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Impact of COVID-related lockdowns on environmental and climate change scenarios

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A R T I C L E I N F O

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A B S T R A C T

The outbreak of COVID-19 pandemic has emerged as a major challenge from human health perspective. The alarming exponential increase in the transmission and fatality rates related to this disease has brought the world to a halt so as to cope up with its stern consequences. This has led to the imposition of lockdown across the globe to prevent the further spread of this disease. This lock down brought about drastic impacts at social and economic fronts. However, it also posed some positive impacts on environment as well particularly in the context of air quality due to reduction in concentrations of particulate matter (PM), NO_2 and CO across the major cities of the globe as indicated by several research organizations. In China, Italy, France and Spain, there were about 20–30% reduction in NO_2 emission while in USA 30% reduction in NO_2 emission were observed. Compared to previous year, there was 11.4% improvement in the air quality in China. Drastic reductions in NO (−77.3%), NO_2 (−54.3%) and CO (−64.8%) (negative sign indicating a decline) concentrations were observed in Brazil during partial lockdown compared to the five year monthly mean. In India there were about −51.84, −53.11, −17.97, −52.68, −30.35, 0.78 and −12.33% reduction in the concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3 and NH_3 respectively. This article highlights the impact of lockdown on the environment and also discusses the pre and post lockdown air pollution scenario across major cities of the world. Several aspect of environment such as air, water, noise pollution and waste management during, pre and post lockdown scenario were studied and evaluated comprehensively. This research would therefore serve as a guide to environmentalist, administrators and frontline warriors for fighting our the way to beat this deadly disease and minimize its long term implications on health and environment.

1. Introduction

The outbreak of COVID-19 pandemic with an alarming exponential spread has created health crises throughout the world. The disease was reported in December 2019 in Wuhan, China (Lu et al., 2020; Zhu et al., 2019). However, its existence has been reported a few decades back. The disease that was later renamed COVID-19 had already affected more than 100 countries (Organization, 2020) before its detection. The disease posed a global threat after its devastating results (Wang et al., 2020a). To contain the virus and to cope up with the negative consequences of the disease, many countries have adopted initiatives to lessen anthropogenic interactions that involve enforcement of strict quarantines, the prohibition of public gatherings, restrictions on different transportation means, encouragement of social distancing, imposing curfews and lockdowns.

After the confirmation of Ist COVID-19 case from India on 30th of January 2020, advisory posing restrictions regarding international travels to the countries like China, Italy, Iran, Republic of Korea and

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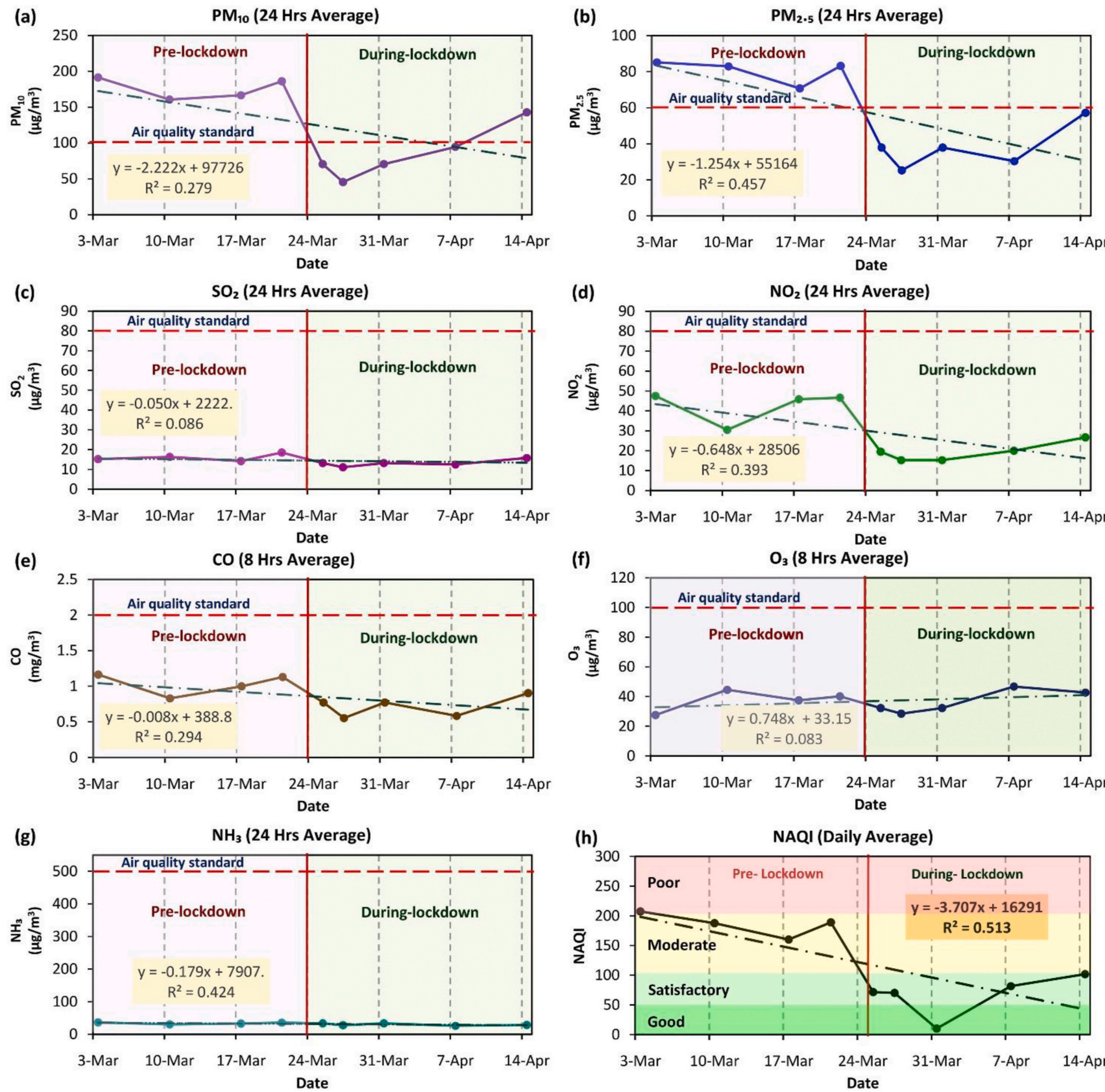

Fig. 1. The trend of 24 h mean concentrations; (a) PM_{10}, (b) $PM_{2.5}$, (c) SO_2, (d) NO_2, (g) NH_3 and (h) NAQI and 8 h mean daily maxima of (e) CO and (f) O_3 between 3rd of March and 14th April 2020 (On 24th March 2020 the lockdown commenced) in NCT Delhi, India (Mahato et al., 2020).

