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Review Article

A Review of the Coronavirus Outbreak and its Effects on India's Natural Environment

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ABSTRACT:
The phrase "coronavirus" was, without a question, the most googled and uttered phrase in the past three years. As the spread of the coronavirus (COVID 19) has increased, various countries had imposed a lockdown that restricted human mobility, and a ban on all types of social activities. This also influences various economic activities. With all the financial and health concerns, the influence of the pandemic lockout on the natural environment was something that the scientific community should be concerned about. The influence of many significant good and evil effects on the environment in several areas of India is reviewed and discussed in this paper. Different regions in India showed an improvement in air quality, a decrease in noise pollution, and wildlife more pleasant and relax than before. Aquatic ecosystems revealed indications of restoration. On the other hand, the rise in plastic waste like personal protective kits (gloves and masks), biomedical waste, disinfectants, and their mismanagement have long-term terrible impacts on the environment. However, as India gradually returned to pre-pandemic conditions, the positive environmental effects will fade as festivals, public transport, growing production, and agricultural activities may raise pollution to critical levels. Hence, Pollution Control Boards and National Health Programmes should integrate the approaches acquired during the pandemic to help foster social cognitive lifestyles, policy interventions, and the development of advanced smart cities that will safeguard individuals from pollution.

Keywords: COVID 19, Air Quality, Water Quality, Wildlife, Noise pollution, Biomedical Waste.

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INTRODUCTION

Due to the scale of illnesses and the number of fatalities it has caused, the phrase "coronavirus" has become the most spoken and contested issue on the planet. In December 2019, a case of unusual pneumonia was documented in Wuhan (China). The clinical symptoms discovered were identical to those of viral pneumonia in the Republic of China (Chan et al., 2020). The World Health Organization (WHO) has designated the coronavirus infection as 'COVID-19'. The International Committee on Virus Taxonomy termed the virus "Severe Acute Respiratory Syndrome Coronavirus 2" (SARS-CoV-2) (Burnell et al., 2016).

Coronavirus occurs in different forms having variations in size, shape, and nuclei of their cells. The shape is roughly rounded withinflated surface projections that resemble crowns. The diameter ranges around 120nm. The membrane, spike structural proteins, and envelope are all bound in the lipid bilayer of the virus membrane. The nucleocapsid, which is made up of several duplicates of the nuclear protein, is situated inside the envelope. The respiratory system is the most impacted, as the virus enters the host cell through the enzyme ACE2, which is found inalveolar cells. Most patients are asymptomatic and only develop minor symptoms. Artificial ventilation is needed for the patients, approximately 7-8 days following the appearance of symptoms (Kripalani et al., 2020). Coughs, extreme physical pain, and a high temperature are the early indicators, which later worsen and cause a serious infection in the lungs, terminating in death (Holshue et al., 2020; Perlman 2020).

