Global Economics Science
http://ojs.wiserpub.com/index.php/GES/

UNIVERSAL WISER PUBLISHER

Research Article

Covid-19 and the Environmental Concerns in India: Repercussions and Sustainable Recovery

Annie Mahajan*, Rinnie Mahajan

Department of Economics, University of Jammu, Jammu, India
E-mail: mahajanannie05@gmail.com

Received: 12 May 2021; **Revised:** 21 March 2022; **Accepted:** 16 May 2022

Abstract: Coronavirus disease has wrecked the lives of people globally. Countries have resorted to several restrictive measures to prevent the transmission of the virus. It has created a standstill in the global economies. The social consequences are far worse. The lives of the people have been aggravated both physically and mentally. This has pushed them on the verge of vulnerability. However, a sense of optimism has emerged for environmental concerns. The air and water quality has witnessed a significant improvement globally. The prospects have proved to be significant for countries trying to meet the international standards of emissions. The closure of economic activities and stringent norms of social distancing has considerable effects on the environment, particularly in India. The paper gives an insight into the Environmental conditions of India pre and post lockdown. As the uncertainties still brim on the way, a strong course of action is needed to address the environmental concerns. The forward course of action has been suggested for a sustainable and green recovery.

Keywords: COVID-19, environment, natural resource management, green recovery, sustainability

JEL Codes: Q53, Q54, Q57, R11

1. Introduction

Towards the end of 2019, the World Health organization received information about the epidemic that originated in Wuhan city of China with an unidentified aetiology. This disease named COVID-19 infecting the respiratory systems has been declared a situation of a medical health emergency (Zhu et al., 2020). The virus has affected several countries including the United States, Germany, Italy, Japan, Singapore, and South Korea through community transmission (Amanat & Krammer, 2020). The first patient of coronavirus was reported on 30 January in the state of Kerala, India. At the beginning of March, the cases had almost doubled and nearly 13 states and union territories had at least one transmission (MoHFW, 2020). In response to the increased cases of infection, the Government of India announced a nationwide lockdown on 25 march 2020 with strict isolation measures and no transboundary movement (Zambrano-Monserrate et al., 2020). The adjournment of economic activities brought a halt to the growth process of countries including India. The lockdown led to several economic and social implications (Chakraborty & Maity, 2020). The vulnerable sections of society were pushed on the verge of poverty (Anderson et al., 2020). However, the paucity of

DOI: https://doi.org/10.37256/ges.322022934

industrial and commercial activities has created optimism for several environmental issues. The impact of the shutdown on air quality, water quality and waste generation has been pivotal (Sharma et al., 2020). Analysis of the fundamental environmental concerns can assist in laying sustainable paths for green recovery.

An induced halt in anthropogenic activities has led to a radical cut in environmental emissions all over the world (Saadat et al., 2020). Specific to India, air pollution, is responsible for nearly 1.2 million deaths in the world (Polk, 2019). Escalated air pollution is attributed to high vehicular traffic and increased levels of industrialization (Gurjar et al., 2016). The figures have reduced substantially (Muhammad et al., 2020). Water pollution bears the onus for around 0.7 million deaths in India (WHO, 2020). Water resources have experienced a sense of rejuvenation as a consequence of decreased human interventions (Somani et al., 2020). A remarkable reduction in solid waste generation with an adjacent increase in biomedical waste has been observed in two months of lockdown (Faizan, 2021). Noise pollution has been lowered because of mandatory restrictions (Mahato et al., 2020). The study aims to identify the implications of the pandemic on the environment with a specific study on air quality, water quality and waste generation for the cities with high population density in India. The environmental changes experienced in the abovementioned categories are unique and set forth an example for the policymakers in the future to fix the pollution levels within limits. The paper further suggests the course of actions that can be adopted to sustain the changes witnessed in the environment and suggest ways for green recovery.

2. Review of literature

Degradation of the environment has earned the concern of researchers and policymakers for a long time (Shandra et al., 2003). Yet, several actions to curtail the pollution levels have proved to be futile (Duraiappah, 1998; Tyagi et al., 2014). However, the scenario of environmental pollution has tilted with the inception of COVID-19 (Chakraborty & Maity, 2020; Atalan, 2020). Though the pandemic has resulted in massive damage to several lives, the only silver line it has brought is relatively less environmental damage (Shakil et al., 2020). The rapid scale of spreading and the danger to the lives created by the pandemic led to an economic shut down globally (Gautam & Hens, 2020). As the economies came to halt, several actions which were environmentally damaging also came into a standby mode (Verma, 2020). The pause of several anthropogenic activities proved to be fruitful for the air conditions due to reduced vehicular movement (Cheval et al., 2020; Guida & Carpentieri, 2021).

Several countries recorded a low level of emission of greenhouse gases during the duration of the lockdown (Sarkodie & Owusu, 2021; Caraka et al., 2020). As the lockdown led to a drop in international/national air movement, the emission of gases reduced to a significant number (Gillingham et al., 2020). A significant improvement is witnessed in the health of several water bodies, which are usually cursed with a huge anthropogenic burden (Eroğlu, 2021). Several developing countries where the water bodies are dumping ground for domestic and industrial waste have experienced a massive reduction in the BOD levels of the water bodies (Nižetić, 2020; Debata et al., 2020). This indicates an improved state of water resources though a rare phenomenon. However, the positive aspects of lockdown to the environment are outweighed by the increased waste generation ratio especially the biomedical waste (Khan et al., 2021). Lockdown emerged as a challenge to the waste management authorities as the proportion of biomedical and municipal waste recorded an unexpected rise (Sharma et al., 2020).

Thus, COVID-19 works as a gentle reminder of the environmental damage that anthropogenic activities are creating (Elavarasan & Pugazhendhi, 2020). Sustaining the controlled environmental conditions is fundamental for the economies to bloom in the coming years. The positive and the negative aspects of the lockdown on the environment can be fundamental for the policymakers to induce actions that are indulgent to the environment (Espejo et al., 2020).

3. Objectives and methodology

The environmental repercussions of COVID-19 are analyzed through three major components-Air Quality, Water Quality and Waste generation. The implications of lockdown induced by the pandemic on air quality have been studied in seven cities in India-Mumbai, Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad and Hyderabad. The choice of the cities is owed to the high population density. Population density is acknowledged as a major factor responsible for the spread of COVID-19 cases (Maji et al., 2016; Pansini & Fornacca, 2020). The period considered for analysis is from 1st March 2020 to 31st May 2020 which is subdivided into three phases-the phase of pre lockdown (1st march-25th March), the phase of strict lockdown (25th March-30th April) and the phase of easing of lockdown (1st May-31st May). The Air Quality Index (AQI) is used for drawing patterns of air quality with the passage of lockdown. The calculations of AQI by the Central Pollution Control Board are used (CPCB, 2020a). The value of AQI ranges from 0 to 500 and is composed of 8 major pollutants: $PM_{2.5}$, PM_{10}, SO_2, NO_2, NH_3, CO, Pb and O_3. Higher the value of AQI, the higher. The major pollutants considered under study are $PM_{2.5}$, PM_{10}, NO_2, CO, SO_2 and Ozone. To study the associations between COVID-19 cases, Air Quality parameters and meteorological factors, Kendell rank Correlation, a non-parametric test are used (Akoglu, 2018).

$$\text{Kendell's Tau} = (C - D/C + D)$$

C = Number of Concordant pairs

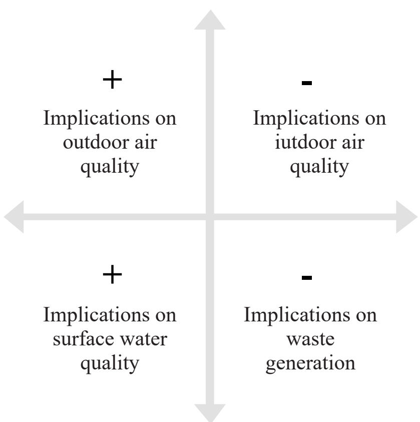
D = Number of Discordant pairs

The p-value < 0.1 indicated the existence of a significant correlation among the factors. Surface water quality is analyzed through the Dissolved Oxygen (DO), Fecal Coliform (FC) and Biochemical Dissolved Oxygen (BOD) for six major river systems of the country-Ganga, Godavari, Krishna, Mahanadi, Yamuna and Sabarmati. The three water parameters are studied for March (pre lockdown) and April (lockdown period). The waste generation is analyzed through the pattern of biomedical waste generation in the country. Lastly, various alternatives are suggested for achieving a green recovery for the economy.

