COMMENTARY

Environmental Impacts of COVID-19 Lockdown: National and Global Scenario

Ekta Gupta[1], Vartika Gupta[1], Mariya Naseem[1], Prem Prakash Singh[1], Sampurna Nand[1], Neha Jaiswal[1], Sunil Tripathi[2], Anju Patel[1], Pankaj Kumar Srivastava[1*]
DOI: 10.18811/ijpen.v8i01.01

Abstract

The unforeseen COVID-19 has spread over the world, affecting almost 5 million people in 213 countries. Lockdown measures have been implemented in several nations, limiting people to their homes and substantially curtailing economic and social activity. The implementation of lockdown halted all the industrial, social, and commercial activities, and had a positive impact on environmental parameters viz., air, water, noise, biodiversity, and wildlife. The decrease in PM_{10}, $PM_{2.5}$, CO, NO_2 were recorded with an average value of 43, 31, 10, and 18%, respectively because of the reduction in transportation and industrial emission in India. Considerable recovery of water quality in lotic ecosystems was observed at several places in the world. Due to the COVID-19 outbreak, the global lockdown has also dropped the noise level ranging from 2.1 dB to 6 dB at several places viz., Europe, Colombia and USA. Wildlife and biodiversity of the world had responded to the COVID-19 shutdown. Human movements in national parks and metropolitan cities through vehicles and other transportation have decreased by 75% to 95%, due to which various wildlife and other creatures had faced fewer human interferences. During the pandemic, China and Lebanon had produced 240 metric tons and 1.3 tonnes of biomedical waste, respectively per day. India has generated around 28,747.91 tonnes of biological waste during the pandemic lockdown. The global pandemic lockdown has given Mother Nature a chance to replenish, but the policy and strategies are required immediately for the confinement of biomedical waste generation and further scientific management.

Keywords: COVID-19, Environment, Impact, Lockdown.

International Journal of Plant and Environment (2022); **ISSN:** 2454-1117 (Print), 2455-202X (Online)

Introduction

In recent decades, concerns about the environment have become one of the most popular subjects among people. The globe has grown overly crowded and filthy because of population growth. People pollute the environment with harmful produced compounds by utilizing natural resources.

COVID-19 is one of the pandemics which has turned out as a devastating and severe threat with a rapidly increasing death toll in society within a very short time. It has put humans in adverse conditions with major societal changes including restrictions to their current lifestyle. COVID-19, a global epidemic (pandemic), reported by World Health Organization (WHO) in March 2020 has emerged throughout the world as one of the deadlier and highly transmissible diseases (WHO, 2020). It has infected a large number of people around the world. This disease has affected a total of 277,523,045 persons from 224 nations as of December 2021 (Worldometer, 2021). The disease is associated with the dreadful respiratory illness caused due to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (Xu *et al*., 2020).

Numerous ways were adopted for early detection of disease but the widely acknowledged detection method includes the quantitative real-time reverse transcription-polymerase chain reaction (qRT-PCR) (Kumari *et al*., 2021). To minimize the effect of this infectious disease, many countries in the world imposed the lockdown. Huang *et al.,* (2020) stated that the outbreak of this major health calamity came into existence from the Wuhan seafood market.

The novel corona virus has not only affected human health but also led to an irretrievable loss to the nation's economy after the global financial crisis of 2008-2009 (Chakraborty and Maity, 2020). Contrary to all these catastrophic impacts of COVID-19 on humans, worthwhile changes were also observed in the environment around the world. These changes were the result of restricted activities due to the partial and complete lockdown in various countries. The shutdown of industrial projects, transportation, aviation, travel and tourism, multipurpose projects, boarding, and lodging, resulting in a noticeable impact on the environment. Many researchers stated that the lockdown has a considerable influence on air and water quality. However, both positive and negative environmental consequences were observed due to lockdown (Fig. 1).

[1*]Department of Environmental Technologies, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh , India

[2]ENVIS-RP, CSIR-National Botanical Research Institute, Lucknow, Uttar Pradesh, India

***Corresponding author:** Pankaj Kumar Srivastava, Department of Environmental Technologies, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India. Email: drpankajk@gmail.com

How to cite this article: Gupta, E., Gupta, V., Naseem, M., Singh, P.P., Nand S., Jaiswal N., Tripathi S., Patel A., Srivastava P.K., Environmental Impacts of COVID-19 Lockdown: National and Global Scenario, International Journal of Plant and Environment (2022).8(1)1-9

Conflict of interest: None

Submitted: 20/01/2022 **Accepted:** 22/02/2022 **Published:** 25/03/2022

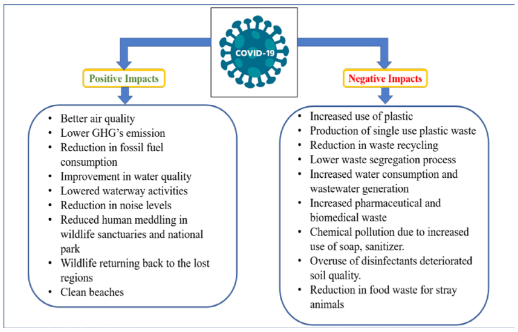

Fig.1: Positive and Negative environmental impacts of COVID-19 lockdown.

Fig. 2: During the lockdown, view of the clear sighting of the Himalayan mountain ranges from (a), Saharanpur, Uttar Pradesh, India (Source: @DushyantKSaini/ Twitter; https://indianexpress.com/article/trending/trending-in-india/snow-capped-himalayas-visible-from-uttar-pradeshs-saharanpur-photos-go-viral-after-cyclone-tauktea-7324268/) and (b) Jalandhar, Punjab, India (Source: https://www.sbs.com.au/language/english/audio/himalayas-visible-for-first-time-in-30-years-as-pollution-levels-in-india-drop)

Environmental issues have been a severe problem since the industrial revolution, although not being managed. Despite the global focus, no long-term durable solutions have yet emerged as solutions to environmental problems viz., deteriorated air, water quality (Ukaogo *et al*., 2020). However, the pandemic resulted in a partial restoration of previously existing environmental conditions due to restricted industrial activity arising because of lockdowns. The consequences of lockdowns arising due to COVID-19 on various segments of the environment have been discussed in this article.

Assessing the Effect of Lockdown on Air Quality

The COVID-19 pandemic has ceased both ground and air travel. Due to which, the year 2020 has shown the major changes in air quality since the beginning of COVID-19 because of reduced emissions from various sources (Gautam, 2020). Several studies were conducted by researchers to study the impact on the air quality of the atmosphere during the lockdown and comparative analysis from the pre-lockdown atmospheric conditions.