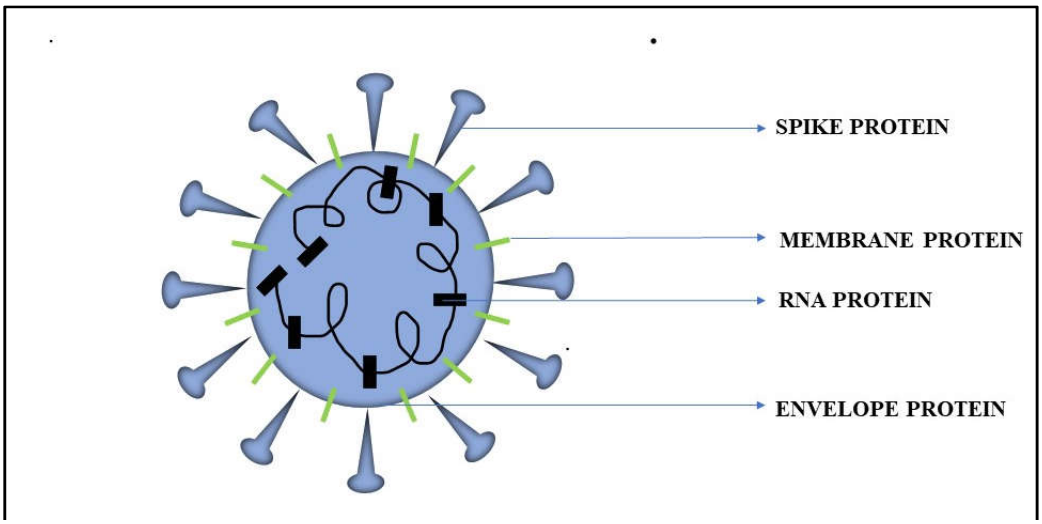

Figure 1: Schematic Diagram of coronavirus

Due to this unique infectious sickness, the World Health Organization (WHO) has declared a global health emergency. There were 1,279,722 verified infected patients and as of April 8, 2020, there have been 72,614 total casualties. (Sahin 2020), which prompted WHO to call for extreme measures to combat the illness, including the establishment of social distance to be limited. The first verified positive case in India was recorded on January 30th in a student from Kerala's Thrissur district who had returned for a holiday from Wuhan University. Later, six new cases were reported in Maharashtra and Kerala. In India, the 50th Covid-19 case was filed 41 days after the first case on January 30 (India Today, 2020). The Ministry of Health and Family Welfare (MOHFW) documented 10,815 positive cases and 358 fatalities in 32 Indian states as of April 14th, 2019. Figure 2 shows the number of confirmed cases and death cases up to 15.02.2022 in different states of India (MOHFW, 2020).

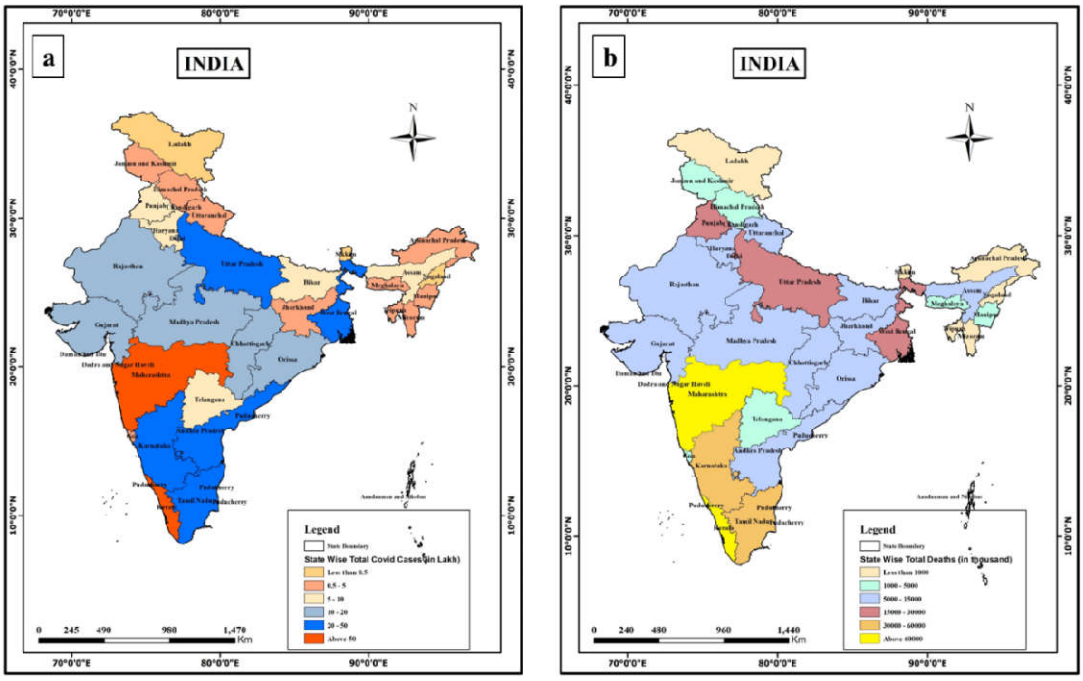

Figure 2: Maps showing state-wise (a) confirmed cases and (b) death cases

Several actions have been implemented to limit the transmission of COVID-19 during this stage of the global pandemic (Gautam and Hens, 2020). Containment strategies include quarantine, travel bans and limitations, social distance enforcement, and lockdown (closing of public venues and termination of public events). Containment measures that were put in place to mitigate the health implications of the worldwide pandemic have affected the sustainability of the environment and economic growth. While various studies have investigated COVID-19's impact on the environment (Gautam and Trivedi, 2020).