4. Results of the study

4.1 *Implications of COVID-19 on environment*

While the effects of a pandemic on society and the economy are unparallel, Covid-19 has repaired environmental damage to some extent as depicted in Figure 1. The positive and the negative impacts of the spread of the virus on the environment can be briefed in the following diagram. While the Outdoor air quality and surface water quality have improved drastically, the indoor air has been polluted and a massive amount of waste is being generated. A detailed analysis of their aspects of the environment is provided in subsequent sections.

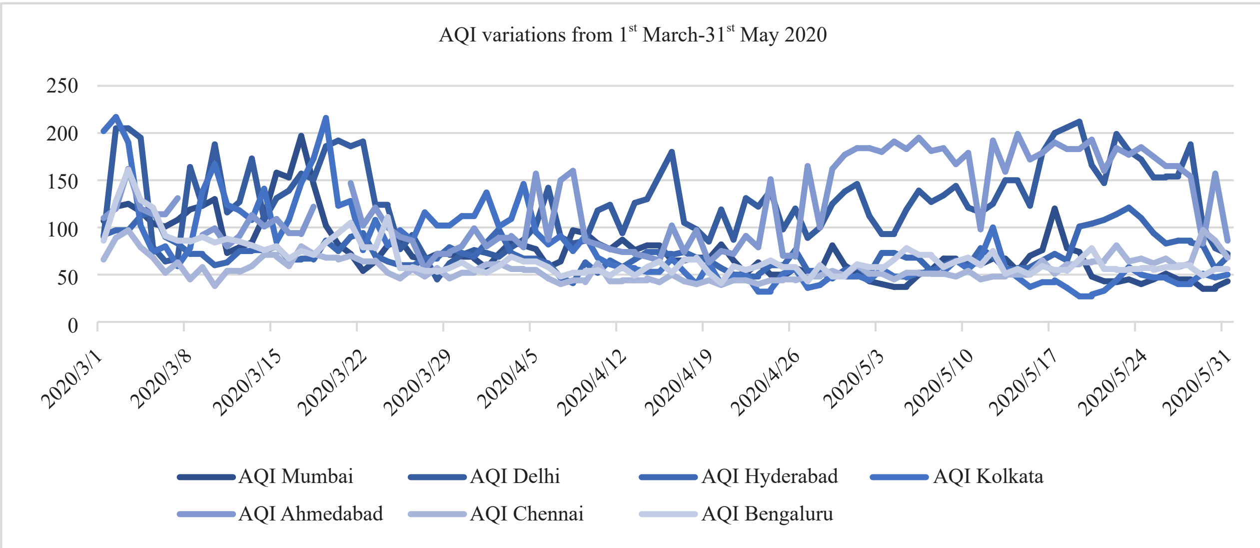


Source: Shakil et al. (2020)

Figure 1. Four dimensions of environmental implications of COVID-19

4.1.1 *Implications on air quality*

The impact of COVID-19 on air quality has been fundamental. The repercussions of the forced shutdown on air quality have been displayed in Figure 2. The chart depicts the Air Quality Index (AQI) variations from the period 1st March 2020 to 31st May 2020. The period has been divided into three phases the pre lockdown phase from 1st March 2020 to 25th March 2020, the lockdown phase with a complete halt on activities from 25th March 2020 to 30 April 2020 and the third phase depicts the ease in regulations of lockdown from 1st May 2020 to 31st May 2020. The overall trend of seven cities depicts the bright side of lockdown. With the advent of lockdown, the Air Quality Index has fallen sharply. This focuses on the extremities of anthropogenic activities of construction, industrial operations, traffic, etc. The path of AQI of Mumbai over the three phases has shown a significant downfall. The AQI of the city ranged in the moderate limits from 101-200. However, the lockdown has been successful in bringing these figures to satisfactory levels and subsequently falling within the range of 0-50. Bengaluru city has experienced falls in levels of AQI similar to Mumbai. The AQI levels of the city ranged from moderate to satisfactory as the figures crossed the mark of 100 occasionally. The shutdown of industrial and commercial activities has resulted in a drop in AQI levels. The pattern has continued in both phases of lockdown. Delhi has witnessed a remarkable change in air quality with the occurrence of lockdown. The AQI levels in the pre-lockdown phase displayed a poor picture of air quality in Delhi. The figures mainly ranged in the category of moderate to poor making it unfit for the people with prolonged exposure. However, the AQI levels fell drastically to satisfactory levels during the initial phase of lockdown. As the certain restrictions on lockdown were eased, the figures again marked an upheaval coming back to moderate levels. Ahmedabad is another major city cursed with air pollution. High AQI levels in the pre-lockdown are witnesses of this fact. With the closure of several textile and chemical industries and zero human movements, the AQI levels have fallen into the satisfactory range (Singh & Chauhan, 2020). The figures of AQI rose to the moderate range again with the easing of lockdown and movement of vehicles. The high values of AQI for Kolkata city show the poor state of the air. The values crossing the 200-point mark in pre-lockdown phase bring out the threat to people prone to respiratory problems. However, the blessing of restricted human activity led to a downward movement in AQI levels in both the phases of lockdown. The figures fell below the 50-point mark which is considered good as per National Ambient Air Quality Standards (NAAQS) (CPCB, 2014). The pre-lockdown scenario of Hyderabad and Chennai was satisfactory. Chennai city has continued the trend of low AQI figures during the duration of lockdown. However, Hyderabad displayed a rising trend of AQI levels after the easing of restrictions. The values ranged from 100-200 portraying the expanded scale of economic and social activities with the easing in restrictions.



Source: Central Pollution Control Board (CPCB, 2020a)

Figure 2. Air Quality Index (AQI) of seven cities from 1st March 2020 to 31st May 2020

Covid-19 affects the respiratory tract in the body. As air pollution is considered to be a major cause of respiratory diseases, several studies have examined the relationship between increased COVID-19 cases and the presence of air pollutants (Zoran et al., 2020; Li et al., 2020). Further, the studies have drawn parallels between meteorological conditions suc as temperature, humidity, wind speed and rainfall and respiratory viruses (Pani et al., 2020; Wu et al., 2020; Ma et al., 2020). To analyze the correlation between increased incidence of COVID-19 cases, air quality parameters and meteorological factors for seven densely populated cities of India, the Kendell Tau test has been used.