The adage behind lockdowns is to curtail the transmission of COVID-19 disease among the human population. Restriction in human activities is directly correlated with reduced emissions from vehicular and industrial sectors. As companies, transportation, and campaigns have stopped down, there has been a noticeable drop in Green House Gas (GHGs) emissions. Because automobiles and people were both inside the dwellings, air pollution had lessened. It was calculated that the closure of heavy industries resulted in a roughly 50% drop in N_2O and CO emissions and that NO_2 emissions from fossil fuel combustion are also showing signs of reduction in several nations (e.g., U.S., Canada, China, India, Italy, Brazil, etc.). It is the most important indicator of global economic activity (The Times of India, 2021).

Air quality data of six major air pollutants namely carbon monoxide, sulfur dioxide, particulate matter (size of 2.5 and 10 µm), and ozone showed a declining trend when compared with the data of 2019 obtained from the Central Pollution Control Board. Although, Nigam *et al.* (2021) reported an increment in O_3 concentration in Akhileshwar and Vapi cities of Gujarat, India due to an 80% reduction in NO_2 concentration. However, with the ease of restrictions after lockdown, the pollutant level in the air starts building up. Sharma *et al.* (2020) reported reduced emission in 22 Indian cities by studying six criteria pollutants including PM_{10}, $PM_{2.5}$, CO, NO_2 with reduced emissions by 43, 31, 10, and 18%, respectively, while there was a 17 percent increase in O_3 concentration, there were no significant changes in SO_2

Table 1: Studies showing comparative data of air quality during the Covid-19 pandemic lockdown.

Study Locations	*Methods / Sources*	*Air Pollutants*	*Observations*	*References*
Western Europe	Modeling system	NO_2, $PM_{2.5,10}$ and O_3	Decreased NO_2 (-30 to -50%) and PM (-5 to-15%) level, Increased O3 level.	Menut *et al.*, (2020)
Ecuador (South America)	Statistical parametric approach	NO_2, $PM_{2.5}$, and O_3	NO_2 (avg 5.6 and 4.8 times less from 2018 and 2019), $PM_{2.5}$ (avg 1.5 and 1.6 times less than 2018 and 2019), O_3 (increased 1.5 times and double in 2018 and 2019).	Zambrano and Ruano (2020)
Palermo (Italy)	Monitoring stations	CO, NO_2, O_3, and $PM_{2.5}$	CO, NO_2, O_3 decrease by 51%, 50%, and 45% respectively. No reduction in O_3 due to non-linear chemical effects.	Vultaggio *et al.*, (2020)
China	Remote sensing and Ground-based in situ data	NO_2, SO_2, CO, O_3, $PM_{2.5}$, and PM_{10}	Reduction in all with the factor of 2 or more except O_3.	Fan *et al.*, (2020)
Rio de Janeiro (Brazil)	Automatic monitoring stations	NO_2, CO, and O_3	Decrease in CO and NO_2 levels, increase in O_3 concentration	Dantas *et al.*, (2020)
Baghdad (Iraq)	Copernicus open data access hub	NO_2, O_3, $PM_{2.5}$, and PM_{10}	NO_2 reduced by 35to 40%, increased O_3, $PM_{2.5}$, and PM_{10}	Hashim *et al.*, (2021)
Chittagong, Bangladesh	Statistical evaluation	PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO	Except for NO_2 and SO_2 other pollutants showed a decreasing trend.	Masum and Pal (2020)

concentration. The ambient air quality regarding $PM_{2.5}$ in India has improved from 58.1 μg/m^3 in the year 2019 to 51.9 μg/m^3 in the year 2020 (World Air Quality Reports, 2019 & 2020). The positive impact of the reduced emission in India was seen in April 2020 as the sight of the Himalayan Dhauladhar Mountain ranges, with their snow-capped peaks visible from the rooftops of the residents of Jalandhar, Punjab, India which is a plain topography area (Fig. 2). Also, the residents of Saharanpur, Uttar Pradesh, India were able to see the Bandarpoonch mountain range in the Garhwal region of Uttarakhand, India, which stands at 6313 meters above sea level and has snow-capped peaks that gleam in the setting sun. This scenario is claimed to have been seen after three decades in India (Roy and Chaube, 2021). Table 1 shows comparative data of air quality during the Covid-19 pandemic lockdown.

Due to quarantine, NO_2 levels in Wuhan and China were lowered by 22.8 and 12.9 g/m^3, respectively. $PM_{2.5}$ levels reduced by 1.4 g/m^3 in Wuhan, but by 18.9 g/m^3 in 367 cities. All these improvements in air quality have resulted in human health gains in China, which have so far exceeded verified SARS-CoV2 death (Chen *et al*., 2020).

In comparison to the same period in 2019, NO_2 levels in Chinese cities and Western Europe/the United States of America reduced by 40 and 20-38% respectively, throughout the complete lockdown period (January-April, 2020). The NASA Earth Observatory (2020) found a 6% drop in NO_2 concentration over the world.

Mostafa *et al.,* (2021) used data from the National Aeronautics and Space Administration (NASA) and the European Space Agency Satellite of the lockdown period in 2020 to compare air pollution levels to the specified baseline time (2015-2019). The Absorbing Aerosol Index (AAI) declined by 30%, NO2 decreased by 15% and 33% in Cairo and Alexandaria, respectively, and CO decreased by 5% in both governorates. Furthermore, during the epidemic, Egypt's greenhouse gas (GHG) emissions were lowered by at least 4%. In the governorates of Cairo and Alexandaria, however, O_3 levels climbed by 2%.

Based on the COVID-19 cases (as of June 2020), Gope *et al.* (2021) identified the most polluted cities on a global scale and revealed air pollution data (i.e., particle pollution, ground-level ozone, nitrogen dioxide, carbon monoxide, and sulphur dioxide) during the lockdown and unlock phases. (Graphs)

Globally GHG, $PM_{2.5}$, and air pollutants (SO_2 and NO_x) emissions are also reduced by 2.5 Gt, 0.6 Mt, and 5.1 Mt, respectively, which is in turn 4.6%, 3.8%, and 2.9% of global annual totals. GHG emissions have been reduced more than any other time in human history, including when fossil-fuel CO_2 emissions fell by 0.46 Gt CO_2 in 2009 because of the global financial crisis (GFC) and when CO_2 emissions from land-use change fell by 2.02 Gt CO_2 in 1998. It's worth mentioning that no government or international agreement has had such a significant impact on air pollution reduction in the 32-year history of intergovernmental climate policy (Lenzen et al., 2020).