Japan were imposed on March 11, 2020. Kerala was initially the most COVID-19 affected state in India. The situation thus demanded the implementation of safety measures to reduce the impact of this novel disease. The places of large gatherings like institutions, shopping malls and theatres were shut across India from March 16, 2020. The first nation-wide shutdown was imposed for 14 h on March 22, 2020, followed immediately by a total lockdown of 21 days beginning from March 24, 2020.

Being neighbouring with China, India with a mass population of more than 1.353 billion, is also struggling against COVID-19. New Delhi is second of the most polluted cities in the world which has $PM_{2.5}$ 32.8 $\mu g/m^3$ (World Health Organization). The effect of air pollution has a severe impact on health. It is vital to study the current air pollution situation of such a country whose economy is depended on power, transport, construction, agriculture, rural development. A major impact of lockdown due to COVID-19 can be observed on air quality, which is being experienced by everyone and recorded in various official reports. Smog has given way to blue skies in cities like Delhi, marine life is seeing increased activity, pollution levels have dropped in almost all the metro cities and animals, as well as birds, are moving around on their own accord. It was also observed that in metro cities like Delhi, as the energy footprint was high, the lockdown has improved the air quality at a higher scale.

Comprehensive data related to air quality from various sites of India revealed that countermeasures related to COVID-19 caused a significant and noticeable enhancement in the quality of air. The fatalities caused

Table 1
Average concentrations and variations of criterion pollutants in NCT Delhi, India from 2 March to21 March 2020 (before lockdown) and 25 March to 14 April 2020 (during lockdown).

Pollutants	Before lockdown					During lockdown			Overall variation	Percentage
	NCT Delhi Avg.	Industrial location Avg.	Transport location Avg.	Residential and other location Avg.	NCT Delhi Avg.	Industrial location Avg.	Transport location Avg.	Residential and other location Avg.	Net	(%)
PM_{10}	176.07	190.74	195.77	160.48	84.79	91.25	90.11	76.48	−91.28	−51.85
$PM_{2.5}$	80.51	88.05	94.83	72.67	37.75	39.67	44.23	31.09	−42.76	−53.11
SO_2	16.08	15.48	14.56	14.17	13.19	14.07	12.53	11.20	−2.89	−17.97
NO_2	42.59	34.81	47.35	48.75	20.16	18.80	23.38	18.79	−22.44	−52.68
CO	1.03	1.33	1.13	1.01	0.72	1.04	0.71	0.64	−0.31	−30.35
O_3	34.05	26.37	35.07	37.36	34.32	31.00	38.87	37.97	0.27	0.78
NH_3	33.93	38.43	38.02	30.66	29.75	35.84	33.06	25.97	−4.18	−12.33
NAQI	185.99	196.38	215.29	174.78	72.64	92.45	87.29	79.80	−113.36	−60.95

by the poor air quality in the year 2016 as reported by WHO (Organization, 2018) was approximately 4.2 million. A positive effect on the air quality index (AQI) during the period of lockdown in India would definitely avert humans deaths. The data regarding the environmental performance index indicates that Delhi is one of the 100 worst polluted cities of the world (Organization, 2016) and its rank in the particulate matter (PM_{10}) pollution list is very high (Organization, 2018). National Ambient Air Quality Standards (NAAQS) signify that $PM_{2.5}$ concentration in Delhi is very high and far beyond the tolerable limits (Mohan and Kandya, 2007; Kumar et al., 2017). Such high-intensity air pollution has been proven to cause public health issues (Heal et al., 2012; Dholakia et al., 2013), particularly respiratory ailments (Rizwan et al., 2013).

The main objective of the study is to evaluate the significant influence of lock-down due to COVID-19 on the Indian air quality. This study tried to examine not only the status of air quality but also the effect of lockdown on water and noise pollution. The study has highlighted the challenges of waste generation and its recycling. The outcomes of this study indicate that the novel coronavirus can be considered as a blessing in disguise.

2. Major pollutants pre-lockdown and during-lockdown scenario

Delhi witnessed a major reduction in the levels of air pollutants (Fig. 1, Table 1) post 3 weeks of lockdown period that started from March 24, 2020. During this study period, a decline in concentrations of PM_{10}, $PM_{2.5}$, CO and NO_2 has been observed by Mahato et al. (2020) (Fig. 1a-e). There was about −51.84% and −53.11% reduction (negative sign indicating a decline) in the mean amounts of PM_{10} and $PM_{2.5}$ respectively. However, the magnitude of $PM_{2.5}$ declined as reported from traffic and industrial background stations was −62.61% and −59.74% (negative sign indicating a decline) respectively. There was a significant variation in the percentage of air pollutants between pre and during the period of lockdown (−52.68% NO_2 and -30.35% CO). Similar results were found by Bera et al. (2020) for Kolkata city, where a drastic reduction in PM_{10} and $PM_{2.5}$ was reported from 25th March to 15th May 2020 compared to the preceding 3 years. During this period, PM_{10} level reduced to 8.94% in comparison to 2019. Furthermore, 19.46% reduction in the concentration of NO_2 was reported during the lockdown in Kolkata. Besides this, the levels of pollutant SO_2 were reduced to 5.36 $\mu g/m^3$ in 2020. The decline in PM_{10}, $PM_{2.5}$, CO and NO_2 concentrations could mainly be attributed to the substantial decrease in vehicle exhaust and industrial output emissions during the lockdown period.