The seven components that define the Air quality Index are-$PM_{2.5}$, PM_{10}, NO_X, CO, SO_2 Ozone and NH_4. A high correlation among the air quality variables has been observed for all the cities as depicted in Tables 1-7. The high values point at the common source of origination of these substances in the air majorly the industrial and automobile usage (Jain & Sharma, 2020). The correlation between AQI and the various parameters highlight those subcomponents responsible for bringing change in the levels of the Air Quality Index during the lockdown. The correlation values of 0.682, 0.695 and 0.506 between $PM_{2.5}$, PM_{10}, NO_2 with AQI for Mumbai city indicate that these components are the major causes of pollution as depicted in Table 3. The restriction on construction activities and prevention of agricultural fires have been the major reasons for the reduced presence of particulate matter in the air (Gupta et al., 2020). Delhi, Bengaluru, Chennai and Hyderabad display a high correlation of AQI with $PM_{2.5}$ and PM_{10} for the above-mentioned reasons as depicted in Tables 2, 4, 5 and 7. The AQI values of Ahmedabad show a significant correlation with Carbon Monoxide and Ozone as calculated in Table 6. The presence of high levels of CO are indicative of high burning activities and Ozone is released from power plants, refineries and chemical industries (Singh & Chauhan, 2020). AQI of Kolkata has a correlation coefficient of more than 0.5 with all the sub-components as calculated in Table 1. The high values of all air quality parameters reflect their significant presence in the air.

The correlation between air quality parameters and meteorological factors such as Wind Speed (WS) and temperature are negative for almost all the selected cities. The values range from r = -0.223 to 0.19 for Kolkata, r = -0.251 to 0.1 for Delhi, r = -0.01 to 0.1, r = -0.2 to 0.4 for Chennai, r = -0.4 to 0.08 for Ahmedabad and r = -0.14 to 0.2 for Hyderabad. Similarly, the correlation values for temperature and air quality parameters were mostly negative. The correlation values for air quality parameters and COIV-19 cases range from negative to weakly positive. The negative correlation of COVID-19 cases with $PM_{2.5}$, PM_{10}, NO_2 and CO displays the decreased presence of these substances with the increased incidences of COVID-19 cases. Furthermore, the relationship between COVID-19 cases and meteorological factors-Windspeed, rainfall and temperature are diverse for states. The correlation between Windspeed and COVID cases is weak ranging from Ahmedabad (r = 0.4), Chennai (r = 0.3), Hyderabad (r = 0.2) Kolkata (r = 0.16), Delhi (r = 0.17) and Mumbai (r = 0.08). The low figures of association indicate the low transmission of covid-19 with air. Temperature and COIVD -19 cases have displayed a negative correlation (r = -0.2 To 0.3). However, Mumbai displayed a positive correlation of temperature with covid-19 cases. The high correlation nullifies the theories of a decrease in the spread of covid-19 with the rise in temperature (Wang et al., 2020; Sajadi et al., 2020; Wu et al., 2020; Ma et al., 2020)

4.1.2 *Implications on indoor air quality*

The ambient indoor air pollution has countered the effect of reduction in air pollution during the period of lockdown. As the country faced a shutdown, the majority population of the country had to confine themselves to their homes. The consequences were faced in terms of increased indoor air pollutants including Nitrogen Oxides (NOx), Carbon monoxide (CO), particulate matter, benzene and several toxic substances released from biomass combustion (Sukhsohale et al., 2013; Chakraborty et al., 2014). The cooking fuels used for cooking in rural areas and urban slums comprise firewood, charcoal, cow dung, crops, etc. (Saha & Chauhan, 2020). Several activities such as smoking, use of air conditioners or burning incense sticks have affected the indoor air quality severely (Bruce et al., 2000; Singhal, 2020). The increased incidence of indoor air quality is reflected in the increased correlation between CO and Ozone with AQI for Ahmedabad, Delhi and Kolkata. The high presence of CO and Ozone in the air is majorly due to the increased burning activities and high usage of refrigerators and air conditioners.

Table 1. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Kolkata from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	WS	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000										
PM_{10}	0.757**	1.000									
NO_2	0.534**	0.511**	1.000								
SO_2	0.391**	0.386**	0.538**	1.000							
CO	0.592**	0.546**	0.759**	0.450**	1.000						
Ozone	0.343**	0.281**	0.367**	0.487**	0.332**	1.000					
WS	-0.223**	-0.200**	-0.208**	-0.187**	-0.190**	-0.155*	1.000				
AQI	0.669**	0.606**	0.539**	0.570**	0.536**	0.599**	-0.244**	1.000			
Active cases	-0.291**	-0.319**	-0.500**	-0.438**	-0.487**	-0.489**	0.167*	-0.546**	1.000		
Recovered cases	-0.304**	-0.332**	-0.493**	-0.435**	-0.490**	-0.513**	0.169*	-0.561**	0.977**	1.000	
Deaths	-0.294**	-0.327**	-0.505**	-0.444**	-0.490**	-0.500**	0.164*	-0.553**	0.984**	0.979**	1.000

Source: Author's calculations (Data from CPCB, 2020a)
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 2. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Delhi from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	WS	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000										
PM_{10}	0.660**	1.000									
NO_2	0.519**	0.584**	1.000								
SO_2	0.461**	0.436**	0.408**	1.000							
CO	0.259**	0.264**	0.225**	0.103	1.000						
Ozone	-0.120	-0.112	-0.336**	-0.264**	0.206**	1.000					
WS	-0.251**	-0.126	-0.209**	-0.164*	-0.078	0.102	1.000				
AQI	0.442**	0.533**	0.406**	0.281**	0.256**	0.089	-0.283**	1.000			
Active cases	-0.133	0.066	-0.091	-0.155*	0.434**	0.485**	0.179*	0.215**	1.000		
Recovered cases	-0.125	0.071	-0.078	-0.144	0.453**	0.488**	0.161*	0.226**	0.963**	1.000	
Deaths	-0.116	0.084	-0.074	-0.141	0.436**	0.498**	0.161*	0.233**	0.952**	0.980**	1.000

Source: Author's calculations (Data from CPCB, 2020a)

Table 3. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Mumbai from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	WS	Temp	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000											
PM_{10}	0.684**	1.000										
NO_2	0.553**	0.524**	1.000									
SO_2	-0.211**	-0.202**	-0.152*	1.000								
CO	0.490**	0.440**	0.583**	-0.042	1.000							
Ozone	0.257**	0.198**	0.141*	-0.068	0.014	1.000						
WS	-0.012	0.026	0.065	0.084	0.048	0.124	1.000					
Temp	-0.490**	-0.406**	-0.379**	0.464**	-0.265**	-0.237*	-0.094	1.000				
AQI	0.682**	0.695**	0.506**	-0.120	0.423**	0.209**	0.017	-0.369**	1.000			
Active cases	-0.640**	-0.536**	-0.643**	0.409**	-0.425**	-0.260**	0.008	0.636**	-0.489**	1.000		
Recovered cases	-0.655**	-0.540**	-0.648**	0.409**	-0.430**	-0.267**	0.004	0.643**	-0.489**	0.977**	1.000	
Deaths	-0.648**	-0.538**	-0.651**	0.402**	-0.434**	-0.267**	0.009	0.639**	-0.495**	0.989**	0.987**	1.000

Source: Author's calculations (Data from CPCB, 2020a)