Liu *et al.,* (2021) studied the effect of global lockdown measures on ambient air quality of 597 cities across 76 countries using a government response tracker dataset and found reduced NO_2in ambient air followed by PM_{10}, SO_2, $PM_{2.5,}$ and CO content compared to the pre-lockdown conditions. A similar observation was reported by Sicard *et al.* (2020), the surge in tropospheric ozone around 36% recorded in Wuhan, China. The stable and

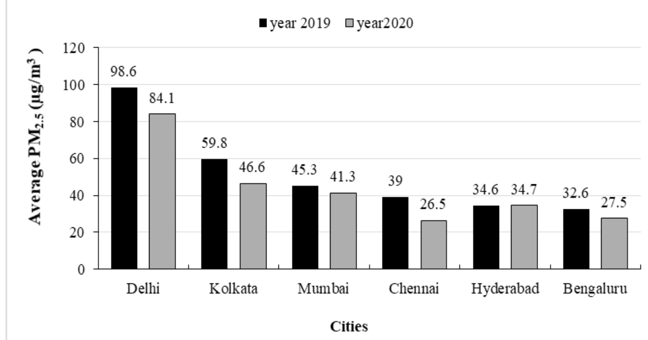

Fig. 3: Graph showing PM2.5 concentration of major Indian cities for the years 2019 and 2020. Source: World Air Quality Report, 2020

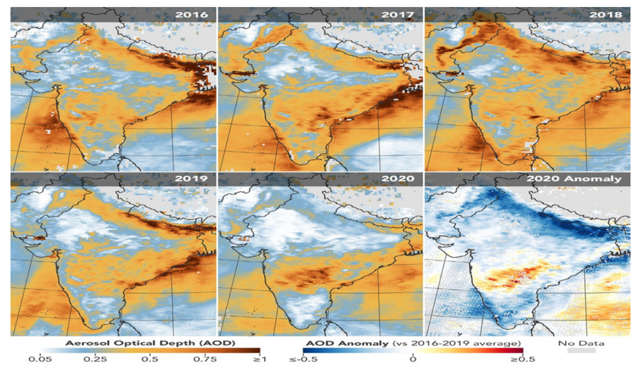

Fig. 4: The map shows Aerosol Optical Depth (AOD) observation over India from 31st March to 5th April in the years 2016, 2017, 2018, 2019, and 2020. Source: NASA, 2020

increased SO_2 trends in many cities were due to the functional coal-based power plants, several forest fires, sandstorms, meteorological conditions (Kumari and Toshniwal, 2020). The particles of an aerodynamic diameter of less than 2.5μm ($PM_{2.5}$) are more dangerous because of lower settling velocity and longer suspension in air. The larger-sized particles of more than 2.5μm are prevented from direct inhaling due to the presence of natural nasal hair filters, but $PM_{2.5}$ particles are micro scopically making them susceptible to inhalation. These ambient airborne particles cause severe health effects including lung cancer, stroke, asthma, ischemic heart disease, pulmonary diseases, and others by entering the blood vessel through respiration (World Air Quality Report, 2019). The dramatic reduction in $PM_{2.5}$ concentration in the COVID-19 scenario due to restrictions on several emission sources resulted in lower health risks due to adequate ambient air quality (Fig. 3). NASA observed the lower aerosol optical depth measurement of airborne particles over India using MODIS Terra satellite data (Fig. 4). Daniella and Leonardo (2020) reported the reduction in $PM_{2.5}$ levels of the most polluted capital cities of the world by comparing each before lockdown and after lockdown using the data of the world air quality index of 2020. However, the progressive air quality did not help to prevent COVID-19 associated lung inflammation with other co-morbidities.

Assessing the Effect of Lockdown on Water Quality

In developing countries, the water bodies have always been in terrible conditions due to the direct discharge of industrial and sewage effluents, treated or untreated (Saadat *et al.*, 2020). Covid-19 associated lockdown showed the indications of recovery of many water ecosystems all over the world (Dutta *et al.*, 2020). Since the lockdown, anthropogenic activities including the discharge of industrial waste, socio-religious activities, waterways, fishing, and so on were entirely halted. Evidence of improvement in water quality has been reportedin many studies. For instance, the data of four main rivers in Uttar Pradesh, India including Ganga, Gomti, Hindon, and the Yamuna during, before, and after lockdown at various sites have been compared, subjected to statistical analysis. The results showed a 98% and 50% decrease in coliform contents of rivers Yamuna and Gomti, respectively (Ghildyal *et al.*, 2020). Likewise, a decrease in Biochemical Oxygen Demand (BOD) of river Hindon, and a decrease in Total Dissolved Solids (TDS) and coliforms were observed in the river Ganga. Results have been confirmed by examining the spatial and temporal changes using Sentinel-2 multispectral remote sensing data. The reduction of turbidity was reported at the pilgrimage stretches (Prayagraj, Kanpur, Varanasi, and Haridwar) of the national river Ganga (Garg *et al.*, 2020). Similarly, enhancement in dissolved oxygen (DO) level and the declining trend in levels of BOD, fecal coliform, total coliform, and nitrates were observed.

Since the state of Uttarakhand was established in the year 2000, the water has always been classified as Class B i.e., Water for outdoor bathing. For the first time in the last two decades, the water at Har-ki-Pauri, Haridwar, was classified as Class A (drinking water without conventional treatment but after disinfection) due to the lockdown. Correspondingly, the Ganga in Rishikesh and Kanpur has substantially improved, particularly upstream, and had been classified as safe to drink (Class A) and bathe (Class B) respectively (Dutta *et al.*, 2020).

Also, the water pollution index of 90.9% of river Damodar samples was upgraded to good quality, while 9.1% of samples were classed as mildly contaminated, indicating similar favorable changes (Chakraborty *et al.*, 2021). River Damodar has historical value and serves as a lifeline for a large population across Jharkhand and West Bengal, its water quality has recently worsened due to untreated industrial effluents and urban trash.

Yunus *et al.* (2020) quantitatively verified the concentration of suspended particle matter (SPM) of Vembanad Lake in Kerala, India using remote sensing images. The concentration of SPM was reduced by 15.9% (average) during lockdown compared to the pre lockdown according to the Landsat-8 OLI data.