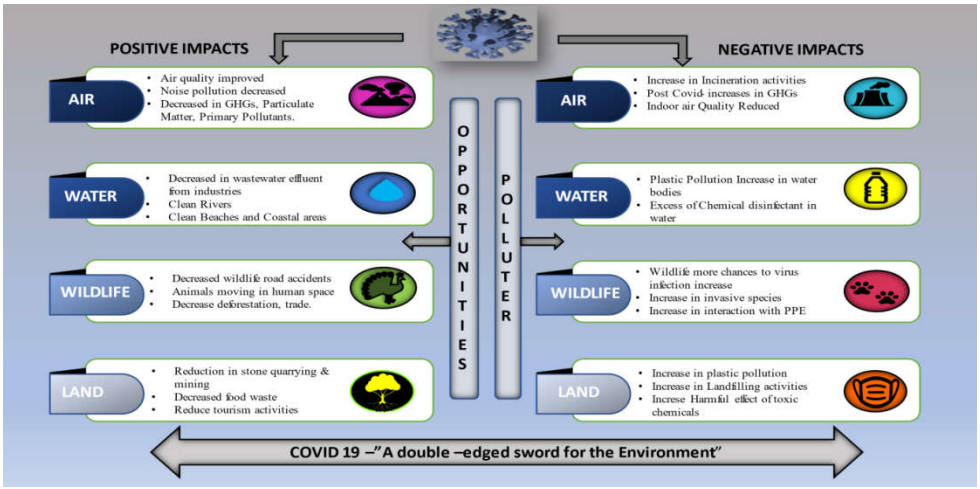

Figure 3: Impact of Covid 19 on the Environment

The findings of this study can help policy makers to recognize difficulties and to introduce new legislation as early as possible to maintain a sustainable environment. Figure 3 displays COVID-19's impacts on various environmental compartments, which is discussed later in this article.

METHOD

Literature research

Published articles from online databases like Web of Science, PubMed, and Google Scholar are included in this study. The keywords used for searching in databases were COVID 19, India, environment, impacts, air quality, water pollution, wildlife, biomedical, and plastic waste. Research articles related to the impacts of COVID-19 on the Indian natural environment in all respect are searched for inclusion. Some reports from organizations or agencies are also used. For final eligibility, the complete text of selected relevant articles was examined independently.

Inclusion and Exclusion Criteria

Regardless of language, all forms of publications are evaluated. In this review, the studies included that focus on COVID 19 and its effect on the environmental quality in different regions of India. Reports and articles not related to COVID-19 impacts on the Indian natural environment are excluded. Updated reports by the agencies like WHO, CPCB, and other environmental agencies are also included in this article.

RESULT AND DISCUSSION

A total of 55 articles related to impacts on environmental compartments of India are included in this study to cover all the aspects Covid-19 related to the environment.

Positive and short-term impacts of Covid 19 on the Environment:

COVID-19 spreads mostly through large groups of people and close touch, especially in socio-cultural get-togethers or job workplace places, hence the World Health Organization (WHO) advises a six-foot social distancing (Singh and Mishra, 2021). To tackle COVID19, a lot of nations affected by the virus have deployed necessary counter measures, like lockdown. Hotspots have been properly sealed and closed, resulting in less unwanted movement. In addition, India's absolute closure, combined with social isolation, aided in the breakup of the COVID-19 transmission chain (Srivastava, 2020). Since the dawn of civilization humans have gradually begun to alter the environment for their gains. Industrialization devastated more than 85 % of wetlands and more than 100 million hectares of tropical forests between 1980 and 2000.Human activities significantly polluted all environment segments (Akimoto, 2003; Schlacher et al., 2016).

Many human activities and industrial operations were halted during the lockdown to avoid social contact. Multiple favorable environmental implications of lockdown due to Covid 19 have been observed, such as reduced air pollution, improved water quality, and low noise pollution (Ghosh, 2020).

Air quality

According to the World Health Organization (WHO), exposure to air pollution kills 7 million individuals worldwide annually, and more than 80% of people living in cities are subjected to pollution exposure (Khan et al., 2021). One of the most dangerous pollutants is particulate matter (PM) 2.5. It's a carcinogenic classified as group I. The 2.5 refers to a specific size (in microns) that is roughly one-thirtieth of the width of a human hair (Xu and Ren, 2019). Anthropogenic aerosols make a significant contribution to unhealthy levels of air pollution in many Indian cities every year. Aerosols are microscopic solid and liquid particles dispersed in the air that reduce visibility and harm the lungs and heart of humans. Volcanic activities, wildfires, and dust storms are all-natural sources of aerosols. Figure 4 shows the map showing aerosol optical density (AOD) monitored by the National Aeronautics and Space Administration (NASA) during the same period from March 31stto April 5th for the year 2016 to 2020 in Northern India and found first

time reduced in the year 2020 since the last 20 years (NASA 2020).

Air pollution in India's major cities such as Delhi, Kolkata, Lucknow, and Bengaluru had significantly decreased during a pandemic. According to government data, in Delhi, the average concentration of PM 2.5 fell by 71% in a week after the lockdown began (Wright 2020). Also, a study has shown that due to the lockdown, the air quality rate in the Delhi area has been improved as compared to other areas. These results were based on data gathered from the Central Pollution Control Board's (CPCB) 12 air monitoring locations. The concentration of nitrous oxide (NOx) declines from 342 ppb on 12-01-2020 to 24 ppb on 30-03-2020 in CRRI-Mathura Road, Delhi. Data analysis indicates a sharp fall in $PM_{2.5}$ and PM_{10} concentration nearly by 200%. Figure 5 reveals the levels of PM_{10}, $PM_{2.5}$, CO, and NO_x before and after the three weeks of lockdown dated 16th March 2020 at 4 different sites in Delhi (Kotnala et al., 2020).