Table 4. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Bengaluru from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	Temp	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000										
PM_{10}	0.609**	1.000									
NO_2	0.110	0.177*	1.000								
SO_2	0.016	0.225**	0.215**	1.000							
CO	0.219**	0.174*	-0.124	0.085	1.000						
Ozone	0.429**	0.331**	-0.105	0.096	0.252**	1.000					
Temp	0.108	0.065	-0.011	-0.137	0.105	0.086	1.000				
AQI	0.436**	0.587**	0.121	0.206**	0.120	0.334**	-0.023	1.000			
Active cases	-0.391**	-0.231**	0.054	0.287**	-0.219**	-0.320**	-0.298**	-0.233**	1.000		
Recovered cases	-0.380**	-0.218**	0.074	0.305**	-0.215**	-0.338**	-0.292**	-0.227**	0.961**	1.000	
Deaths	-0.396**	-0.222**	0.084	0.328**	-0.206**	-0.352**	-0.290**	-0.236**	0.949**	0.980**	1.000

Source: Author's calculations (Data from CPCB, 2020a)

Table 5. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Chennai from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	NO_2	SO_2	CO	Ozone	WS	Temp	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000										
NO_2	0.148*	1.000									
SO_2	0.295**	0.210**	1.000								
CO	0.356**	0.164*	0.096	1.000							
Ozone	0.059	0.056	-0.117	0.282**	1.000						
WS	-0.317**	-0.237**	-0.318**	-0.103	0.186**	1.000					
Temp	-0.181*	-0.058	-0.209**	-0.019	0.100	0.464**	1.000				
AQI	0.455**	0.064	0.087	0.373**	0.289**	0.013	0.037	1.000			
Active cases	-0.271**	-0.137	-0.210**	-0.080	0.337**	0.705**	0.341**	0.023	1.000		
Recovered cases	-0.305**	-0.141	-0.232**	-0.087	0.343**	0.760**	0.367**	0.072	0.892**	1.000	
Deaths	-0.303**	-0.128	-0.218**	-0.085	0.344**	0.758**	0.370**	0.071	0.884**	0.982**	1.000

Source: Author's calculations (Data from CPCB, 2020a)

Table 6. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Ahmedabad from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	WS	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000										
PM_{10}	0.658**	1.000									
NO_2	0.457**	0.409**	1.000								
SO_2	0.503**	0.478**	0.356**	1.000							
CO	-0.036	0.021	0.046	-0.024	1.000						
Ozone	-0.127	-0.136	-0.105	-0.268**	0.225**	1.000					
WS	-0.275**	-0.234**	-0.438**	-0.259**	-0.018	0.089	1.000				
AQI	-0.049	0.040	-0.120	-0.159*	0.386**	0.425**	0.108	1.000			
Active cases	-0.340**	-0.279**	-0.282**	-0.593**	0.358**	0.452**	0.416**	0.375**	1.000		
Recovered cases	-0.349**	-0.290**	-0.295**	-0.590**	0.341**	0.431**	0.430**	0.366**	0.958**	1.000	
Deaths	-0.358**	-0.299**	-0.296**	-0.595**	0.334**	0.426**	0.427**	0.354**	0.966**	0.992**	1.000

Source: Author's Calculations (Data from CPCB, 2020a)

Table 7. Kendell Tau Correlation between air quality parameters, meteorological components and COVID-19 cases for Hyderabad from 1st March 2020 to 31st May 2020

	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO	Ozone	WS	Temp	AQI	Active cases	Recovered cases	Deaths
$PM_{2.5}$	1.000											
PM_{10}	0.559	1.000										
NO_2	0.282	0.386	1.000									
SO_2	0.268	0.267	0.330	1.000								
CO	0.365	0.424	0.388	0.311	1.000							
Ozone	0.153	-0.078	-0.128	0.038	-0.040	1.000						
WS	-0.136	0.090	0.157	0.129	0.119	-0.145	1.000					
Temp	-0.011	-0.150	0.001	0.114	-0.024	0.294	0.006	1.000				
AQI	0.597	0.681	0.273	0.200	0.384	0.020	-0.037	-0.125	1.000			
Active cases	-0.148	-0.059	-0.220	-0.008	0.024	0.052	0.212	0.037	-0.084	1.000		
Recovered cases	-0.126	0.087	-0.136	0.032	0.074	-0.056	0.213	-0.029	0.004	0.632	1.000	
Deaths	-0.100	0.106	-0.140	0.055	0.088	-0.049	0.226	0.000	0.027	0.656	0.960	1.000

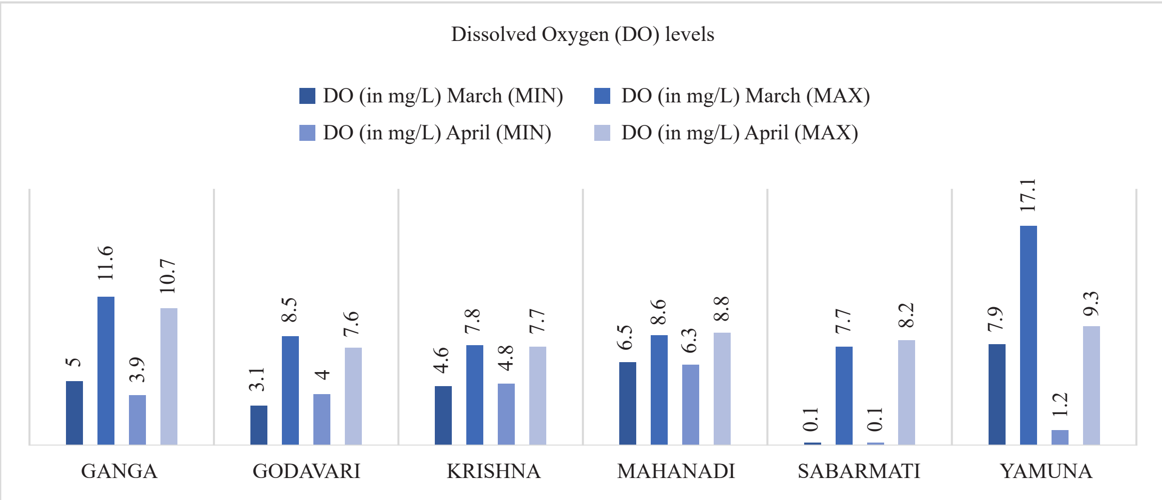
Source: Author's calculations (Data from CPCB, 2020a)

4.1.3 *Implications on surface water quality*

The lockdown in India ignited a ray of hope for water ecosystems. The revival of water resources has raised a question about the existing conduct of anthropogenic activities (Bashir et al., 2020). An impact of lockdown on the health of rivers has been presented in Figure 3, 4 and 5. To study the impact of lockdown, three water quality parameters-dissolved oxygen, Biochemical oxygen demand and Fecal Coliform were observed for six major river systems-Ganga, Yamuna, Krishna, Mahanadi, Sabarmati and Godavari in the month of March and April. Ganga is one of the holiest and largest river systems in the country. As the river passes through five major states-Uttarakhand, Uttar Pradesh, Jharkhand, Bihar and West Bengal. The banks of the river are the hub of several industrial clusters. This has created several hotspots for pollution in the river. The composition of Dissolved Oxygen (DO) in the month of march ranged from 5-11.6, whereas the figures fell to 3.9-10.7 in the month of lockdown. The state-wise composition of dissolved oxygen has shown an increasing pattern for the states of Uttar Pradesh, Bihar, West Bengal and Jharkhand. The increasing figures of DO reflect better conditions for sustaining the living organisms in the water. The overall figures of BOD for the river Ganga do not show much variation. However, a significant decrease in BOD levels has been observed at 4 locations in Uttrakhand, 9 locations in Uttar Pradesh, 4 locations in Bihar, 7 locations in West Bengal and all the testing locations in Jharkhand. The presence of Faecal Coliform (FC) in the water is an indicator of the contamination of water with the faecal matter of humans. The high figures for the river Ganga bring out the depleted state of the water source. However, the major impact of the lockdown has been the decrease in FC levels of river Ganga from 1,600,000 to 1,400,000. The reduction in FC levels was observed in all the testing station states. This marks a significant achievement for the water quality of river Ganga not witnessed in the past decades.