In Venice, the cleaned water within the canals resulted in noticeable water flow along with a diverse fish population. The settling of silt exacerbated by waterway activities during the lockdown was thought to be responsible for the decreased contamination and greater clarity along the rivers (Saadat *et al.*, 2020). Furthermore, the pandemic also created a flawless environment for olive Ridley turtles on the beaches of Venice, Italy (Khan *et al.*, 2020). The reduced human interruption provided benefits to turtles with adequate time to incubate and hatch in solitude.

Although there has been evidence of good results in the lockdown, a few weeks or months will not be enough to undo or repair the damage that has been done over many years. Several researchers have gathered data that can be used to develop better environmental regulations. The lockdown offered us hope that we might be able to reduce unnecessary human meddling and reintroduce a safer environment in our natural surroundings. The lockdown's environmentally positive influence on aquatic life can be long-lasting if proper operation of sewage treatment plants and strict restrictions/regulations onindustries may prevail.

Assessing the Effect of Lockdown on Noise Pollution

Another environmental issue that has substantially shown decrement during the Covid-19 lockdown is noise pollution. Transportation (air, water, land) and the industrial sector are the major sources of noise pollution. The problems caused by noise pollution include discomfort and health issues (hearing impairment, sleep disturbance, cardiovascular disease, psychological illness, hormone abnormalities, etc.) in the human population (Jariwala *et al.*, 2017). Noise pollution also hurts other inhabitants of the earth like animals and birds. Chronic traffic noise is dangerous to birds as it damages the auditory systems of bird species and can alter their breeding habits (Paital, 2020). Anthropogenic noise disrupts the basic sensory systems of animals, making it difficult for them to communicate, perceive predatory cues, find mates, and alter habitat quality and animal population (Finch *et al.*, 2020).

During the lockdown, the all-time busy road traffic was decreased dramatically due to the restrictions imposed worldwide (Somani *et al.*, 2020). The effect of lockdown on noise levels has been investigated by many researchers. For instance, Mishra *et al.* 2021 studied the impact of lockdown on noise levels of residential, commercial, industrial, and silence zone of Kanpur city of India using data of portable electrochemical sensors of six monitoring stations (IIT Kanpur, Mariampur, Kidwai Nagar, Deep Talkies, GolChauraha, Fazalganj) of Central Pollution Control Board, India. The average results revealed a considerable drop in equivalent sound levels (Leq) of 42-87decibel and 38-66 decibel (dB) during the pre-lockdown and lockdown phase. The quality of noise pollution in the urban environment is majorly affected by road vehicle traffic leading to a risk of annoyance and sleep disturbances. The study further indicated the reduction in risk of sleep trouble (37.96% to 14.72% in a residential zone) and annoyance in residential (86.23% to 41.25%), industrial (87.44 to 50.28%), and silence (84.47 to 43.07%) zone of Kanpur. Likewise, a 40-50% reduction in the noise level in dense localities of Delhi was also observed. This happened due to lower automobile transportation, the sound levels have dropped to 50-60dB, which was around 100dB (near Govindpuri metro station, Delhi) (Gandhiok and Ibrar, 2020).

Shipping is a major source of noise pollution in the marine ecosystem, and noise levels range from 20 to 200 Hz which affects aquatic life. During COVID-19 lockdown noise level is reduced by 6 dB with a significant drop below 150 Hz (Khan *et al.*, 2020).

The COVID-19 outbreak has had a substantial influence on environmental noise from the road, rail, air, and marine traffic, providing a rare chance to detect instantaneous noise reduction. According to Čurović *et al.* (2021), environmental noise data were analyzed from three monitoring stations at the port's edge and concluded that the decrease in noise level seen at all monitoring locations corresponds to a decrease in maritime activity. It was also mentioned that the number of persons exposed to noise levels over 55 dB in the day-evening-night period owing to maritime and industrial operations was decreased by 20% in the COVID-19 period compared to the historical period.

During the COVID-19 shutdown, Ulloa *et al.* (2021) organized a citizen science acoustic sampling project across Colombia, measuring the influence of human activity on the auditory environment of cities. The sound was captured during periods of severe movement limitations (April 2020) and strengthened restrictions (May-June 2020). They noticed a 12% increase in human activity, as well as a substantial 2.1 dB increase in sound pressure levels (128% increase).

"Lockdown Wildlife Tracker" App developed by Wildlife Institute of India

Mountain goats roam in Wales, the UK on March 31, 2020. (Credit: Christopher Furlong)

An African penguin walks to Cape Town, South Africa on April 14, 2020. (Credit: Rodger Bosch)

Peahens saw at New Delhi on April 19, 2020. (Credit: Arvind Yadav/Hindustan Times)

Lions napping at South Africa on April 15, 2020. (Credit: Richard Sowry)

Deer feed in Yosemite Valley in California on April 11, 2020. (Credit: Carolyn Cole)

Grey langurs run along a deserted road at Ahmedabad on April 19, 2020. (Credit: Sam Panthaky/AFP Photo)

Fig: 5 The evidence of behavioral changes of animals and birds during lockdown to curve Covid-19 Pandemic

During the French lockdown period, Munoz *et al.* (2020), investigated a decrease in sound levels of 4 dB to 6 dB compared to the normal situation, i.e., before lockdown at monitoring stations with extremely dominant road traffic sound. The table shows the summarized data of reduced average sound levels at numerous places in the pandemic COVID-19 (Lee and Kumar, 2021).

According to Mostafa *et al.* (2021), the Egyptian government revealed that the environmental noise level in Egypt was dropped by around 75% during the period of lockdown.

The mitigation measures of lockdown to curtail the blowout of novel corona virus disease resulted in a drop of >50% noise level. This seismic noise reduction is the longest and the most significant seismic noise reduction on record during 2020 (Lecocq *et al.*, 2020). Similarly, 4-6 dB of reduction was monitored in noise level from March to June 2020 in the city of Madrid, USA (Asensio *et al.*, 2020).

Assessing the Effect of Lockdown on Wildlife and Biodiversity

This lockdown impacted biodiversity in a fruitful positive way (Corlett *et al.*, 2020). Wildlife, restricted earlier to their protected areas away from human interferences, found a relief state to move out of their habitats without any fear. The Wildlife Institute of India released real-time data via an android application called "Lockdown Wildlife Tracker" to share safe wildlife movement in human-restricted areas (Paital, 2020). Due to lockdown, this free app makes it easy to keep track of wildlife animal movements, enabling the user to photograph and share those incidences across the world. All data in the app was made publicly available for scientific research and education. Lesser human intervention around wildlife areas was observed around the world. Due to strict lockdown measures, the number of visitors in national parks and metropolitan areas has decreased resulting in reduced human interaction with nature (Manan *et al.*, 2020).