Despite the economic slowdown, the lockdown has been a blessing for the environment which has been restored because of reduced pollution. This should serve as a reminder for decision-makers, allowing them to tactically harmonize humans, economic growth, and nature (Debata et al., 2020).

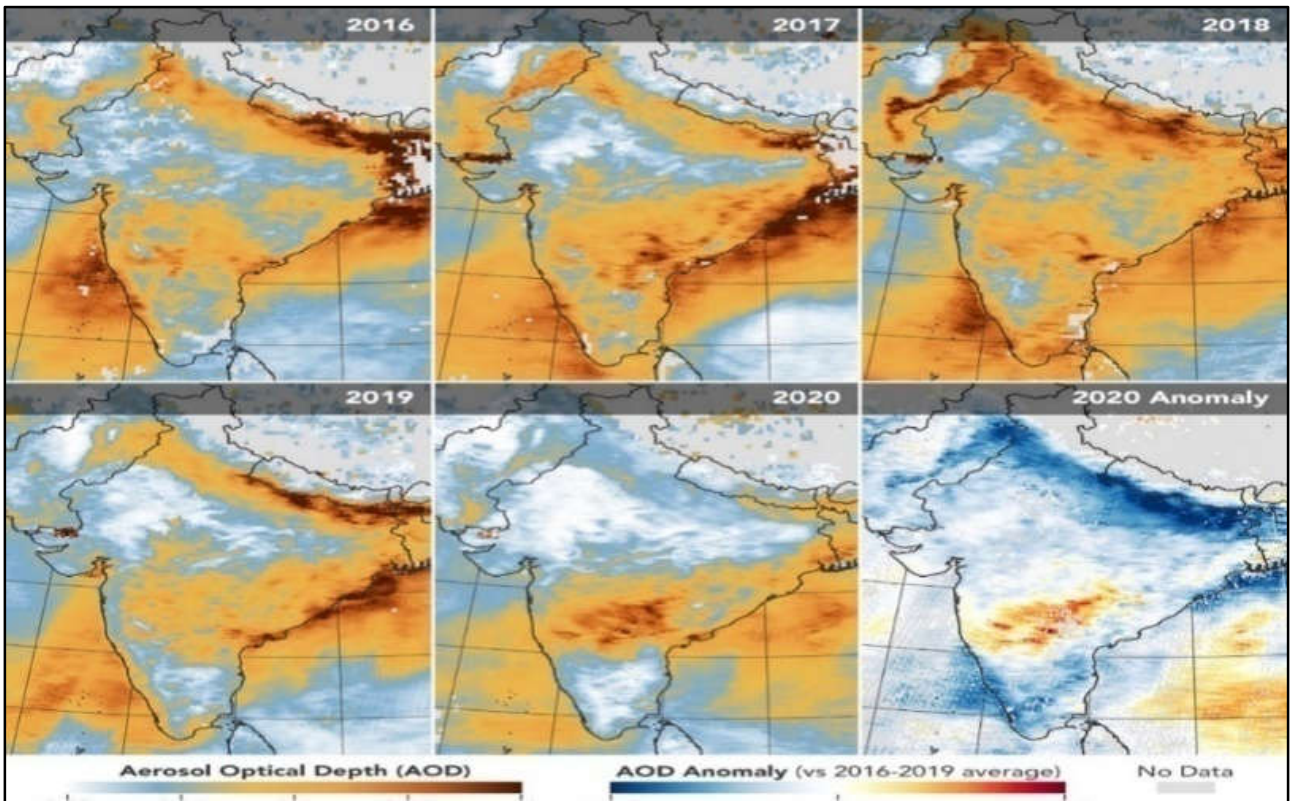

Figure 4: Shows the map of aerosol optical density (AOD) monitored by the National Aeronautics and Space Administration (NASA, 2020)