The river Yamuna presents a mixed picture of water quality during the duration of the lockdown. As the river passes through the national capital along with Haryana and Uttar Pradesh, it is home to the disposal of industrial and municipal wastes from the three regions. The overall DO levels in river Yamuna have declined from March to April. However, a state-specific analysis reveals that DO levels have followed an increasing trend in the majority of testing centres of Himachal Pradesh, Haryana and Uttar Pradesh. The Biochemical Oxygen Demand composition in the river system has witnessed a remarkable decrease from 78 to 0.6. The BOD levels of all the testing centres in four states depicted a downward movement. The lockdown has gifted revival to river Yamuna as the FC levels dropped from 92 Lakh to 46,000. The decreased FC composition in the water of river Yamuna has made it fit for bathing in the state of Haryana. The notable change in water quality components of river Yamuna reveals the extent of anthropogenic intervention in the water system.

The southern rivers-Mahanadi, Krishna and the Godavari follow the rouse from west to east and enter the Bay of Bengal. The river Godavari follows the route through the states of Maharashtra, Andhra Pradesh and Telangana. Krishna river flows Maharashtra, Karnataka and Telangana. River Mahanadi follows the course through Chhattisgarh and Odisha state. As the three rivers flow through industrial and densely populated states, the implications of lockdown have been significant. The overall composition of DO has shown a significant increase in all three river systems. The BOD composition has followed a declining trend during the period of lockdown. The composition of faecal coliform has experienced a remarkable decrease with the closure of anthropogenic activities in-country. River Mahanadi observed an extraordinary fall in FC parameters reflecting a need for a slowdown in human intrusions. Sabarmati holds an important position as it follows the course covering the states of Rajasthan and Gujarat. The river has displayed an increasing trend for the DO parameter of water quality. The closure of several textile and chemical industries has contributed to declining levels of BOD composition in the waters of the Sabarmati river. Further, the diminishing pattern of the FC parameter indicates the reduced patterns of sewage contamination in water bodies. Apart from the abovementioned water bodies, the lockdown has led to the self-cleaning of several other water bodies and river systems.

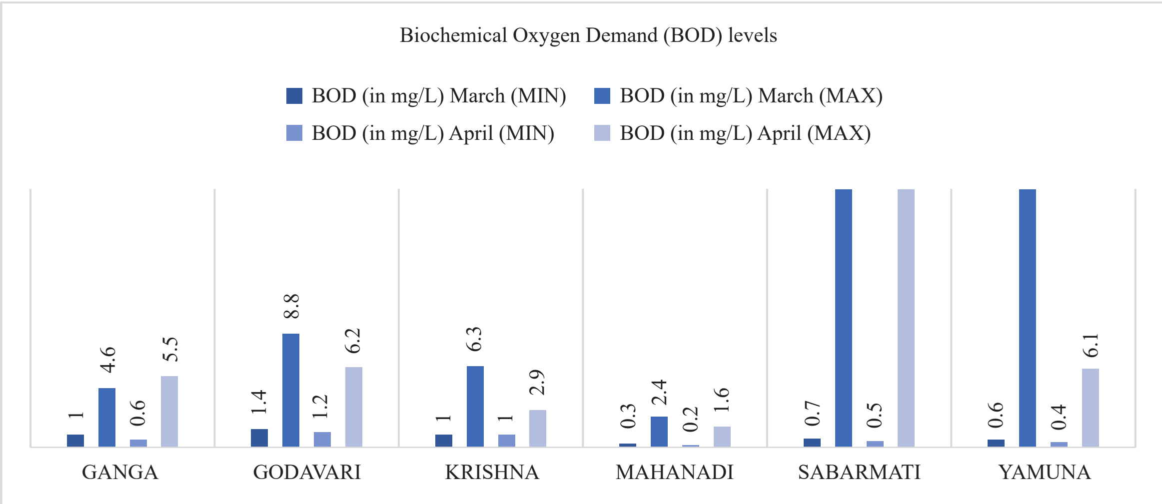


Source: Central Pollution Control Board (CPCB, 2020b)

Figure 3. Dissolved Oxygen (DO) levels for six major river systems of India during March and April

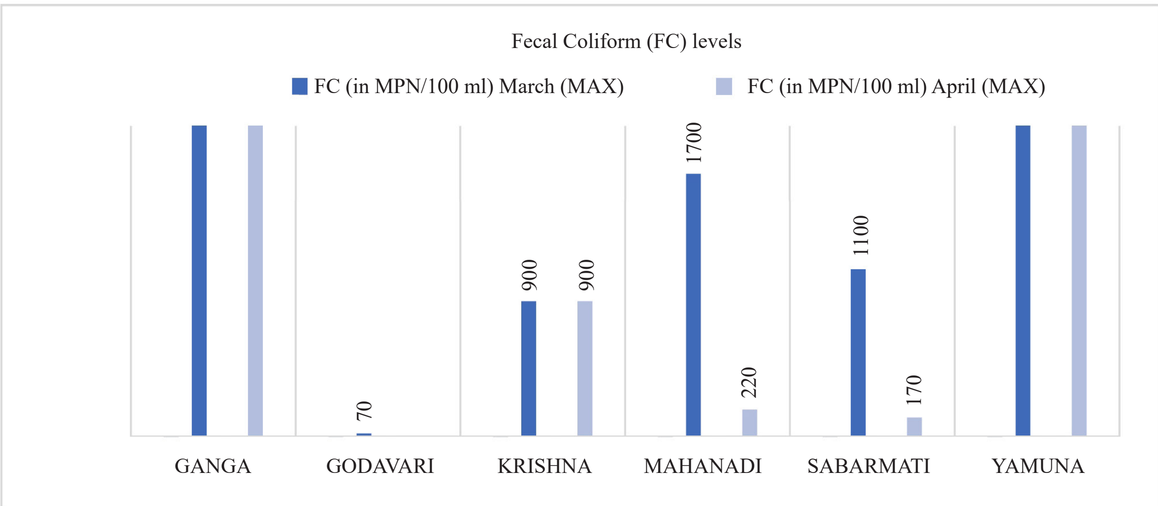
4.1.4 *Implications on waste management*

The implications of shut down and home quarantine on waste generation have been alarming. The waste management sector is prone to efficiencies as around 2 billion people have no access to waste collection (Hoornweg & Bhada, 2012). The pandemic has worsened the situation for this sector. As the pandemic has called for the shut of shops, restaurants and cafes, there has been a drop in the waste generated by them (Klemes et al., 2020). However, working from home, restricted travel, increased food consumption and online shopping have counterintuitive effects on the decrease (Sarkodie, 2021). To avoid the spread of the virus, one-time use packing is being followed up. The increased patterns of panic buying of perishable goods have contributed to substantial leftovers, adding to the waste generation (Reconomy, 2020). Biomedical waste has been the biggest contributor to the pattern of waste generation during the pandemic (Silpa, 2020). The contagious nature of the virus has called upon an increased usage of PPE, gloves, disposable masks, syringes and plastic equipment by patients and doctors. Pharmaceutical waste including drugs and chemical substances tends to be toxic thus, posing a menace to the environment (Fiazan, 2021). The spread of the novel coronavirus has led to 15 times increase in biomedical waste generation in India (CPCB, 2020c).



