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Review Article

Impacts of COVID-19 Lockdowns on Environmental Degradation and Climate Change: A Review

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Abstract

The COVID-19 pandemic, first identified in late 2019, rapidly transformed social and economic systems worldwide. To contain its spread, many governments imposed strict restrictions that closed businesses, schools, airports, factories, and other socio-economic activities. These unprecedented measures created a global "experiment" in reducing human pressures on the environment, providing valuable insights into how ecosystems respond when anthropogenic activities are curtailed. Short-term environmental improvements were widely reported. Urban air quality improved markedly, with nitrogen dioxide concentrations falling and global daily CO_2 emissions declining by up to 17% at the peak of lockdowns. Air pollution dropped by about 25% in China and nearly 50% in New York compared with the previous year. Water bodies also exhibited temporary gains, including greater clarity and reductions in biochemical and chemical oxygen demand, largely due to reduced industrial discharges. Lockdowns further suppressed anthropogenic noise and seismic activity, while wildlife displayed shifts in movement and behavior during the "anthropause." At the same time, the pandemic introduced new environmental pressures. Increased household wastewater and detergent use added pollutant loads to urban systems, while surges in personal protective equipment (PPE) and medical waste intensified plastic pollution risks. Conservation programs were interrupted, and global CO_2 emissions rebounded strongly by 2021, highlighting the temporary nature of early gains. These contrasting outcomes underscore the complexity of human–environment interactions under crisis conditions. While the pandemic revealed the scale of improvement achievable through short-term behavioral change, it also confirmed that durable benefits require systemic policy interventions. Strengthening environmental monitoring, building resilient waste management systems, and aligning recovery strategies with climate and biodiversity objectives are essential to embedding the lessons of the pandemic into long-term sustainability planning. This review therefore synthesizes emerging evidence on the environmental impacts of COVID-19 lockdowns, identifying both opportunities and challenges to inform future climate and sustainability strategies.

Keywords

Air Pollution, Climate Change, COVID-19, Environmental Degradation, Waste Management

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1. Introduction

Climate change has impacted generally how most ecosystems function over the last 3 to 4 decades. This has also affected how marine ecosystems function including terrestrial and fresh water, which has caused ecological disturbance that has disrupted the functions of the ecosystem services globally [5]. Species of organisms were impacted by climate change, where they shift their climatic niche to adapt to effects of climate change [4]. Although there is relatively limited evidence of current extinctions caused by climate change, studies suggest that climate change could surpass habitat destruction as the greatest global threat to biodiversity over the next few decades [4].

1.1. Environmental Changes Due to Anthropogenic Activities

Due to human population growth, ecological footprint is rapidly increasing the degradation of ~60% of the world's essential ecosystem services for example (15 of 24 services) as evaluated by the Reid *et al.* [19], including freshwater, fisheries, air and water purification, and regulation of regional and local climates. In order to meet increasing wood fiber demands, forests have been destroyed at an alarming rate of 25 ha every minute of every day, the equivalent of some 13 million ha globally deforested each year during the past decade or 88, 000 US football fields each day over this period, based on Food and Agriculture Organization [FAO] [10] statistics. Deforestation rates and the loss of over 40% of the world's forests [7].

Studies have investigated how the COVID-19 outbreak that has rattled the World and caused death to many people [9]. There are insufficient environmental and energy impacts of the pandemic. However, some studies have argued that COVID-19 outbreak has reduced environmental pollution and degradation around the world [8]. Others studies stated that there will be significant environmental damages in future due the effects of COVID-19 outbreak. It is evident that over the decades human activities in environmental have caused serious degradation to world ecosystems.

1.2. How COVID-19 Outbreak Has Reduced Environmental Degradation and Causes Climate Change

Despite the adverse impacts of the COVID-19 pandemic, there are some positive effects to it. Studies have reported that carbon and other greenhouse gases emission have significantly reduced during the lockdown [8, 31]. Mainly, this is due to lockdown enforced in many countries around the world to reduce the virus transmission. Many businesses and commercial activities have reduced in countries such as China, India, UK and US, thus decreasing used on machines and vehicles that amount for significant percent of the carbon and other greenhouse gas emission. There has been decrease of 25% in carbon emission in China during the lockdown [9]. Air pollution of gases such as nitrogen dioxide and carbon dioxide emission have decrease in China in regions with the movement restrictions. WHO [27], reported that air pollution causes ~8 of total deaths in world annually especially in Asia, Africa and certain parts of Europe.

It was reported that there has been ~96% drop in world air travels, whereas ~35% to 50% drop travels in the US which varies according to states [3]. This has also reduced fog in many cities around the especially places such as New Delhi, Beijing, Mumbai and Shanghai [3].