However, no such drastic reduction was reported for SO_2 (−17.97%), and NH_3 (−12.33%) (Fig. 1 c, g). The ozone concentration (+0.78% total variation) revealed its negligible increase during the study period with an insignificant increasing trend (Fig. 1f). A similar increasing trend in the concentration of ozone was reported by Bera et al. (2020) that showed the concentration of O_3 boosted up to 9.73% in April 2020 in Kolkata. Moreover, this rise in ozone concentration occurred in the sites dominated by manufacturing and transportation due to decline in nitrogen oxide (NO) levels that resulted in low O_3 consumption (>10% increment) (Table 1). Furthermore, it is an exceptional incident that the density of O_3 has been amplified in Kolkata during this ongoing lockdown period. The overall quality of air is observable from NAQI data for past and during lockdown (Fig. 1h), which depicts a decline in NAQI during the period of lockdown (Indian National Air Quality Standard; CPCB 2015). Improvement of about −59.45% (net decrease in NAQI: 128.0) and −52.92% (Net decrease in NAQI: 103.93) in the air quality for the industrial and transportation locations respectively was reported during the lockdown period. This signifies a considerable enhancement in the quality of air expected to be if the stern implementation of air quality prevention and control regulations are put into practice. The findings of the current study could help in planning better air pollution reduction strategies, improving air quality modelling and forecasting for the betterment of health and environment.

3. National air quality index pre-lockdown and during lockdown

The effect of lockdown on the quality of air between 3rd of March and 14th of April 2020 was studied by Mahato et al. (2020) (Fig. 2). One day after the onset of lockdown (25th March 2020), Significant enhancement of quality of air was reported (Fig. 2e) when compared with the pre-lockdown phase. NAQI showed 51% reduction on the 4th day (27th March 2020) of lockdown (Fig. 2f) when compared with the statistical data of the 3rd preceding day (21st March 2020) of the lockdown (Fig. 2d). During the lockdown time, there was 43% reduction in NAQI (24th March to14th April 2020) in contrast to the NAQI of first 3 weeks of March (from 3rd to 21st March 2020). An approximate reduction of about 54, 49, 43, 37 and 31% in NAQI were reported in Central, Eastern, Western, Southern and Northern zones of NCT Delhi, respectively. This abrupt decline in NAQI is related to the alteration in the concentrations of existing pollutants; mainly PM_{10}, $PM_{2.5}$, NO_2 and CO. However, after 2 weeks of the shutdown, a slight rise in NAQI was reported on 7th and 14th of April 2020 (Fig. 2h and 2i) due to limited relaxation on the necessary vehicular moment, thermal power plant operations and industrial activities in Northern regions of India (Sharma et al., 2020).

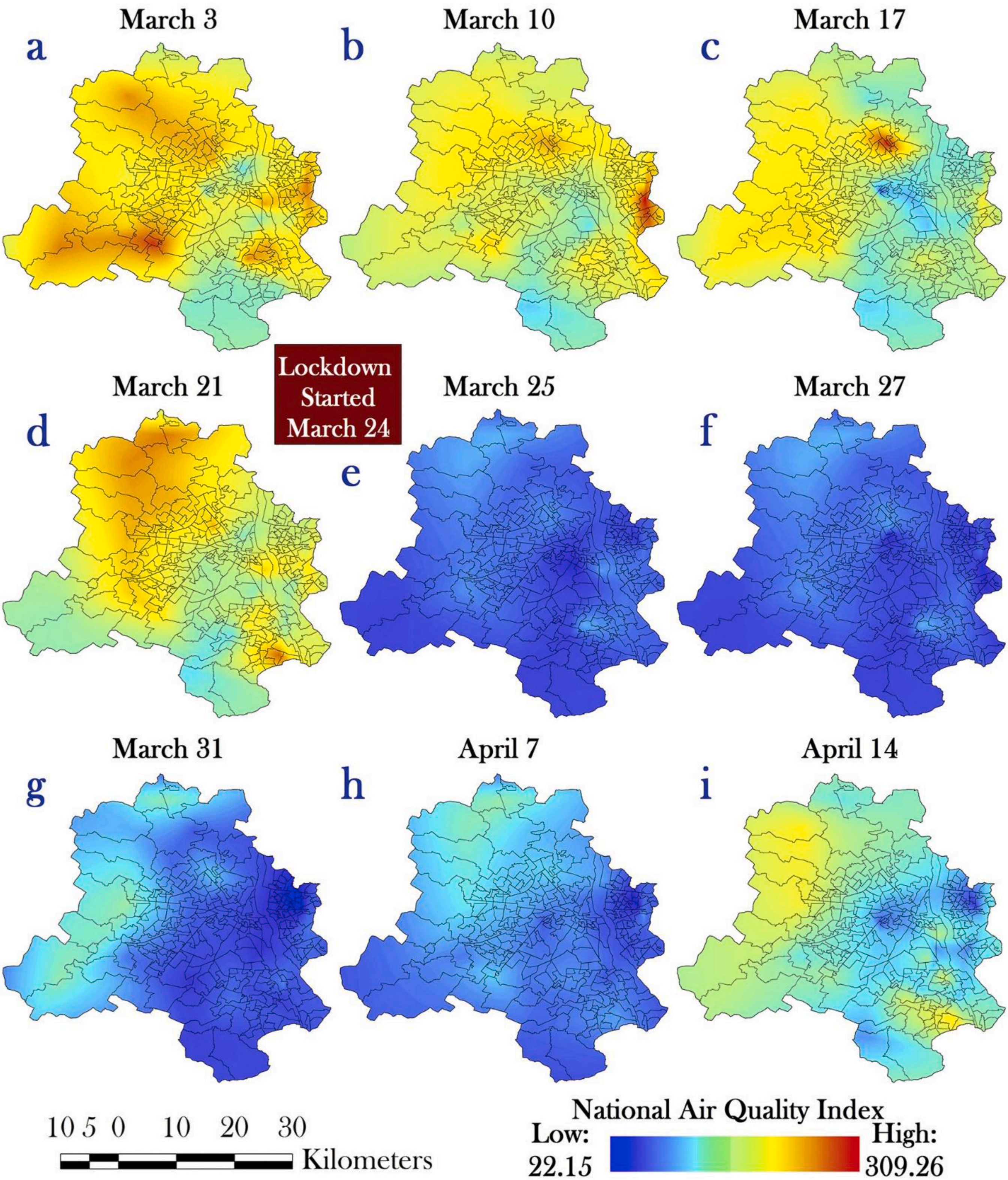

Fig. 2. NAQI change at NCT Delhi from 3 March to 14 April 2020 (Mahato et al., 2020).

Table 2
Analysis of current air quality work during COVID-19 across different regions of the world.