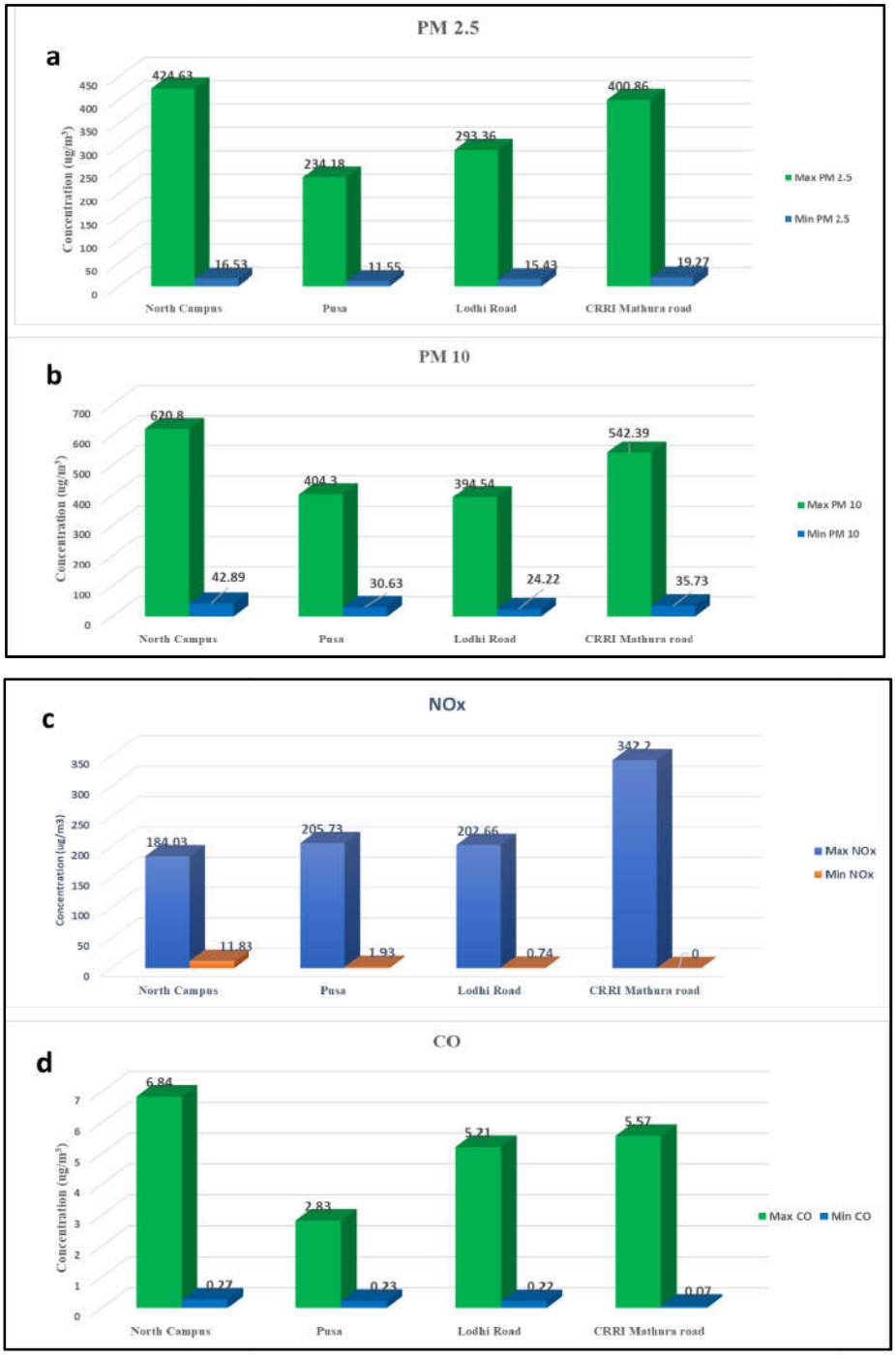

Figure 5: Shows concentration of PM2.5, PM10, NOx, and CO during the lockdown in Delhi (Kotnala et al., 2020)

Water quality

During the pandemic, as the discharge of toxic chemicals from industrial activities, tourism, and water activities reduced, it imposed good impacts on water quality. Waterbodies showed indications of restoration. The quality of the surface water in India's longest freshwater lake, Vembanad, has improved in terms of suspended particle matter (SPM).For this study, remote sensing photographs (Landsat-8OLI) were used. The results indicated that the presence of SPM during the shutdown period was 15.9% lower on average than before the lockdown. SPM levels were also reduced in 18 of the lake's 20 zones (Yunus et al., 2020). If manmade activities and wastewater are managed effectively through environmental monitoring, the water ecosystem can be recovered. Water quality notably upgraded by 40% to 50% of Hooghly River (Ganges) Estuary, West Bengal. A difference was noticed in the concentration of dissolved heavy metals Cadmium (50%) and Lead (53%).Also decline in BOD, TDS, fecalcoliforms, and total coliforms was also observed (Chakraborty et al., 2021).

The CPCP and SPCB's conducted water quality assessments of major Indian rivers. The upper and lower limits of DO, BOD, and FC values were observed in rivers during the pre-lockdown (March 2020) and lockdown (April 2020) period. Due to less discharge of industrial wastewater during the shutdown period, prohibition of human activities like open bathing, religious activities, disposal of consecrated materials, vehicles and cattle and clothes cleaning, etc. Livestock mobility was also significantly reduced, leading to less microbial contamination of lakes and rivers. The report shows that the water quality of seven rivers namely Brahmaputra from (87.5% to 100%), Brahmani (85% to 100%), Godavari (65.8% to 78.4%), Krishna (84.6% to 94.4%), Cauvery (90.5% to 96.97%), Tapi (77.8% to 87.5%), Yamuna (42.8% to 66.67%) has enhanced (CPCB 2020).