Source: Central Pollution Control Board (CPCB, 2020b)

Figure 4. BOD levels for six major river systems of India during March and April



Source: Central Pollution Control Board (CPCB, 2020b)

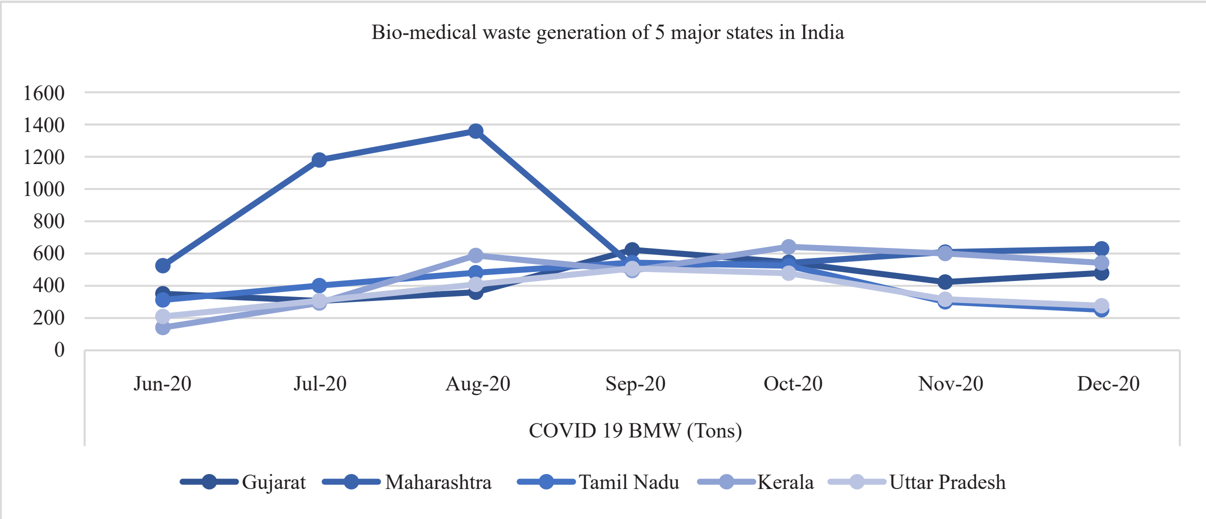
Figure 5. FC composition for six major river systems of India during March and April

A state-wise generation of biomedical waste from June to December 2020 has been presented in Table 8. The dark colour in the columns reflects an increase in biomedical waste generation as compared to the previous month for the state. The light columns indicate a decrease in the generation rates compared to the previous month. Overall Waste generation has increased from 3,025 tons in June to 5,490 Tons in September 2020. The increased generation of biomedical waste correlated with the increase in several covid-19 cases. Five states that have witnessed a considerable increase in biowaste generation are Maharashtra, Kerala, Gujarat, Tamil Nadu and Uttar Pradesh. Maharashtra has followed an upward trajectory in the generation of biomedical waste from June to August. Thereafter, there is a decline of 61 percent from August to September in waste generation and the responsibility goes to the better management of waste in the state. Gujarat has witnessed a 73 percent increase from August to September 2020 owing to the increased covid cases in the state. Tamil Nadu, Uttar Pradesh and Kerala experienced maximum waste generation during the peak of the first COVID wave in September. Subsequently, the rates have fallen in states.

Table 8. State/UT wise biomedical waste generation from June 2020 to December 2020

Name of States	COVID 19 BMW (Tons)						
	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
Andhra Pradesh	165.5	182.8	118.8	112.4	116.1	317.9	328.5
Arunachal Pradesh	3.4	3.4	3.8	3.4	3.5	3.4	3.5
Assam	28.4	20.7	12.6	62.6	51.7	50.1	23.4
Bihar	6.8	20.8	41.5	45.4	44.6	28.1	23.3
Chandigarh	29.9	5.7	55.3	43.0	73.2	70.8	73.2
Delhi	333.4	389.6	296.1	382.5	365.9	385.5	321.3
Gujarat	350.8	306.1	360.0	622.9	545.9	423.5	479.6
Haryana	75.3	184.2	210.7	278.3	238.5	239.4	209.9
Himachal Pradesh	3.8	12.5	4.9	25.2	28.1	30.0	48.2
Jammu and Kashmir	10.7	9.8	51.8	57.4	59.3	44.8	35.1
Karnataka	84.0	540.3	588.0	168.0	218.0	211.0	218.0
Kerala	141.3	293.3	588.1	494.1	642.0	600.4	542.5
Madhya Pradesh	224.6	56.4	106.6	339.0	308.4	208.7	249.5
Maharashtra	524.8	1180.0	1359.0	524.8	542.3	609.0	629.3
Manipur	5.1	0.2	2.1	5.1	5.3	5.1	9.3
Meghalaya	5.1	1.7	6.3	9.9	12.0	7.7	8.6
Nagaland	3.6	3.4	3.1	2.9	3.3	1.9	2.3
Odisha	31.9	106.6	109.2	134.0	183.5	222.7	125.6
Puducherry	18.6	35.8	41.5	63.0	58.7	28.7	17.1
Punjab	48.0	35.6	21.2	234.4	149.6	96.5	87.0
Rajasthan	177.0	7.2	50.4	145.1	171.6	141.9	105.9
Sikkim	6.0	0.2	0.3	6.0	4.2	3.7	2.5
Tamil Nadu	312.3	401.3	481.1	543.8	524.2	300.8	251.2
Telangana	12.3	10.5	24.0	188.8	144.8	103.9	68.8
Uttarakhand	0.5	0.8	41.9	21.7	109.0	56.8	76.3
Uttar Pradesh	210.0	307.5	408.9	507.2	478.1	316.7	276.5
West Bengal	195.0	136.4	235.1	434.8	486.8	330.8	279.1

Source: Central Pollution Control Board (CPCB, 2020c)



Source: Central Pollution Control Board (CPCB, 2020c)

Figure 6. Bio-medical waste generation of 5 major states in India

5. Conclusions and policy implications

The man is introduced to himself at the time of adversity. The pandemic has provided an opportunity of reflecting on the actions and discover sustainable paths for the future. The situation has led to choosing between the economy or society. The vulnerability of several countries has become a guide for lifelong lessons. A sense of gratitude has arisen for the limited resources that we possess. It has become fundamental to analyze the excessive human interventions in the environment and restrict them to minimum levels needed for sustenance. As the countries have resorted to shutting down, the environment has got the time to breathe. Humongous repercussions of the virus on the environment call for exploring the path of green recovery for the environment.

The shutdown of business operations, industrial activities and transportation has brought a pivotal change in the air quality of severely polluted areas. The analysis of the AQI and correlation matrix of air quality variables with covid cases and meteorological factors is indicative of a blessing in disguise for the air conditions in seven majorly populated cities of the country. Further, the high exposure to particulate matter can increase the risk of COIVD mortality. There is a need to engage the stakeholders at multiple levels to bring the air pollution down by a significant level. As the restrictions on transportation and human movement have brought AQI levels down, there is a necessity to endure this practice by making sustainable choices. Policymakers need to inculcate the shift from motorized vehicles to environmentally friendly transportation (cycling or public transportation). The lockdown has brought up the culture of working from home contributing to the reduced levels of air quality parameters. Such a sustainable workstyle of remote working must be stimulated to maintain environmental balance.