Issues addressed/Major outcomes	Region	Reference
Restricted human activities have contributed to air quality deterioration and reduced excessive associated risk.	Major cities of India	Sharma et al. (2020)
Deficient air quality regions are related to high mortality rates.	China	Isaifan (2020)
In several cities, lockout led to an increase in the quality of air and a decrease in premature death.	China	(Wang and Su, 2020), (He et al., 2020)
The air pollution and Covid-19 infection relationship is considerable.	China	Xie et al. (2020)
Decrease of primary pollutants (like NOx) during lockdown offers compensation for increased secondary pollutants (like O_3).	China	Huang et al. (2020)
Adverse weather conditions overwhelmed emissions reductions.	China	Wang et al. (2020b)
Significant decrease in most contaminants and increased concentrations of ozone during the lockdown.	Spain	Tobías et al. (2020)
Accelerated Covid-19 transmissions are mainly using "air pollution -to -human transmission" rather than "human -to -human transmission".	Italy	Coccia (2020)
Mean temperature, minimum temperature and air quality were strongly related to Covid-19 outbreak.	New York, USA	Bashir et al. (2020)
After four days of lockdown in Delhi, about 40–50% enhancement in the quality of air is identified.	Delhi, India	Mahato et al. (2020)
The Covid-19 pandemic lock-down caused the quality of air in many cities around the world to increase and water pollution to decrease in some parts of the world.	Major cities of the world	Saadat et al. (2020)
The AQI and concentrations of $PM_{2.5}$ were decreased by 25% within weeks.	China	(Guojun et al., 2020), (He et al., 2020)
Reducing concentrations of $PM_{2.5}$ and NO_2 in China, Germany, Spain, France and Italy.	Major cities of the world	Zambrano-Monserrate et al. (2020)
A sudden drop in CO_2 emission profile in the atmosphere. Decreased percentage of CO_2 ranged from 24.56 to 45.37 at Deshbandhu park and Sealdah station respectively.	Kolkata, India	Mitra et al. (2020)
Reduction in the concentration of major air contaminants $PM_{2.5,}$ PM_{10}, NO_2 and CO in most cities around the world.	Major cities of the world	Shrestha et al. (2020)
A decrease in concentrations of major air pollutants.	Cities across the globe	Muhammad et al. (2020)
Observable air pollution reduction following lockdown.	Cities across the globe	Anjum (2020)

4. Air pollution amid Covid-19 across the world-A contemporary examination

Fortunately, the lockdown measures have brought a chance to rationalize positive human environmental impacts on other parts of the world as well. A sudden drop in carbon emissions has occurred because almost all the industries, transportation means and other business establishments have shut down. When compared with the data related to the pollutant gas emissions of the previous year, it can be stated that air pollution levels in New York, USA have decreased by almost 50%. In China, almost 30% NO_2 and 25% carbon emission reduction have been reported during the lockdown (Lau et al., 2020). According to ecology and environment ministry, almost 11.4% improvement in air quality in China was reported when compared with data of the previous year. In Europe, NO_2 emission levels reduced over northern Italy, Spain and the UK (Ficetola and Rubolini, 2020). In India, the average tropospheric NO_2 concentrations during lockdown revealed 12.10% reduction. However, in 2019, there was an increase of 0.8% in tropospheric NO_2 concentrations over India during the same period. The results indicate that restrictions on major anthropogenic activities resulted in the reduction of NO_2 levels. During the lockdown period, tropospheric NO_2 concentrations in Delhi declined by 65.90%.

Studies conducted by Watts et al. (Watts and Kommenda, 2020) and Cadotte et al. (Cadotte, 2020) observed a decrease in air pollutants in the big cities of the world during the lockdown period. Ogen et al. (Ogen, 2020) reported a strong correlation between the levels of NO_2 and fatal outcomes of COVID-19. Coccia et al. (Coccia, 2020) have suggested similar findings in relation to air quality, PM_{10} and O_3 from the capitals of the province of northern Italy. There are few other reports on the improvements in air quality during COVID-19 outbreak lockout with particular regard to many areas around the world (Table 2). Fig. 3 demonstrates the analysis of the quality of air in some of the world's largest cities before and after the COVID-19.

European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA) published new documentation that intimated the quality of environmental improved and NO_2 emission turns down up to 30%. The NASA gather data by making use of Ozone Monitoring Instruments (OMI) on its AURA satellite. However, using the Tropospheric Monitoring Instrument (TROPOMI), ESA collected data via Sentinel-5P satellite. The NASA and ESA data acquisition of NO_2 emissions across different regions are shown in Table 3. Fig. 4 presents the NO_2 concentrations in Wuhan during the year 2019 and 2020, the emissions of NO_2 are reduced to 30% (NASA 2020). The satellite based ozone monitoring instrument sensor data of different countries were analyzed in order to investigate the variations in tropospheric NO_2 concentrations. The reduction in NO_2 concentrations was attributed to reduced industrial and commercial activities and restricted and vehicular movements.

5. Air quality index and health risk estimations in India

To explain the total change in the quality of air, air quality index (AQI) was measured (Sahu and Kota, 2016). Air quality index makes the use of $PM_{2.5}$, PM_{10}, $SO_{2,}$ NO_2, NH_3, CO, O_3 and Pb, of which lowest concentration is of three contaminants, at minimum one of them being $PM_{2.5}$ or $PM_{10.}$ The concentration of pollutants was converted into numbers on a scale ranging from 0 to 500. For each pollutant (i), the sub-index AQI (AQI*i*) was determined using Eq. (1).

$$AQI_{i=}\frac{IN_{HI-IN_{LO}}}{B_{HI}-B_{LO}}+(C_i-B_{LO})+IN_{LO} \tag{1}$$

where Ci refers to the pollutant concentration '*i*', B_{LO} and B_{HI} are the breakpoint concentrations smaller and greater to Ci and $IN_{LO\&}$ IN_{HI} are the corresponding AQI values. The total air quality index is the highest AQI_i, and the corresponding pollutants being the dominate pollutants. The AQI is categorized into 5 different types; good (AQI range 0–50), satisfactory (51–100), moderate (101–200), poor (201–300), very poor (301–400) and severe (401–500). In India, over comparable times with and without lockdown, the possible health welfare in many cities owing to concentration change was calculated using the excess risks linked with a load of pollutants. Relative pollutant risks are measured with Eq. (2).