According to collaborative research by experts from New Zealand and Canada, the COVID-19 shut down global shipping and lowered ocean noise. In the study, auditory data were collected between February’20 and May’20 at five locations in the Hauraki Gulf. The focus of the study was two species commonly found in the Gulf, bottlenose dolphins and blue eye fish. It was revealed that deprived of small boats, the gulf became much quieter at all five auditory monitoring locations, particularly at frequencies below 1 kHz. Median sound pressure levels were downcast by 8 and 10 dB on the first day and vessel noise levels fell by almost half, before even more to 8% of normal levels. The study showed that during the lockdown, the ability of dolphins and blue eyes to hear each other was more than doubled.

In many developed countries, travel limitations have lowered mobility by 75 to 95%, resulting in lower oil and fossil fuel use. This is excellent news for biodiversity because higher CO_x, NO_x, SO_2, and the other various air pollutants have been shown to harm plant, insect, bird, and animal species in the past. Besides, when compared to the same period last year, Amazonian rain forest damage increased by 55% in the first four months of 2020 during the lockdown. Human-to-wild animal anthroponotic transmissions of corona virus strains have been observed, including transmissions to some endangered species as Great Apes. In the past, similar transmissions in Chimpanzee communities have resulted in moderate-to-severe consequences, such as 90 to 100% illness and roughly 20% death (Bang and Khadakkar, 2020).

Derry berry *et al.* (2020) discovered that the COVID-19 shutdown reduced traffic noise in the San Francisco Bay Area of California to levels not observed in half a century, resulting in a change in song frequency in white-crowned sparrows. Because the human-produced traffic noise frequency within a specified array interfered with the best performance and most effective music, this shift was very apparent.

During the COVID-19, variations in crickets’ (and other invertebrates) auditory characteristics and exploratory behavior were observed (Tan and Robillard, 2021). The loss of animal life due to vehicle collisions on roads and high traffic volume also reduced at several places during lockdowns (Bil *et al.*,2021). High-volume noise also has a notable harmful impact on the lives of birds. Behavioral changes have been observed in the migratory birds with their extended stay time in the sanctuaries due to less human disturbance (Bar, 2020). The reduced pollution levels in all the areas result in the sighting of many animals roaming freely in the vicinity of communities, where they have not been seen in years (Rutz *et al.*, 2020). For instance, small Indian civet was spotted on a zebra-crossing in Kozhikode, Kerala, India. A herd of spotted deer explored the streets of Haridwar in Uttarakhand, India. An increase in the number of flamingoes congregating was seen in Mumbai, India. Olive Ridley turtles were seen on the beaches of Odisha, India, and critically endangered Ganges dolphins returned to the ghats of Kolkata (Roy, 2020).

The Wildlife Institute of India has released data via an app named “Lockdown Wildlife Tracker” to record and notify wildlife movements in people's territory (Paital, 2020).

Many reports are published on wildlife movement in people-dominated areas: mountain goats move in Wales, Penguin walks at Cape Town, Peahens seen on road at New Delhi, Lions napping at South Africa, Wild Boar found in Italy, Deer were once seen in the US (Fig. 5).

Assessing the Effect of COVID-19 Scenario on Waste Generation

A major drawback of the life-threatening coronavirus disease concerning environmental pollution is the generation of an enormous amount of municipal and biomedical waste all over the world (Liang *et al.*, 2021). Biomedical waste generated from the hospitals during the pandemics included masks, gloves, personal protective equipment (PPE) kits, disposable bed sheets, and others. Improper disposal of these biomedical wastes can result in the transmission of more infectious diseases (Roy and Chaube, 2021). A substantial increase in medical waste was the result of an amplified infection rate worldwide. About a 600% increase in hazardous waste volume was reported in the Hubei province of China during the pandemic (Haque *et al.*, 2021). Also, during the first phase of lockdown in the city of Ahmedabad 1000kg/day of biomedical waste was produced earlier that used to be 550-600 kg/day (Somani *et al.*, 2020). The high rate of disinfectant application on roads and surface sterilization using alcohol also enhanced the chemical contamination in soil and water. Many of these chemicals like hypochlorite is corrosive and harms other living organisms like a bee, birds the street animal.

The unexpected emergence of the virus leads to a gigantic upsurge in biological waste. During the first wave of the corona, from June to December 2020, India generated around 28,747.91 tonnes of biological waste. Out of which Maharashtra, Kerala, Gujarat, Tamil Nadu, Uttar Pradesh, Delhi, West Bengal, Karnataka, Madhya Pradesh, and Haryana were among the top ten states in terms of biomedical waste generation, Table (Chand *et al.,* 2021). During the second covid wave average monthly covid-19 biomedical waste generation followed the increasing trend from January 2021 to May 2021 (CPCB, 2021)

Many individuals adopted an alternative for lockdown by making online shopping orders of the essential products resulting in more waste generation. The process of waste collection, disposal, and recycling was reduced at several places to avoid viral transmission resulting in the overburden of single-use disposable products (Haque *et al.*, 2021). The increased waste volume in COVID-19 resulted in difficulties for the waste management sector due to decreased recycling activities, low budget, and inadequate workforce (IFC 2020). For instance, the indirect negative impact of the virus is seen as reduced recycling activity in the USA, Italy, and other European countries (Zambrano-Monserrate *et al.*, 2020). Furthermore, the quantity of municipal waste reaching the dumpsites was also reduced in cities like Delhi, Hyderabad, Pune, Panchkula because of poor collection efficiencies (Somani *et al.*, 2020). Although the prior knowledge about the virus and its spread during the second wave resulted in timely management and segregation of waste through policy actions by the CPCB. It is important to keep track of waste produced to properly channelize collection and treatment efficiencies. Modern approaches like the artificial intelligence model should be considered in the waste management sector to precisely estimate waste generation and its effective management.

According to the World Health Organization estimate, over 16 million hand gloves and 89 million masks are worn every day throughout the world during the lockdown. During the pandemic, 240 metric tons of medical waste was produced every day in hospitals in Wuhan, China only (Parikh and Rawtani, 2022).