Another major consequence of pandemic-induced lockdown is seen in the surface water quality. The increase in DO levels accompanied by a reduction of BOD and Fecal Coliform exhibit significant differences that can be brought in water resources with reduced anthropogenic involvement. The six rivers are banks of several industrial houses and disposal grounds for huge municipal waste. The restoration of water properties in the rivers indicates that there is a need to formulate the schemes targeting preservation of water quality in the post-pandemic era. Furthermore, a framework needed to be chartered to encompass the defaulters within legal boundaries. The explosion of biomedical waste generation in the era of pandemics brings out its negative repercussions for the environment. The need of the hour is to implement green practices that are economically productive and at the same time fruitful for the environment. It is only through the inclusion of the concept of sustainability that the environment and economy can go hand in hand. To manage waste recycling is considered a prime option. Apart from the institutional initiatives, a behavioural change needs to be inculcated at the individual level to prevent the occurrence of another disaster.

Conflict of interest

The authors declare no conflict of interest.

References

Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine, 18*(3), 91-93.

Amanat, F., & Krammer, F. (2020). SARS-CoV-2 vaccines: A status report. *Immunity, 52*(4), 583-589. https://doi.org/10.1016/j.immuni.2020.03.007

Anderson, R. M., Heesterbeek, H., Klinkenberg, D., & Hollingsworth, T. D. (2020). How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet, 395*, 931-934.

Atalan, A. (2020). Is the lockdown important to prevent the COVID-19 pandemic? Effects on psychology, environment and economy-perspective. *Annals of Medicine and Surgery, 56*, 38-42. https://www.sciencedirect.com/science/article/pii/S2049080120301485

Bashir, M. F., Bilal, B. M., & Komal, B. (2020). Correlation between Environmental Pollution Indicators and COVID-19 Pandemic: A brief study in Californian context. *Environmental Research, 187*, 109652. https://doi.org/10.1016/j.envres.2020.109652

Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: a major environmental and public health challenge. *Bull World Health Organ, 78*(9), 1078-1092. https://www.scielosp.org/article/bwho/2000

Caraka, R. E., Lee, Y., Kurniawan, R., Herliansyah, R., Kaban, P. A., Nasution, B. I., Gio, P. U., Chen, R. C., Toharudin, T., & Pardamean, B. (2020). Impact of COVID-19 large scale restriction on environment and economy in Indonesia. *Global Journal of Environmental Science and Management, 6*, 65-84. https://www.gjesm.net/article_40288.html

Chakraborty, D., Mondal, N. K., & Datta, J. K. (2014). Indoor pollution from solid biomass fuel and rural health damage: A micro-environmental study in a rural area of Burdwan, West Bengal. *International Journal of Sustainable Built Environment*. https://doi.org/10.1016/j.ijsbe.2014.11.002

Chakraborty, I., & Maity, P. (2020). COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Science of the Total Environment, 728*, 138882. https://doi.org/10.1016/j.scitotenv.2020.138882

CPCB (2014). *National Air Quality Index Report*. Central Pollution Control Board, New Delhi.

CPCB (2020a). *Central Control Room for Air Quality Management-All India*. CCR (cpcbccr.com).

CPCB (2020b). *Biomedical Waste Generation Status*. https://cpcb.nic.in/covid-waste-management/

CPCB (2020c, Septemeber 23). *Assessment of Impact of Lockdown on Water Quality of Major Rivers*. Central Pollution Control Board. Ministry of Environment, Forest & Climate Change. https://cpcb.nic.in/upload/Assessment-of-Impact-Lockdown-WQ-MajorRivers.pdf

Cheval, S., Adamescu, C. M., Georgiadis, T., Herrnegger, M., Piticar, A., & Legates, D. R. (2020). Observed and potential impacts of the COVID-19 pandemic on the environment. *International Journal of Environmental Research and Public Health, 17*(11), 4140. https://doi.org/10.3390/ijerph17114140

Debata, B., Patnaik, P., & Mishra, A. (2020). COVID-19 pandemic! It's impact on people, economy, and environment. *Journal of Public Affairs, 20*(4), e2372. https://doi.org/10.1002/pa.2372

Duraiappah, A. K. (1998). Poverty and environmental degradation: A review and analysis of the nexus. *World Development, 26*(12), 2169-2179.

Elavarasan, R. M., & Pugazhendhi, R. (2020). Restructured society and environment: A review on potential technological strategies to control the COVID-19 pandemic. *Science of The Total Environment, 725*, 138858. https://doi.org/10.1016/j.scitotenv.2020.138858

Eroğlu, H. (2021). Effects of Covid-19 outbreak on environment and renewable energy sector. *Environment, Development and Sustainability, 23*, 4782-4790. https://doi.org/10.1007/s10668-020-00837-4

Espejo, W., Celis, J. E., Chiang, G., & Bahamonde, P. (2020). Environment and COVID-19: Pollutants, impacts, dissemination, management and recommendations for facing future epidemic threats. *Science of The Total Environment, 747*, 141314. https://doi.org/10.1016/j.scitotenv.2020.141314

Faizan, M. (2021). Solid waste management in India under Covid-19 pandemic: Challenges and solutions. *International Journal of Waste Resources.*

Gautam, S., & Hens, L. (2020). COVID-19: Impact by and on the environment, health and economy. *Environment, Development and Sustainability, 22*, 4953-4954. https://doi.org/10.1007/s10668-020-00818-7

Gillingham, K. T., Knittel, C. R., Li, J., Ovaere, M., & Reguant, M. (2020). The short-run and long-run effects of Covid-19 on energy and the environment. *Joule, 4*(7), 1337-1341. https://doi.org/10.1016/j.joule.2020.06.010

Guida, C., & Carpentieri, G. (2021). Quality of life in the urban environment and primary health services for the elderly during the Covid-19 pandemic: An application to the city of Milan (Italy). *Cities, 110*, 103038. https://doi.org/10.1016/j.cities.2020.103038

Gupta, S., Raghuwanshi, G. S., & Chanda, A. (2020). Effect of weather on COVID-19 spread in the US: A prediction model for India in 2020. *Science of the Total Environment, 728*, 138860. https://doi.org/10.1016/j.scitotenv.2020.138860

Gurjar, B. R., Ravindra, K., & Nagpure, A. S. (2016) Air pollution trends over Indian megacities and their local-toglobal implications. *Atmospheric Environment, 142*, 475-495. https://doi.org/10.1016/j.atmosenv.2016.06.030

Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*. Urban development series, knowledge papers no. 15. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/17388

Jain, S., & Sharma, T. (2020). 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 and Air Quality Research, 20*, 1222-1236. https://doi.org/10.4209/aaqr.2020.04.0171

Khan, I., Shah, D., & Shah, S. S. (2021). COVID-19 pandemic and its positive impacts on environment: An updated review. *International Journal of Environmental Science and Technology, 18*, 521-530. https://doi.org/10.1007/s13762-020-03021-3

Klemes, J., Van Fan, Y., Tan, R., & Jiang, P. (2020). Minimizing the present and future plastic waste, energy and environmental footprints related to COVID-19. *Renewable & Sustainable Energy Reviews, 127*, 109883. https://doi.org/10.1016/j.rser.2020.109883

Li, H., Xu, X. L., Dai, D. W., Huang, Z.-Y., Ma, Z., & Guan, Y. J. (2020). Air pollution and temperature are associated with increased COVID-19 incidence: A time-series study. *International Journal of Infectious Diseases, 97*, 278-282.

