution indices in Lucknow and New Delhi, India. *Bull Environ Contam Toxicol*, (2020) 1.

14 Air Quality Report-2019, *Air Quality Visuals.* [Cited 2020 June 30]. Available from: www.iqair.com.

15 Ma CJ & Kang GU, Air Quality in Wuhan, Daegu and Tokyo during the explosive outbreak of COVID-19 and its health effects. *Int J Environ Res Public Health*, 17 (2020) 4119.

16 Kerimray A, Baimatova N, Ibragimova OP, Bukenov B, Kenessov B, Plotitsyn P & Karaca F, assessing air quality changes in large cities during COVID-19 lockdowns: The impacts of traffic-free urban conditions in Almaty, Kazakhstan. *Sci Tot Environ*, 730 (2020) 139179.

17 Mandal I & Pal S, COVID-19 pandemic persuaded lockdown effects on environment over stone quarrying and crushing areas. *Sci Tot Environ*, 730 (2020) 139281.

18 Selvam S, Muthukumar P, Venkatramanan S, Roy PD, Bharath KM & Jesuraja K, SARS-CoV-2 pandemic lockdown: Effects on air quality in the industrialized Gujarat state of India. *Sci Tot Environ*, 737 (2020) 140391.

19 Jain S & Sharma T, Social and travel lockdown impact considering coronavirus disease (COVID-19) on air quality in megacities of India: Present benefits, future challenges and way forward. *Aerosol Air Qual Res*, 20 (2020) 1222.

20 Mahato S, Pal S & Ghosh KG, Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India. *Sci Tot Environ*, 730 (2020) 139086.

21 Kumari P & Toshniwal D, Impact of lockdown measures during COVID-19 on air quality- A case study in India. *Int J Environ Health Res*, (2020) http://doi.org/10.1080/09603123.2020.1778646.

22 Collivignarelli MC, Abbà A, Bertanza G, Pedrazzani R, Ricciardi P & Miino MC, Lockdown for CoViD-2019 in Milan: What are the effects on air quality?. *Sci Tot Environ*, 732 (2020) 139280.

23 Tobías A, Carnerero C, Reche C, Massagué J, Via M, Minguillón MC, Alastuey A & Querol X, Changes in air quality during the lockdown in Barcelona (Spain) one month into SARS-CoV-2 epidemic. *Sci Tot Environ*, 726 (2020) 138540.

24 Baldasano JM, COVID-19 lockdown effects on air quality by NO_2 in the cities of Barcelona and Madrid (Spain). *Sci Tot Environ*, 741 (2020) 140353.

25 Dantas G, Siciliano B, França BB, Da Silva CM & Arbilla G, The impact of COVID-19 partial lockdown on the air quality of the city of Rio de Janeiro, Brazil. *Sci Tot Environ*, 729 (2020) 139085.

26 Nakada LYK & Urban RC, COVID-19 pandemic: impacts on the air quality during the partial lockdown in São Paulo state, Brazil. *Sci Tot Environ*, 730 (2020) 139087.

27 Jia C, Fu X, Bartelli D & Smith L, Insignificant impact of the "stay-at-home" order on ambient air quality in the Memphis Metropolitian Area, USA. *Atmosphere*, 11 (2020) 630.

28 Zangari S, Hill DT, Charette AT & Mirowsky JE, Air quality changes in New York City during the COVID-19 pandemic. *Sci Tot Environ*, (2020) http://doi.org/10.1016/j.scitotenv.2020.140496. [Pre-print].

29 Shim E, Tariq A, Choi W, Lee Y & Chowell G, Transmission potential and severity of COVID-19 in South Korea. *Int J Infect Dis*, 93 (2020) 339.

30 Krivec U, Kofol SA & Tursic J, COVID-19 lockdown dropped the rate of paediatric asthma admissions. *Arch Dis Child*, (2020).

31 Picano E, Where have all the myocardial infractions gone during the lockdown? The answer is blowing in the less-polluted wind. *Eur Heart J (online)*, (2020). doi: 10.1093/euheartj/ehaa411.

32 NASA earth observatory. [Cited 2020 July 7]. Available from https://earthobservatory.nasa.gov/global_maps/MOD_LSTD_M/MOD_NDVI_M.