Wildlife

In lockdown, wild creatures and uncommon species have taken over the empty locations as humans self-isolate and quarantine themselves resulted in decrease noise pollution, less traffic, and improvement in air quality. During this pandemic, prohibitions lowered the number of people visiting natural areas, thus relieving stress on wild animals (Corlett et al., 2020). Swallows sang, sparrows chattered, doves cooed, this music brought joy to nature enthusiasts who had been depressed by the coronavirus tragedy and lockdown issues (Yuhas, 2021). Wild animals have been reported coming over to cities, towns, and urban clusters in many regions of India during the lockdown. An elephant was reported to have come down strangely near Hari ki Pauri in Haridwar, Uttarakhand. A leopard has been spotted in Almora. Sambar deer, spotted deer, and elephants had invaded Karnataka villages. In Maharashtra, people have reported seeing a lot of mongooses, porcupines, and civet cats in their localities. (Balasubramanian, 2020).

The Wildlife Institute of India released real-time data through the app called "Lockdown Wildlife Tracker" shown in Figure 6 to share safe wildlife mobility in human-restricted areas. During the lockout, this free open-source software made it easy to monitor the movement of animals. The photographs can be shared by anyone in the world and all data in this app can be saved and made publicly available for education, protection of wildlife, and research purposes (Wildlife Institute of India 2020).

Figure 6: Wildlife Tracker App by Wildlife Institute of India

According to a report, spotting Gangetic dolphins wasn't uncommon 30 years ago. They used to inhabit the Kolkata ghats, but because of industrial contamination released into the river, they gradually moved away from the city. Because of the lockdown, the quality of the Hooghly River improved dramatically, causing the dolphins to return after 30 years (Times of India 2020). Grey Langurs move along a lonely road in Ahmedabad, India, on 19 April 2020, and Peahens were sitting on Motilal Nehru Marg of New Delhi, India. Figure 7 shows the piece of evidence of the pandemic giving space to wildlife to move in urban areas(The Guardian 2020).

Figure 7: Shows wildlife in urban areas during lockdown-Peahens on Motilal Nehru Marg in New Delhi, India, on 19 April 2020.

Noise Pollution

Due to the noise exposure from industrial activities, trains, traffic, and airplanes millions of individuals in metropolitan areas are believed to be at threat of noise-induced hearing impairment. Besides hearing impairment, chronic exposure to noise levels much higher than 50 decibels has been demonstrated to produce unpleasant, generally hidden side effects. Increased blood pressure and mental stress increase the livelihood of depression, associated with decreased cognitive health (Sims, 2020). According to the World Health Organization (WHO) the issue of noise pollution is a significant one for the public. It has detrimental consequences for human health, and it has become a significant cause of worry (WHO, 2018).

According to accumulating data, most Indian cities are at risk of greater noise exposure which has resulted in negative implications for human health. Nevertheless, the enforcement of the pandemic social lockdown had drastically decreased the density of traffic and cultural gatherings which impacted the noise pollution levels. During the lockdown phase, noise levels at six sampling sites in Kanpur dropped dramatically. Daytime, the noise levels were measured to be significantly greater than those during the nighttime in all zones when comparing day and night sound equivalent dropped by an average of 9 decibels, while in the pre-lockdown and unlock stages, the average reduction was roughly 15 decibels in all zones monitored (Mishra et al., 2021).

In India, festivals are extremely important. Every religion celebrates its own culture with great enthusiasm. Most of these celebrations end up polluting the environment, particularly noise pollution. Ganesh Utsav is by far the most important and biggest celebration in Maharashtra, notably in the city of Mumbai. But during a pandemic, the city experienced a simple festival celebration, due to restrictions and guidelines imposed by the state government. There were fewer pandas and a smaller number of people celebrating the event pandas, which resulted in a reduction in noise pollution. The noise level was measured during the Ganesh festival in the years 2018, 2019 and 2020. It was estimated that in previous years, noise levels (Leq) reached 102 dB and 80.5 dB respectively and that in the year 2020,the maximum level of festive noise reached 73.7 dB (Kalawapudi et al., 2021). This pandemic can be used to design new norms and laws aimed at reducing various pollution and promoting ecologically friendly festival celebrations. This is at the turning point for society, as it shows that to enjoy festivals, vacations, or any ceremonies people can try to forgo prior practices that may have resulted in pollution of many kinds.

Negative and long-term impacts on Environment:

The impacts of the Covid-19 lockdown were mixed with some improvements and some downsides for the environment. Below is the overview of Covid-19 adverse impacts on the environment.