Ma, Y., Zhao, Y., Liu, J., He, X., Wang, B., Fu, S., Yan, J., Niu, J., Zhou, J., & Luo, B. (2020). Effects of temperature variation and humidity on the death of COVID-19 in Wuhan, China. *Science of the Total Environment, 724*, 138226. https://doi.org/10.1016/j.scitotenv.2020.138226

Mahato, S., Pal, S., Ghosh, K. G. (2020). Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India. *Science of the Total Environment, 730*, 139086. https://doi.org/10.1016/j.scitotenv.2020.139086

MoHFW (2020). Ministry of Health and Family Welfare (MoHFW), Government of India. (2020). COVID-19 INDIA. https://www.mohfw.gov.in/

Maji, K., Dikshit, A., & Deshpande, A. (2016). Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India. *Cogent Environmental Science, 2*(1), 1-16.

Muhammad, S., Long, X., & Salman, M. (2020). COVID-19 pandemic and environmental pollution: A blessing in disguise? *Science of the Total Environment, 728*, 138820. https://doi.org/10.1016/j.scitotenv.2020.138820

Nižetić, S. (2020). Impact of coronavirus (COVID-19) pandemic on air transport mobility, energy, and environment: A case study. *International Journal of Energy Research, 44*(13), 10953-10961. https://doi.org/10.1002/er.5706

Pani, S. K., Lin, N. H., & RavindraBabu, S. (2020). Association of COVID-19 pandemic with meteorological parameters over Singapore. *Science of the Total Environment, 740*, 140112. https://doi.org/10.1016/j.scitotenv.2020.140112

Pansini, R., & Fornacca, D. (2020). Higher virulence of COVID-19 in the air polluted regions of eight severely affected countries. *medRxiv preprint*. https://doi.org/10.1101/2020.04.30.20086496

Perry, W. (2020, March 24). *Industry should not exploit COVID-19 to push more plastic pollution*. https://www.greenpeace.org/usa/news/industry-should-not-exploit-covid-19-to-push-more-plastic-pollution/

Polk, H. S. (2019). *State of Global Air 2019: A Special Report on Global Exposure to Air Pollution and Its Disease Burden*. Health Effects Institute: Boston.

Reconomy (2020, April 30). *Food waste: An opportunity for change*. Food Waste: An Opportunity for Change-RECYCLING magazine. https://www.recycling-magazine.com/2020/04/30/food-waste-an-opportunity-for-change/

Saadat, S., Rawtani, D., & Hussain, C. M. (2020). Environmental perspective of COVID-19. *Science of the Total Environment, 728*, 138870. https://doi.org/10.1016/j.scitotenv.2020.138870

Saha, J., & Chouhan, P. (2020). Indoor Air Pollution (IAP) and pre-existing morbidities among under-5 children in India: are risk factors of coronavirus disease (COVID-19)? *Environmental Pollution, 266*(2), 115250. https://doi.org/10.1016/j.envpol.2020.115250

Sajadi, M. M. Habibzadeh, P., Vintzileos, A., Shokouhi, S., Miralles-Wilhelm, F., & Amoroso, A. (2020). Temperature, humidity, and latitude analysis to predict potential spread and seasonality for COVID-19. *SSRN*. https://doi.org/10.2139/ssrn.3550308

Sarkodie, S. A., & Owusu, P. A. (2021). Impact of COVID-19 pandemic on waste management. *Environment, Development and Sustainability, 23*, 7951-7960. https://doi.org/10.1007/s10668-020-00956-y

Shakil, M. H., Munim, Z. H., Tasnia, M., & Sarowar, S. (2020). COVID-19 and the environment: A critical review and research agenda. *Science of The Total Environment, 745*, 141022. https://doi.org/10.1016/j.scitotenv.2020.141022

Shandra, J. M., London, B., & Williamson, J. B. (2003). Environmental degradation, environmental sustainability, and overurbanization in the developing world: A quantitative, cross-national analysis. *Sociological Perspectives, 46*(3), 309-329. https://doi.org/10.1525/sop.2003.46.3.309

Sharma, S., Zhang, M., Gao, J., Zhang, H., & Kota, S. H. (2020). Effect of restricted emissions during COVID-19 on air quality in India. *Science of the Total Environment, 728*, 138878. https://doi.org/10.1016/j.scitotenv.2020.13887

Sharma, H. B., Vanapalli, K. R., Cheela, V. R. S., Ranjan, V. P., Jaglan, A. K., & Dubey, B. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling, 162*, 105052. https://www.sciencedirect.com/science/article/pii/S0921344920303694

Silpa, K. (2020, April 9). *Waste workers are protecting our communities during COVID-19*. https://blogs.worldbank.org/sustainablecities/waste-workers-are-protecting-our-communities-during-covid-19#:~:text=Reacting%20to%20the%20rapidly%20evolving,have%20been%20generated%20by%20COVID

Singh, R. P., & Chauhan, A. (2020). Impact of lockdown on air quality in India during COVID-19 pandemic. *Air Quality, Atmosphere & Health, 13*, 921-928. https://doi.org/10.1007/s11869-020-00863-1

Singhal, T., (2020). A review of Coronavirus Disease-2019 (COVID-19). *Indian Journal of Pediatrics, 87*, 281-286. https://doi.org/10.1007/s12098-020-03263-6

Somani, M., Srivastava, A. N., Gummadivalli, S. K., & Sharma, A. (2020). Indirect implications of COVID-19 towards the sustainable environment: An investigation in Indian context. *Bioresource Technology Reports, 11*, 100491. https://doi.org/10.1016/j.biteb.2020.100491

Sukhsohale, N. D., Narlawar, U. W., & Phatak, M. S. (2013). Indoor air pollution from biomass combustion and its adverse health effects in central India: an exposure-response study. *Indian Journal of Community Medicine, 38*(8), 162-167. https://doi.org/10.4103/0970-0218.116353

Tyagi, S., Garg, N., & Paudel, R. (2014). Environmental degradation: Causes and consequences. *European Researcher, 81*(8-2), 1491.

Verma, A. K., & Prakash, S. (2020). Impact of covid-19 on environment and society. *Journal of Global Biosciences, 9*(5), 7352-7363. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3644567

Wang, J., Tang, K., Feng., K., & Lv, W. (2020). *High temperature and high humidity reduce the transmission of COVID-19*. SSRN 3551767.

World Health Organization (WHO) (2020). *Air pollution*. http://www.who.int/airpollution/en/

Wu, Y., Jing, W., Liu, J., Ma, Q., Yuan, J., Wang, Y., Du, M., & Liu, M. (2020). Effects of temperature and humidity on the daily new cases and new deaths of COVID-19 in 166 countries. *Science of the Total Environment, 729*, 139051. https://doi.org/10.1016/j.scitotenv.2020.139051

Zambrano-Monserrate, M. A., Ruano, M. A., & Sanchez-Alcalde, L. (2020). Indirect effects of COVID-19 on the environment. *Science of the Total Environment, 728*, 138813. https://doi.org/10.1016/j.scitotenv.2020.138813

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., Zhao, X., Huang, B., Shi, W., Lu, R., China Novel Coronavirus Investigating and Research Team, et al. (2019). A novel coronavirus from patients with pneumonia in China. *The New England Journal of Medicine, 382*, 727-733.

Zoran, M. A., Savastru, R. S., Savastru, D. M., & Tautan, M. N. (2020). Assessing the relationship between surface levels of PM2.5 and PM10 particulate matter impact on COVID-19 in Milan, Italy. *Science of the Total Environment, 738*, 139825. https://doi.org/10.1016/j.scitotenv.2020.139825