Following the start of the pandemic COVID-19 in March 2020, various nations advised or enforced the use of fitting face masks to prevent SARS-CoV-2 virus transmission via aerosols. With the widespread usage of non-sterile, surgical type single-use face masks (SUM), there has been an upsurge in the number of masks lost or abandoned in diverse environments. It was revealed that 75% of the bits of SUM cloth collected in the catcher were less than 10 mm^2, indicating that they will degrade into microfibers when exposed to UV radiations. UV radiation causes embrittlement and fragmentation of the fibers, resulting in long-lasting microplastics. While there appears to be little knowledge of the lifespan of these micro-and nano plastics derived from polypropylene, it can be measured in decades, if not centuries (Spennemann, 2022). Based on an acceptance rate of 80% and a daily average of face masks per inhabitant, the total number of face masks per day in just 15 African nations is reported to be 586,833,053 (Nzediegwu and Chang, 2020).

Mostafa *et al*. (2021) concluded a rise in medical solid waste from 70 to 300 tonnes per day with a less effective solid waste recycling process. An excess mismanaged plastic waste produced during the pandemic was accrued to an average of 4.4 to 15.1 million tons up to August 2021at different places in India.

One of the studies based on medical waste management in Lebanon concluded that the estimated average of COVID-19 related infectious healthcare waste generation was 39,035 kg per month or 1.3 tonnes per day, which constitutes between 5to 20%of total infectious healthcare waste in Lebanon (Maalouf and Maalouf, 2021).

The World Health Organization projected that 1.6 million plastic-based shielding eyewear, 76 million plastic-based-inspection masks, and 89 million plastic-based-medical masks will be desirable each month to stop the spread of COVID-19 (Anderson, 2020). In February, China's daily output of plastic-based masks climbed by 116 million (a dozen times more than January) (Sarkodie and Owusu, 2020). There have been multiple reports of massive plastic trash in Thailand, ranging from 1500 to 6300 tonnes per day, owing to food supplied to houses, while illicit rubbish disposal in the UK increased by 300% during the lockdown time (Weforum, 2020). The influx of COVID-19 patients reportedly resulted in the building of garbage plants and the deployment of 46 mobile waste treatment facilities in China due to the enormous spike in daily waste (i.e., over 240 metric tonnes) and raising levels of hospital medical waste six-fold (Sarkodie and Owusu, 2020).

Conclusion

The lockdown resulted in many positive changes globally, but such impacts are not permanent as lockdown cannot be offered as a solution to control environmental pollution. Although some referred to it as a blessing for the environment. The COVID-19 pandemic gave society long-term life lessons to reduce the human-induced manipulation of the natural ecosystem. It also offered an opportunity to design and implement a wide range of new approaches for sustainable interaction between people and the environment. The lockdown-induced impact can be long-lasting if a practical approach is given to fulfill the principles of sustainable development. Also, the development of strict environmental policies can help in maintaining lockdown impacts and intangible benefits derived from it. Government should adopt a sustainable way of economic development, and strict restrictions should be imposed on polluters if their emission/ discharges are above the permissible limits. Waste management policies should be implemented across the nation so that clean water, air, and soil will be available for upcoming generations. Humans should learn to live with nature as a part of it.

References

Airborne Particle Levels Plummet in Northern India. NASA earth observatory (n.d.). NASA Retrieved February 08, 2022, from https://earthobservatory.nasa.gov/images/146596/airborne-particle-levels-plummet-in-northern-india.

Akinsorotan, O. A., Olaniyi, O. E., Adeyemi, A. A., &Olasunkanmi, A. H. (2021). Corona Virus Pandemic: Implication on Biodiversity Conservation. Front. Water 3: 635529.

Maalouf, A.,&Maalouf, H.,(2021). Impact of COVID-19 pandemic on medical waste management in Lebanon. Waste Management & Research. 39: 45 –55.

Ankit, Kumar, A., Jain, V., Deovanshi, A., Lepcha, A., Das, C., Bauddh, K., &Srivastava, S. (2021). Environmental impact of COVID-19 pandemic: more negatives than positives. Environmental Sustainability, 4: 447–454.

Asensio, C., Pavón, I., & de Arcas, G. (2020). Changes in noise levels in the city of Madrid during COVID-19 lockdown in 2020. The Journal of the Acoustical Society of America,148:1748.

Bang, A., &Khadakkar, S. (2020). Opinion: Biodiversity conservation during a global crisis: Consequences and the way forward. Proceedings of the National Academy of Sciences, 117, 29995-29999.

Bar. H. (2020). COVID-19 lockdown: animal life, ecosystem, and atmospheric environment. Environment, Development and Sustainability 1: 1–18.

Bíl, M., Andrášik, R., Cícha, V., Arnon, A., Kruuse, M., Langbein, J., Náhlik, A., Niemi, M., Pokorny, B., Colino-Rabanal, V., Rolandsen, C. & Seiler, A. (2021). COVID-19 related travel restrictions prevented numerous wildlife deaths on roads: A comparative analysis of results from 11 countries. Biological Conservation256:109076.

Chakraborty, B., Roy, S., Bera, A., Adhikary, P. P., Bera, B., Sengupta, D., Bhunia G.S.,&Shit, P. K. (2021). Cleaning the river Damodar (India): impact of COVID-19 lockdown on water quality and future rejuvenation strategies. Environment, Development, and Sustainability, 23, 11975–11989.

Chakraborty, I.,&Maity, P. (2020). COVID-19 outbreak: Migration, effects on society, global environment, and prevention. The Science of the total environment728:138882.

Chand, S.,Shastry, C.S.,Hiremath, S., Joel, J.J.,Krishnabhat, C.H.,Mateti, U.V. (2021). Updates on biomedical waste management during COVID-19: The Indian scenario. Clinical Epidemiology and Global Health 11:100715.

Chen, K., Wang, M., Huang, C., Kinney, P. L., &Anastas, P. T. (2020). Air pollution reduction and mortality benefit during the COVID-19 outbreak in China. The Lancet Planetary Health, 4:210-212.

Corlett, R. T., Primack, R. B., Devictor, V., Maas, B., Goswami, V. R., Bates, A. E., Koh, L. P., Regan, T. J., Loyola, R., Pakeman, R. J., Cumming, G. S., Pidgeon, A., Johns, D.,& Roth, R. (2020). Impacts of the coronavirus pandemic on biodiversity conservation. Biological conservation246:108571.