Biomedical and Plastic waste generation

Pathogenic microbial communities constitute a biomedical waste. During the treatment of COVID-19 patients, a range of medical services and equipment were required, resulting in the generations of medical waste such as disposable PPE kits, face masks, face masks, medicines, dressing materials, serum, blood samples, and so on (Haque et al., 2021)**.** Deleterious impacts of a pandemic have resulted in anenormous increase in medical waste, causing a serious threat to the environment and human health. During the outbreak, hospitals produced a substantial amount of contagious and biomedical waste every day, but before the pandemic, trash generation was much less (Saadat et al., 2020). In India, medical and healthcare centers, hospitals, isolation wards, outpatient sections, and other sections produce about 517 tonnes of biomedical waste per day (Anwer and Faizan 2020). Hospitals are expected to produce roughly six times more medical waste during the COVID-19 era than they did before the pandemic (Ranjan et al., 2020). Figure 8 shows the status of biomedical waste in India obtained from CPCB during the month from July 2021 to December 2021(CPCB 2021).

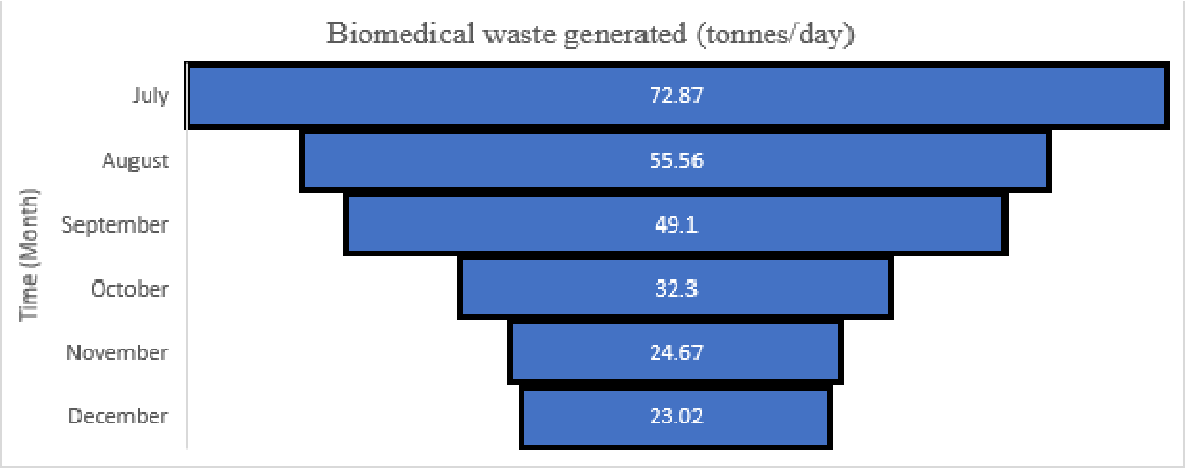

Figure 8: The volume of biomedical waste generated during the pandemic from July to December 2021 (CPCB)

According to the report of "The Hindu", the pandemic of COVID-19 has led to the production of more than eight million tonnes of plastic garbage worldwide, with over 25,000 tonnes of it ending up in the oceans (The Hindu, 2021). Biomedical waste increased by 17% in India during the pandemic, with most of it being plastic. The polymers polypropylene (23.4%) and polyester (15.3%) in personal protective equipment were confirmed by FTIR-ATR analysis (Robin et al., 2021).

For every 1000 covid-19 tests, about 22 kg of plastic trash is generated while using PCR procedures (CPCB 2020). Reverse transcription-PCR (RT-PCR) has been demonstrated to yield 37.27 g of plastic waste per sample, according to evidence (Celis et al., 2021).

Table 1: Summary of other research articles revived for this study

Impacts of Covid 19 lockdown on water quality			
References	**Purpose of the study**	**Study Area**	**Key Findings**
(Aswathy et al., 2021)	To evaluate the suspended particulate matter via remote sensing photographs	Asthamudi lake(Tropical Ramsar site), South India	Reduction in SPM concentration as during lockdown was (mean 8.01 mg/l) less than pre lockdown (mean 10.3mg/l).During the shutdown noticeably, decrease in 43% SPM concentration as compared to the last five years.
(Aravinthasamy et al., 2021)	To study the shallow groundwater microbes and heavy metals of industrial cities.	Coimbatore city (South India)	Reduction in E. coli, Faecal coliform, total coliform, and the amounts of Ni, Mn, Cr, and Pb was over the acceptable limits for potable water as per WHO except Fe during lockdown
(Aman et al., 2020)	A case study to assess the improvement in air and water quality	Ahmedabad City, India	Lands at 8 OLI photographs of Sabarmati River, reveal that the mean SPM concentration was 8.08 mg/l during the lockdown. Also, improvement in air quality in