$$RR_I=exp\beta_i\left(C_I-C_{I_0}\right),C_I>C_{I_0} \tag{2}$$

where, RRi relative threat of contaminants i, βi is coefficient of exposure response showing the further health risk (e.g. mortality) produced by

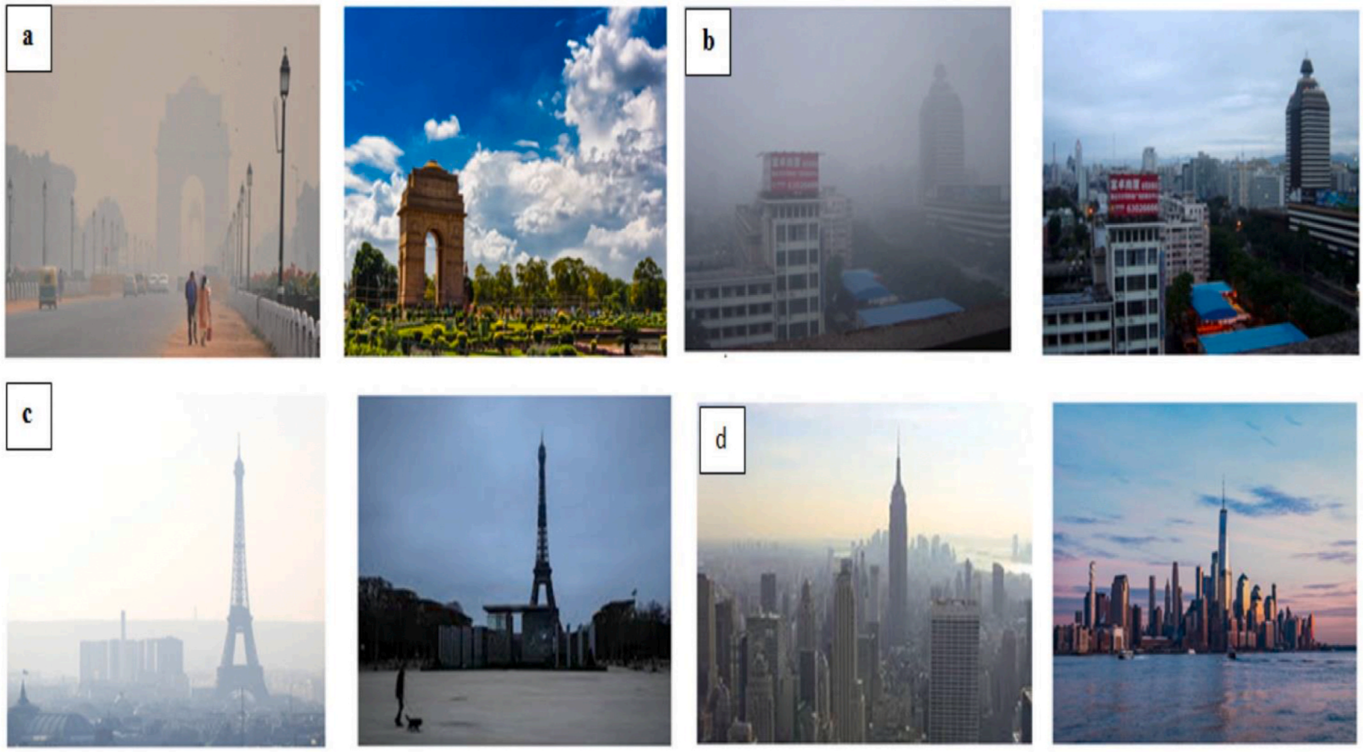

Fig. 3. Comparison of air quality before the COVID-19 pandemic and after the lockout in several largest cities of the world; (a) New Delhi, India, (b) Beijing, China, (c) Paris, France and (d) New York, USA (Saadat et al., 2020).

Table 3
Acquisition of data of NO_2 emissions across various regions of the world.

Agency	Location	Reduction (%)	Satellite	Source
NASA and ESA	Wuhan	30	Aura and Sentinel-5P	(NASA 2020)
ESA	China	20 to 30	Sentinel-5P	(ESA 2020)
ESA	Europe	20 to 30	Sentinel-5P	(ESA 2020)
NASA	USA	30	Aura	(NASA 2020)
ESA	Italy	20 to 30	Sentinel-5P	(ESA 2020)
ESA	France	20 to 30	Sentinel-5P	(ESA 2020)
ESA	Spain	20 to 30	Sentinel-5P	(ESA 2020)

per unit of air pollutant i, when it overcomes threshold value of concentration. The values of β are 0.038, 0.032, 0.081, 0.13 and 0.048% for m^3, PM_{10}, SO_2, NO_2 and O_3 per μg/m^3 respectively and for CO, it is 3.7% per mg/m^3 (Hu et al., 2015; Shen et al., 2020). $Ci_{,0}$ is the level of concentration, indicating that there is no excess health risk when the concentration of the pollutant i is less or equal to excess risk (ER) from the pollutant I and the overall excess risk of all the pollutants are determined using Eqs. (3) and (4).

$$ER_I = RR_I - 1 \tag{3}$$

$$ER_{total} = \sum ER_I - \sum (RR_I - 1) \tag{4}$$

During the lockdown, Sharma et al. (2020) studied ER associated with pollutant parameters in contrast with the same duration in the earlier 3 years (Fig. 5). The threshold values of 25 μg/m^3 (24 h mean), 50 μg/m^3 (24 h mean), 100 μg/m^3 (8 h mean) and 200 μg/m^3 (1h mean) for $PM_{2.5}$, PM_{10}, O_3, NO_2 and SO_2 are studied for estimation (Organization, 2006). For CO, Central Pollution Control Board (CPCB's) recommended guidelines on air quality, 4 mg/m^3 (1h mean) were used. In all regions, major health threats caused by $PM_{2.5}$ and PM_{10} were studied during the lockdown time. Nevertheless, the average ER in the country owing to PM decreased by an average of ~52%. Except for O_3 in east India and SO_2 in north India, ER reduced during the lockdown period for all pollutants in each region. This total drop in India's ER during the lockout phase (~4 times) could save India nearly 0.65 million deaths in a year.