COVID-19's impact on the waste sector. International Finance Corporation (IFC), World Bank (n.d). IFC 2020 Retrieved February 8, 2022, from https://www.ifc.org/wps/wcm/connect/dfbceda0-847d-4c16-9772-15c6afdc8d85/202006-COVID-19-impact-on-waste-sector.pdf?MOD=AJPERES&CVID=na-eKpI.

CPCB (2021). Generation of COVID-19 related biomedical waste in states/UTs.Status Report 2021, Central Pollution Control Board, Government of India.

Čurović, L., Jeram, S., Murovec, J., Novaković, T., Rupnik, K., &Prezelj, J. (2021). Impact of COVID-19 on environmental noise emitted from the port. Science of The Total Environment, 756, 144147.

Daniella, R.U. & Leonardo, R.U. (2020). Air quality during the COVID-19: PM2.5 analysis in the 50 most polluted capital cities in the world. Environmental Pollution266:115042.

Dantas, G., Siciliano, B., França, B.B., da Silva, C.M.,&Arbilla, G. (2020). The impact of COVID-19 partial lockdown on the air quality of the city of Rio de Janeiro, Brazil. The Science of the total environment 729:139085.

Derryberry, E. P., Phillips, J. N., Derryberry, G. E., Blum, M. J., & Luther, D. (2020). Singing in a silent spring: Birds respond to a half-century soundscape reversion during the COVID-19 shutdown. *Science*, 370: 575-579.

Dutta, V., Dubey, D., & Kumar, S. (2020). Cleaning the River Ganga: Impact of lockdown on water quality and future implications on river rejuvenation strategies. The Science of the Total Environment 743:140756 - 140756.

Fan, C., Li, Y., Guang, J., Li, Z., Elnashar, A., Allam, M. & de Leeuw, G. (2020). The Impact of the Control Measures during the COVID-19 Outbreak on Air Pollution in China. Remote Sensing12:1613.

Finch, D., Schofield, H.,& Mathews, F. (2020). Traffic noise playback reduces the activity and feeding behavior of free-living bats. *Environmental Pollution*263:114405.

Gandhiok, J., &Ibrar, M. (2020). *Covid-19: Noise Pollution Falls as Lockdown Rings in Sound of Silence (n.d.)*The Times of India. Retrieved February 08, 2022, from https://timesofindia.indiatimes.com/india/covid-19-noise-pollution-falls-as-lockdown-rings-in-sound-of-silence/articleshow/75309318.cms.

Garg, V., Aggarwal, S.P. & Chauhan, P. (2020). Changes in turbidity along Ganga River using Sentinel-2 satellite data during lockdown associated with COVID-19. *Geomatics, Natural Hazards and Risk* 11:1175-1195.

Gautam, S. (2020). The Influence of COVID-19 on Air Quality in India: A Boon or Inutile. *Bulletin of environmental contamination and toxicology*104:724–726.

Ghildyal, D., Singh, K.P., Singh, P. &Verma, R. (2020). Healing of rivers during coronavirus lockdown in India: a statistical approach. International Journal of Lakes and Rivers13:105-119

Gope, S., Dawn, S., & Das, S. S. (2021). Effect of COVID-19 pandemic on air quality: a study based on Air Quality Index. Environmental Science and Pollution Research, 1-20.

Haque, M. S., Uddin, S., Sayem, S. M., &Mohib, K. M. (2021). Coronavirus disease 2019 (COVID-19) induced waste scenario: A short overview. *Journal of environmental chemical engineering*9:104660.

Hashim, B. M., Al-Naseri, S. K., Al-Maliki, A. & Al-Ansari, N. (2021). Impact of COVID-19 lockdown on NO2, O3, PM2.5, and PM10 concentrations and assessing air quality changes in Baghdad, Iraq. The Science of the total environment 754:141978.

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zha, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M. & Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet395:497-506.

IQ air (2019). World Air Quality Report Region & City PM2.5 Ranking. https://www.iqair.com/world-most-polluted-cities/world-air-quality-report-2019-en.pdf.

IQ air (2020). World Air Quality Report Region and City PM2.5 Ranking. https://www.iqair.com/world-most-polluted-cities/world-air-quality-report-2020-en.pdf.

Jariwala, H., Syed, Huma, Pandya, M. &Gajera, Y. (2017). Noise Pollution & Human Health: A Review.Noise and Air Pollution: Challenges and Opportunity, 29.

Khan, I., Shah, D.,& Shah, S.S. (2020). COVID-19 pandemic and its positive impacts on the environment: an updated review.International Journal of Environmental Science and Technology,18:521–530.

Kumari, D., Prasad, B. D., Dwivedi, P., &Sahni, S. (2021). Molecular Evaluation of COVID-19 in Pandemic Era. Journal of Pharmaceutical Research International32:79-95.

Kumari, P.,&Toshniwal, D. (2020). Impact of lockdown on air quality over major cities across the globe during COVID-19 pandemic. Urban climate 34:100719.

Lecocq, T., Hicks, S. P., Van Noten, K., Van Wijk, K., Koelemeijer, P., De Plaen, R. S., Massin, F., Hillers, G., Anthony, R. E.,&Apoloner, M. T. (2020). Global quieting of high-frequency seismic noise due to COVID-19 pandemic lockdown measures. Science369:1338–1343.

Lee, Heow P., & Sanjay Kumar. 2021. "Perspectives on the Sonic Environment and Noise Mitigations during the COVID-19 Pandemic Era" Acoustics 3, no. 3: 493-506.

Lenzen, M., Li, M., Malik, A., Pomponi, F., Sun, Y. Y., Wiedmann, T., Faturay, F., Fry, J., Gallego, B., Geschke, A., Gómez-Paredes, J., Kanemoto, K., Kenway, S., Nansai, K., Prokopenko, M., Wakiyama, T., Wang, Y., &Yousefzadeh, M. (2020). Global socio-economic losses and environmental gains from the Coronavirus pandemic. PloS one, 15, e0235654. https://doi.org/10.1371/journal.pone.0235654

Liang, Y., Song, Q., Wu, N., Li, J., Zhong, Y. & Zeng, W. (2021). Repercussions of COVID-19 pandemic on solid waste generation and management strategies. Frontiers of Environmental Science & Engineering15: 115.

Liu, F., Wang, M. & Zheng, M. (2021). Effects of COVID-19 lockdown on global air quality and health. The Science of the total environment755:142533.

Loh, H.C., Looi, I., Ch'ng, A.S.H., Goh, K.W., Ming, L.C., Ang, K.H. (2021). Positive global environmental impacts of the COVID-19 pandemic lockdown: a review. GeoJournal, 23:1-13.