			terms of $PM_{2.5}$, PM_{10}, and NO_2 was observed.
(Panja et al., 2022)	To study the impact of 2nd wave lockdown on water quality and total alkalinity	Diu, Indian west coastal area	Sudden changes were observed in physicochemical parameters like pH, salinity, phosphate, nitrite, and nitrate. During April 2021 reductions in different bacterial counts were seen. A principal component analysis (PCA) plot was used to show the changes in various water quality parameters.
(Kaur et al., 2021)	To evaluate the water quality of polluted stretch with the help of cluster analysis	Tawi River Jammu, North India	Altogether, the water quality at the river during shutdown was good, with a class B grade-pH (7.0-8.5), hardness (84.25-177.5mg/L), alkalinity (23.25-185.0mg/L), conductivity (117-268ms/cm)
(Chakraborty et al., 2021)	In Eastern India's industrial zone, eco-restoration of river water quality took place.	Damodar River (Border of Jharkhand and West Bengal)	The WQI valves showed very poor and unfit for drinking purposes at some stretches. The nutrient content evaluated by Trophic State Index (TSI) showed high algal blooms in the overall stretch while a reduction in total nitrogen and Total Phosphate.
(Mandal and Pal, 2020)	To examine lockdown impacts on the environment as shutdown on stone mining and crushing zone	Dwarka river basin (eastern India)	The total dissolved solids of the Dwarka river were found to be reduced. Noise level decreased to < 65dBA which was earlier above 85dBA.Land surface temperature declines by 3-5°C.In pre lockdown period maximum PM_{10} concentration was 189 to 278 ug/m3whileduring lockdown it was 50-60ug/m^3[30]
Impacts of covid-19 on wildlife			
(Behera et al., 2022)	To study the impact of Covid-19 on wildlife	Deccan Plateau, India	Both positive and negative impacts were found on wildlife. Reduced human interruptions encouraged wildlife to take advantage of new habitats and boost daytime activities while at some places illegal wildlife operations were also witnessed.

Learnings from the coronavirus outbreak

Despite its fatal effects, Covid-19 has good environmental consequences that could serve as a lesson and motivation for future human behavior towards nature. The prevailing pandemic revealed a strong link between environmental contamination and commercial activities (Cheval et al., 2020). The pandemic showed us that using environmentally sustainable energy-based technologies and compostable waste is significantly more

advantageous. We gained optimism throughout the lockdown time that there are ways to reduce wasteful anthropogenic activity in the environment (Singhal 2020). Individuals and organizations can design and execute strategies to obtain beneficial environmental changes. (Silva et al., 2021). Therefore, key approaches such as sustainable and green industrialization, adopting renewable energy, and proper waste management methods are urgently needed (Cheval et al., 2020).

a. Nature can recover.
b. To avoid future zoonotic diseases, the wildlife trade must be stopped.
c. It is possible to achieve rapid improvements in air quality.
d. Coronavirus and other human diseases are associated with various environmental pollutions.
e. The environmental movements must be revived.
f. Environment awareness campaign must be conducted

Covid-19 might be regarded as a "late lesson from an early warning". Pandemics are more likely when the environment is degraded. Covid-19 outbreak arose from the complicated interaction of change factors such as environmental disruptions, industrialization, urbanization, overseas travel, global warming, and climate change. Human wellbeing and environmental protection are inextricably linked. To rebuild better, citizens and governments must determine what should be done differently and what should be avoided completely (European Environment Agency 2022)

CONCLUSION

SARS-CoV-2 wreaked havoc on the world economy, reducing GHG emissions, reduction in energy consumption, and CO_2 emissions, which have caused several impacts on the natural environment. As a result of the pandemic outbreak, many countries were put on lockdown, forcing citizens to stay at home. In this current era, the environment has several benefits and drawbacks. Several of these acts were observed in different regions in India during the lockdown.

1. Ambient air pollutants concentrations in the environment were lowered.
2. Due to decreased in commercial activities and traffic resulted in less noise pollution.
3. River water quality has also improved significantly by the reduction of various anthropogenic activities.
4. Wildlife seemed to be flourished more peacefully than before.
5. The release of microplastic may be the most important environmental issue. Plastic and municipal solid wastes were improperly disposed of causing havoc in the land and water ecosystems.
6. Biomedical waste generation increased which caused a burden on solid waste management workers.

Positive changes in the environment are likely to be transient, thus developing a more robust conserving mechanism will be critical. This will not only aid the wildlife but also benefit mankind. There is a growing recognition that safeguarding the environment is our best defense against future pandemics. Hence to avoid future pandemics and reconstruct our balance in the ecosystem, people must make decisions and manage vast swaths of land and oceans, as well as sustainably manage the rest of the planet in a well-organized way.

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