6. Predicting meteorological impact on concentrations

Additionally, this change in the total air quality may be attributed to more pre-monsoon dispersion when the lockdown occurred. Owing to unfavourable weather conditions, similar lockdown did not cause any major change in China's air quality (Wang et al., 2020b). Two simulations were conducted to understand the effect. Although the real meteorology was used in Simulation 1, during the study time in 2020. The meteorology of the worst case in early November 2019 was used in Simulation 2 (Beig et al., 2020). Table 4 shows the model performance at 30 observation stations in town. Results indicate that the mean fractional bias (MFB) occurs within the USEPA criteria of ±0.6, except in eight sites (EPA, 2007). The relative concentration change in Simulation 2 in comparison with Simulation 1 is also incorporated in Table 4.

An increase in concentration was noticed at 24 sites owing to adverse weather conditions. On average, the concentrations at sites with strong model output in Simulation 2 raised by 33% in contrary to Simulation 1. This suggests that it was not favourable meteorology, the mean daily concentration of $PM_{2.5}$ in Delhi-NCR increased to 54 μg/m^3, which is lower than the CPCB standard (60 μg/m^3) and 1.13 times greater than the applicable WHO norm. Nonetheless, this surge may not be having accuracy as in the air pollution episode during November 2020. Since, the same restrictions are being imposed on anthropogenic activities, as residential emissions are chiefly because of space heating in northern India (Guo et al., 2017).

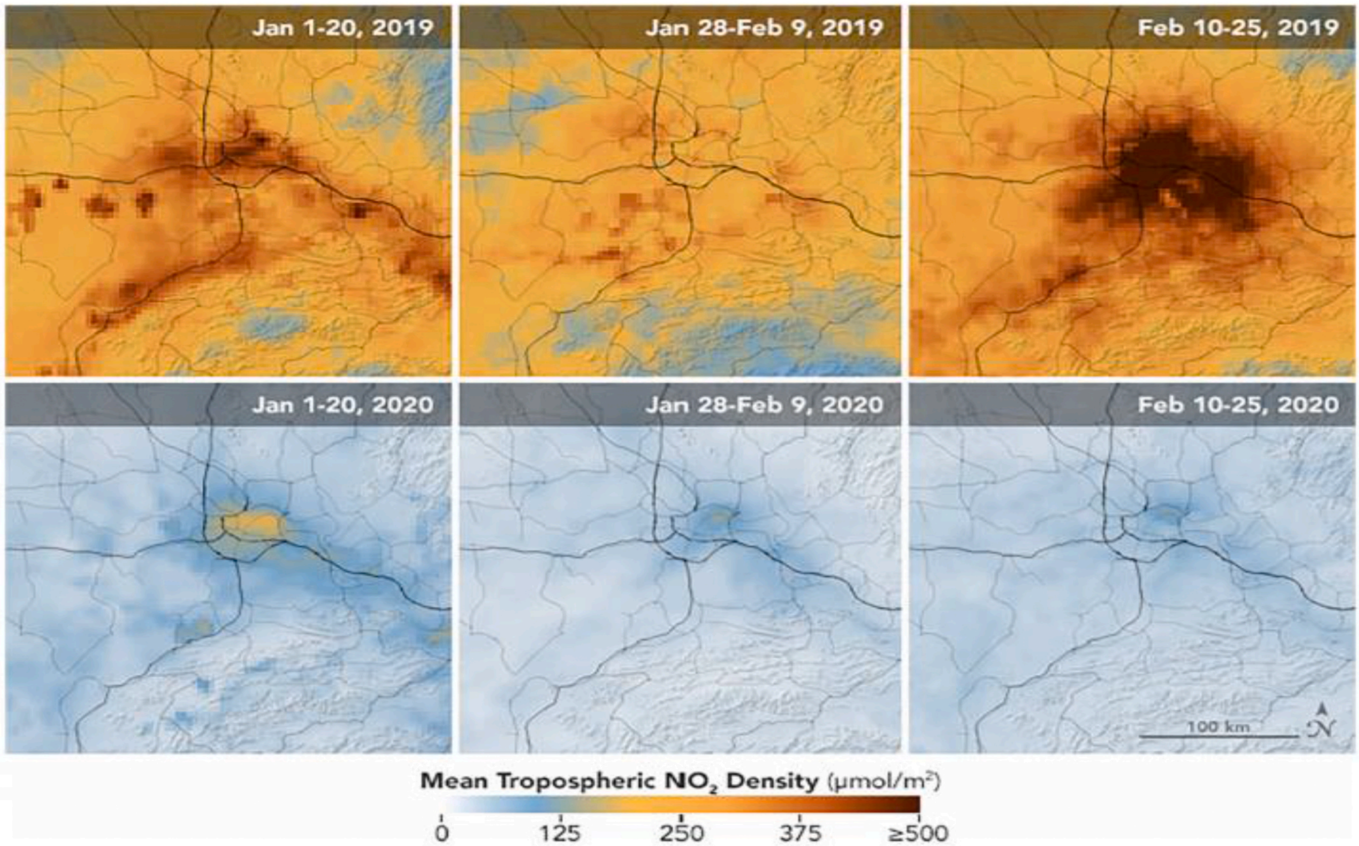

Fig. 4. NO_2 emissions in Wuhan (China) during the year 2019 and 2020 (NASA 2020).

7. Water amid Covid-19

Beaches have become one of the indispensable natural resources located in coastal regions (Zambrano-Monserrate et al., 2018). The resources offered by the beaches such as fishing, air, land and leisure are very important to the survival of coastal peoples and have basic values that must be preserved from overuse (Lucrezi et al., 2016). On the other hand, non-responsible consumption of the resources by individuals has affected various world' beaches that face emerging environmental hazards (Partelow et al., 2015). The current coronavirus pandemic has restricted tourists' flow to these beaches, resulting in a remarkable transformation in the appearance of many world beaches. Beaches like Acapulco (Mexico), Salinas (Ecuador), and Barcelona (Spain) still look unpolluted with sparkling clean waters.

A new surprising environmental effect of COVID-19 has been witnessed in Venice, Italy. Since the number of visitors reduced due to this worldwide pandemic, now the waters flowing in the channels of Venice are cleaner than before. While speedboats, residue churning and other aquatic impurities have been reduced effectively, China has observed wastewater treatment plants improving their disinfection procedures (mainly through improved use of chlorine) to stop wastewater dispersal of the current coronavirus. Still, there are no convincing evidences that the SARS-CoV2 virus is found in wastewater (Water and sanitation, 2020). However, excess chlorine may be present in the water that has detrimental public health effects (Koivusalo and Vartiainen, 1997).