Manan, S., Ullah, M., Guo, Z. & Yang, Guang. (2020). Impact of COVID-19 on Environment Sustainability. ES Energy & Environment8:1-2.

Masum, M.,& Pal, S. (2020). Statistical evaluation of selected air quality parameters influenced by COVID-19 lockdown. *Global Journal of Environmental Science and Management*6:85-94.

Menut, L., Bessagnet, B., Siour, G., Mailler, S., Pennel, R. &Cholakian, A. (2020). Impact of lockdown measures to combat Covid-19 on air quality over Western Europe. The Science of the total environment741:140426.

Mishra, A., Das, S., Singh, D., &Maurya, A. K. (2021). Effect of COVID-19 lockdown on noise pollution levels in an Indian city: a case study of Kanpur. Environmental science and pollution research international 28:46007–46019.

Mostafa, M. K., Gamal, G., &Wafiq, A. (2021). The impact of COVID 19 on air pollution levels and other environmental indicators-A case study of Egypt. Journal of environmental management, 277, 111496.

Munoz, P., Vincent, B., Domergue, C., Gissinger, V., Guillot, S., Halbwachs, Y., &Janillon, V. (2020). Lockdown during COVID-19 pandemic: Impact on road traffic noise and on the perception of sound environment in France. Noise Mapping, 7, 287-302.

Nigam, R., Pandya, K., Luis, A. J., Sengupta, R., &Kotha, M. (2021). Positive effects of COVID-19 lockdown on air quality of industrial cities (Ankleshwar and Vapi) of Western India. Scientific Reports, 11: 1-12.

Nzediegwu, C., & Chang, S. X. (2020). Improper solid waste management increases potential for COVID-19 spread in developing countries. *Resources, conservation, and recycling*, 161, 104947.

Paital, B. (2020). Nurture to nature via COVID-19, a self-regenerating environmental strategy of the environment in a global context. *The Science of the total environment*729:139088.

Parikh G. &Rawtani D. (2022). Environmental impact of COVID-19. In: COVID-19 in the Environment: Impact, Concerns, and Management of Coronavirus(Editor(s): Rawtani, D., C. M. Hussain, N. Khatri). pp. 203-216.https://doi.org/10.1016/B978-0-323-90272-4.00001-4

Roy, N. &Chaube, R. 2021. Environmental Impact of COVID-19 Pandemic in India. *International Journal of Biological Innovations*3: 48-57.

Roy, S. (2020). *"Wildlife during a pandemic: The other side of the coin". Down to earth* Retrieved February 8, 2022, from https://www.downtoearth.org.in/blog/wildlife-biodiversity/wildlife-during-a-pandemic-the-other-side-of-the-coin-72547.

Rutz, C., Loretto, M. C., Bates, A. E., Davidson, S. C., Duarte, C. M., Jetz, W., Johnson, M., Kato, A., Kays, R., Mueller, T., Primack, R. B., Ropert-Coudert, Y., Tucker, M. A., Wikelski, M. &Cagnacci, F. (2020). COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife. *Nature ecology and evolution* 4:1156–1159.

Saadat, S., Rawtani, D. & Hussain, C. M. (2020). The environmental perspective of COVID-19. *The Science of the total environment*728:138870.

Sarkodie, S. A., &Owusu, P. A. (2020). Impact of COVID-19 pandemic on waste management. *Environment, Development and Sustainability*, 26: 1–10.

Sharma, S., Zhang, M., Anshika, Gao, J., Zhang, H. & Kota, S. H. (2020). Effect of restricted emissions during COVID-19 on air quality in India. *The Science of the total environment*728:138878.

Sicard, P., De Marco, A., Agathokleous, E., Feng, Z., Xu, X., Paoletti, E., Rodriguez, J. &Calatayud, V. (2020). Amplified ozone pollution in cities during the COVID-19 lockdown. *The Science of the total environment* 735:139542.

Somani, M., Srivastava, A. N., Gummadivalli, S. K. & Sharma, A. (2020). Indirect implications of COVID-19 towards the sustainable environment: An investigation in the Indian context. *Bioresource technology reports*11:100491.

Spennemann, D. H. (2022). COVID-19 Face Masks as a Long-Term Source of Microplastics in Recycled Urban Green Waste. *Sustainability*, 14, 207.

Tan, M. K., &Robillard, T. (2021). Population divergence in the acoustic properties of crickets during the COVID-19 pandemic. *Ecology* 102, pp.e03323.

Ukaogo, P.O., Ewuzie, U.,&Onwuka, C.V. (2020). Environmental pollution: causes, effects, and the remedies. *Microorganisms for Sustainable Environment and Health*21:419-429.

Ulloa, J. S., Hernández-Palma, A., Acevedo-Charry, O., Gómez-Valencia, B., Cruz-Rodríguez, C., Herrera-Varón, Y., Roa, M., Rodríguez-Buriticá, S., Ochoa-Quintero, J. M.(2021). Listening to cities during the COVID-19 lockdown: How do human activities and urbanization impact soundscapes in Colombia?. *Biological Conservation*, *255*, 108996.

Vultaggio, M., Varrica, D.,&Alaimo, M. G. (2020). Impact on Air Quality of the COVID-19 Lockdown in the Urban Area of Palermo (Italy). *International journal of environmental research and public health*17:7375.

Weforum.(2020).The plastic pandemic is only getting worse during COVID-19. Retrieved from https:// bu.ly/2Ui4K7s.

WHO (2020). Naming the coronavirus disease (COVID-19) and the virus that causes it. https://www.who.int/emergencies/diseases/novel-coronavirus2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virusthat-causes-it.

Xu, H., Yan, C., Fu, Q., Xiao, K., Yu, Y., Han, D., Wang, W. & Cheng, J. (2020). Possible environmental effects on the spread of COVID-19 in China. *The Science of the total environment*731:139211.

Yunus, A. P., Masago, Y., &Hijioka, Y. (2020). COVID-19 and surface water quality: Improved lake water quality during the lockdown. *Science of the Total Environment*, 731, 139012.

Zambrano-Monserrate, M. A.,&Ruano, M. A. (2020). Has air quality improved in Ecuador during the COVID-19 pandemic? A parametric analysis. *Air quality, atmosphere, and health*6:1–10.

Zambrano-Monserrate, M. A., Ruano, M. A. &Sanchez-Alcalde, L. (2020). Indirect effects of COVID-19 on the environment. *The Science of the total environment* 728:138813.