8. Waste generation and recycling amid Covid-19

Soil deterioration, deforestation, pollution of air and water are the various environmental hazards produced due to organic and inorganic waste generation (Mourad, 2016; Schanes et al., 2018). WHO has deemed the widespread dissemination of COVID-19 an emergency, causing people around the globe to remain at home. Since COVID-19 is disseminating briskly to different countries around the globe and in no time, managing medical waste may be a major problem. For proper disposal of medical wastes, organizations and companies in relation to the waste management have already taken measures in coronavirus decontamination programs. Moreover, for concerned governments, it is becoming very critical to find solutions about the issue.

It is the responsibility of each person to obey the rules and regulations when discarding the face masks and other medical wastes (Luan and Ching, 2020). The personal protective equipments (PPEs) such as gloves and masks have caused a rise in the quantity of garbage in many developed countries, especially in the USA (Calma, 2020) (Fig. 6). Towards the end, our planet earth will arise stronger than this disease that is only achievable by people's shared awareness and willingness. There are certain individuals in the community who are often at greater risk of dire consequences from interaction with medical waste, like household employees, waste collectors and other people who tend to spend more time in public places. The plastic-based masks are resistant to liquids and long life but end up in the ocean after they are discarded.

In addition to these plastic-based masks, surgical masks, empty sanitiser bottles along with solid tissue papers when discarded also accounts for a substantial amount of environmental medical waste. A recent study was carried out on Soko Islands, Hong Kong by an environmental NGO Ocean Asia; a substantial quantity of single-use masks were discarded that were washed up to a hundred-meter strip of beach. The wearing surgical masks by the general public amid this COVID-19 outbreak have become mandatory just to take preventive actions.

The sudden amount of trash created by daily use masks and gloves and hand sanitisers by 7 million people around the globe is going to be a very big issue. The conflicting effects of various medicinal wastes are certain in the coming days. When such trashes are dumped in the natural environment of a species on land and in the seas, it may cause animals to

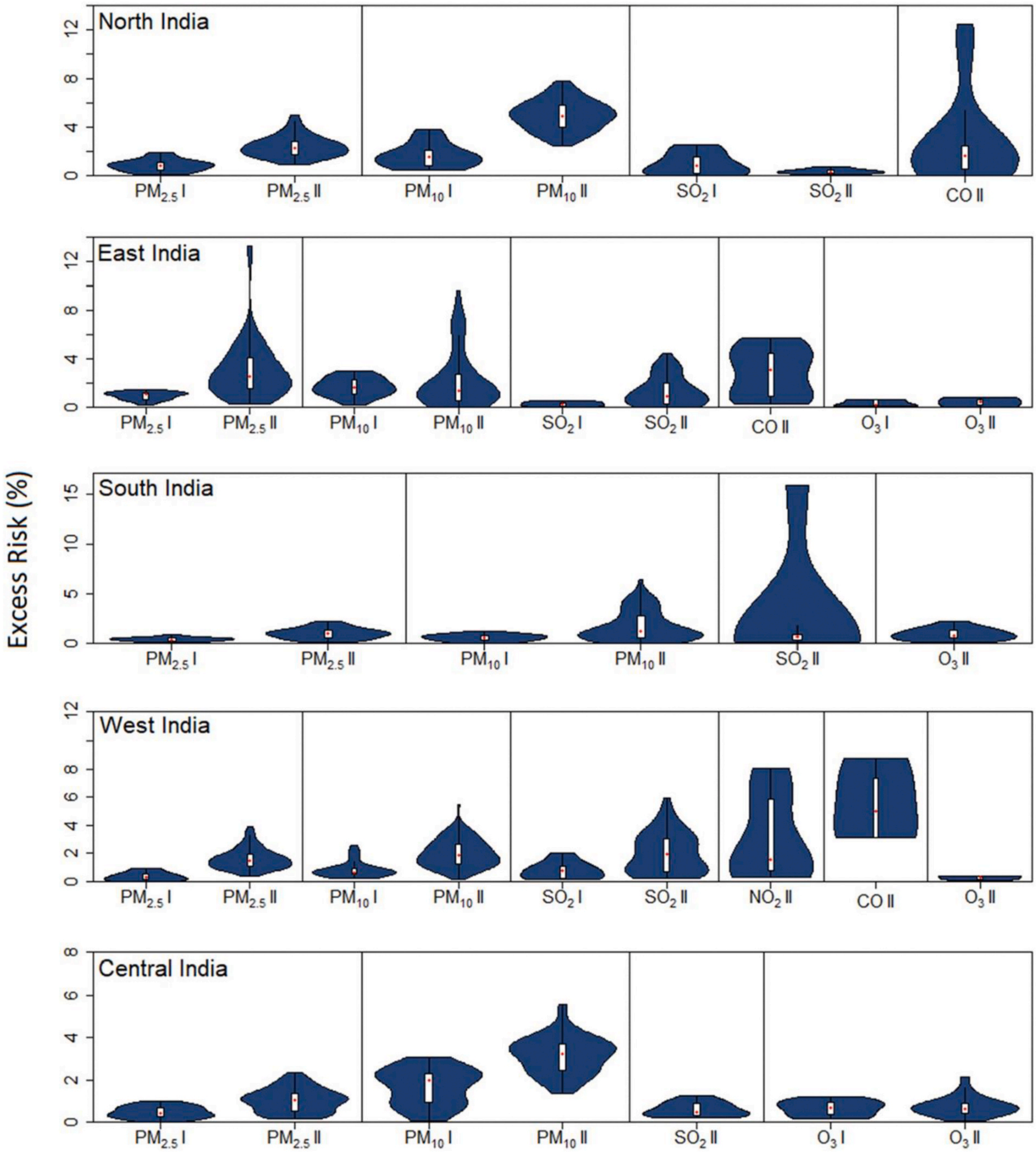

Fig. 5. ER correlated with pollutant parameters in different regions of India; PM2.5, PM_{10}, O_3, NO_2, SO_2 and CO. ERs are shown separately during the current year and previous 3 years (2017–2019) during the study period (Sharma et al., 2020).

consume these mistakenly that could be lethal to them (Hellewell et al., 2020). Now a days, there has been an extensive debate of the constructive ecological advantages on media as well as on social networking of the pandemic and the subsequent strike in universal growth and production. A lot of these have demonstrated to be creations, e.g., the images of dolphins frisking in the canals of Venice, besides better air quality in major cities and the worldwide reduction in greenhouse gas discharges are evident and undeniable.

The COVID-19 pandemic is a fiasco on a worldwide scale and not with standing its human effect, it will deliver a colossal measure of waste that should be overseen economically. In any case, this reflection is not really earth-shattering. After sharing the photos of face covers washed aground on the seashore, Morris named his post 'this is our next issue', however, this is not new. Recycling waste is an essential ecological issue that is of primary concern to all nations (Liu et al., 2020). It is an important method of pollution control, preservation of natural resource and energy conservation (Varotto and Spagnolli, 2017; Ma et al., 2019).

9. Environmental noise levels amid Covid-19

Environmental noise is described as an unwelcome sound that could be created by anthropogenic high-volume operation (e.g., commercial or industrial operation), vehicle engine movement and melodies. It is one of the main causes of irritation for the population and the environment, causing health issues and changing the natural environmental conditions (Zambrano-Monserrate and Ruano, 2019). Some countries

Table 4
Model results using MFB and expected concentration shifts in the worst meteorological case in comparison to the base case at the Delhi-NCR examination sites.

Station	MFB	Change (%)
Najafgarh	−0.10	−54.33
Narela	−0.70	−40.40
Okhla Phase-2	−0.40	12.97
Lodhi Road	0.00	28.19
Mandir Marg	−0.10	21.75
MDC National Stadium	0.10	33.29
North Campus, DU	0.80	−23.03
NSIT Dwarka	0.30	−43.13
CRRI Mathura Road	−0.90	17.62
ITO	0.40	154.64
IGI Airport (T3)	−0.40	−52.73
IHBAS, Dilshad Garden	−0.20	104.51
JLN Stadium	−0.90	04.04
Burari Crossing	−0.60	105.27
Punjabi Bagh	0.10	−21.10
Pusa	−0.40	29.37
R K Puram	0.10	−47.06
Sonia Vihar	−0.30	31.20
Vivek Vihar	−0.40	36.65
Wazirpur	0.60	268.75
Anand Vihar	−0.30	64.30
Ashok Viha	−0.10	71.32
Rohini	0.10	−48.35
Shadipur	−0.40	12.31

enforced quarantine measures that resulted in people staying at home. In spite of this, the usage of transport has declined sharply. All over the world, the flights were cancelled. The commercial activities have almost completely stopped. All the outdoor games like cricket, volleyball, football and hockey have been stopped. Malls and markets have been closed. All educational institutes were shut and the private and public gatherings have been suspended. The streets of the most cities were deserted; the business units, industries, factories, bars and theatres have been closed. All of these changes have brought significant fall in the level of noise in the major cities throughout the world.

10. Risks, rules regulations (RRR) amid Covid-19

a) Common actions to decrease the spread of coronavirus from person to person are critical to control the current outbreak. Social distancing is highly effective in preventing disease transmission. Homeland work will minimize social interaction. Staying at home will be more than a struggle for those living in smaller and cramped homes or without space outside.
b) There should be special restriction strategies and efforts for protecting vulnerable populations like health care workers, children and elderly (Kucharski et al., 2020). Individuals with diabetes, cardiovascular disease or even elevated blood pressure, chronic respiratory illness and cancer are at increased risk from coronavirus (Giannis et al., 2020).
c) A guideline for medical personnel, individuals and researchers interested in working with coronavirus has already been published (Mossa-Basha et al., 2020). Public services must provide multiple daily reagents for decontaminating hands (Luan and Ching, 2020). A large household could have a higher risk of taking the virus home.
d) Travel screening could limit the virus and prevent it from spreading. Epidemiological changes must be observed in coronavirus infections. It is important to take into account the possible ways of transmission and subclinical infections, adaptation, development and spread of the virus among humans and perceive possible intermediate animals and reservoirs. Nevertheless, so far, only fewer pediatric cases were reported due to lack of clinical tests (Rothan and Byrareddy, 2020).
e) Colour codes can be used to identify no infection zones, mild infection zones and highly infectious zones in a particular country.
f) Household wastes should not be thrown and collected outside to have a building site for flies and nuisance. Instead, it should be dumped into pits. Proper protective gears need to be put on while spraying disinfectants. One should individually become a responsible citizen in these tough situations.
g) Online booking and delivery of medicines, vegetables, grocery, milk etc. should be promoted to avoid the movement of people. Playing outdoor games should be avoided. There should also be a temporary suspension of religious activities to avoid large gatherings. Time should be spent on books, internet etc. to overcome the depression due to lockdown.

11. Conclusions

The lockdown strategies due to COVID-19 pandemic disaster offers a meaningful message to all the countries worldwide for restoring the environmental quality as well as natural ecosystem stability. Apparently, the slaughterer COVID-19 pandemic and constant lockdowns become a curse towards the millions of people and the world economy confronts a massive disruption due to the unpleasant and unusual incident. The COVID-19 pandemic has led to improved environmental quality, water and noise pollution. Due to COVID-19, actions taken by governments across the world have led to significant reductions in environmental pollution and improvements in environmental quality particularly in countries with severe COVID-19 transmission such as China, USA, Italy and Spain. These countries experienced sharp reductions in carbon emissions, air pollution and sound pollution. In India there were about −51.84, −53.11, −17.97, −52.68, −30.35, 0.78 and −12.33% reduction in the concentration of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3 and NH_3, respectively. The remarkable improvement in air quality could lead to substantial health benefits. Nevertheless, this epidemic is taking people's lives, certainly it should not be seen as a way of bringing about positive environmental change. The safe management of domestic and medical waste could be critical during the COVID-19 emergency. Finally, it is concluded that COVID-19 will produce both positive and negative indirect effects on the environment, however, the latter will be greater. Decreasing greenhouse gas concentrations during a short period is not a sustainable way to clean up the environment. Furthermore, the virus crisis brings other environmental problems that may last longer and maybe more challenging to manage if countries neglect the impact of the epidemic on the environment.

Credit author statement

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Declaration of competing interest

The authors declare that they have no known competing financial

Fig. 6. Ben Morris posted pictures of the beach masks on the Soko Islands, Hong Kong (Kalina and Tilley, 2020).

interests or personal relationships that could have appeared to influence the work reported in this paper.

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