Figure 1. *New Delhi in January and April 2020 Source: [3].*

Figure 2. *A sea lion is seen on a sidewalk of Mar del Plata harbour, south of Buenos Aires, Argentina, on 16 April Source: [26].*

Discharge of effluents into water bodies and wastes in to rivers have drastically reduced. Businesses and factories that contribute to increasing water pollution and indiscriminate waste disposal. Due to the pandemic lockdown many wildlife animals were seen roaming the streets of some few cities in Argentina (Buenos Aires), India (New Delhi), Japan (Nara), Ahmedabad (India), Turkey (Istanbul) and Wales (Llandudno) [26]. In conservation of wildlife disturbance and habitat destruction affects reproduction of animals [26]. Despite the freedom and wildlife have experience during the lockdown period, it has also posed a serious threat to some wildlife in zoos and nationals parks around the world. The lockdown has become problematic to the conservation programmes where they struggled with funding, food supply and excessive poaching due to reduced patrols [25].

1.3. Air Quality and Greenhouse Gas Changes

Lockdown measures in 2020 produced rapid and large, but largely transient, decreases in many air pollutants. Satellite and ground observations showed marked declines in NO_2 concentrations across major urban areas during strict mobility reductions [11, 16]. Transport-sector shutdowns contributed substantially to observed short-term drops in daily CO_2 emissions, with global daily emissions decreasing by roughly 17% at the peak of confinement in early April 2020 [16]. However, these gains were temporary: emissions rebounded strongly by 2021 as economies reopened [15]. Scholars stress that these temporary reductions are not substitutes for structural mitigation policies but demonstrate the scale of behavioral changes needed to generate measurable improvements [11]. Studies rely on different baselines and indicators, and disentangling meteorological variability from emission changes remains a challenge.

1.4. Detergent and Household Wastewater Pollution

Several case studies documented measurable but temporary improvements in surface-water quality during strict lockdown periods. For example, rivers such as the Ganga and Yamuna in India recorded reductions in suspended particulate matter and biochemical oxygen demand (BOD) during early 2020 when industrial discharges and transport activities were largely suspended [20, 21, 28]. These improvements, however, were short-lived, with most water-quality parameters reverting toward baseline once restrictions were lifted and industrial operations resumed.

At the same time, the pandemic reshaped the composition of urban wastewater. Extended stay-at-home orders, frequent handwashing, and heightened domestic cleaning practices significantly increased the release of detergents and surfactants into municipal sewage systems. Unlike many industrial effluents, which may be more stringently regulated, domestic discharges often enter wastewater streams with minimal pretreatment. Surfactants are of particular concern because they elevate both BOD and chemical oxygen demand (COD), reduce biodegradability, and can exert ecotoxicological stress on aquatic organisms by altering membrane permeability and inhibiting microbial activity [32].

Emerging evidence illustrates this shift. A case study from Tehran proposed a biodegradability index based on detergent concentrations, providing a novel framework for assessing the ecological implications of household wastewater inputs on urban rivers [32]. Taken together, these findings suggest that while lockdowns temporarily reduced industrial pollution, they simultaneously intensified domestic wastewater contributions, effectively transferring the pollution burden rather than eliminating it.

These dual dynamic underscores the need for integrated urban wastewater monitoring systems that account for both industrial and household sources. In particular, detergent and surfactant loads should be systematically incorporated into water-quality assessments, alongside traditional effluent indicators, to capture the full spectrum of anthropogenic pressures on aquatic ecosystems during and beyond crisis periods.

1.5. Noise and Seismic Quieting

Reduced mobility and industrial activity also caused marked declines in environmental noise. Urban noise levels dropped, and global seismic stations recorded unprecedented reductions in high-frequency anthropogenic seismic noise up to ~50% at some stations during mid-2020 [17]. This “global quieting” provided unique opportunities to study natural seismic and acoustic signals normally masked by human activity. Moreover, reduced urban noise likely benefited some wildlife species by facilitating communication and reducing stress [24]. Observed noise reductions were spatially variable, depending on lockdown stringency, urban density, and monitoring infrastructure.

1.6. Wildlife and Biodiversity (the “Anthropause”)

The so-called “anthropause” a dramatic reduction in human mobility during lockdowns produced both direct and indirect effects on wildlife. Reports documented changes in animal movement patterns, expanded habitat use, and altered behaviour such as vocalizations and activity timing [18, 24]. However, conservation operations, including patrolling and ecotourism revenues, were disrupted, raising concerns about poaching and reduced enforcement in some regions [24]. These mixed effects underscore the dual nature of the anthropause: while some species benefited from reduced human presence, systemic threats to biodiversity persisted. Most studies were anecdotal or short-term; rigorous monitoring is required to assess lasting impacts.

1.7. Medical Waste and PPE Disposal

The pandemic triggered a surge in single-use plastics, particularly personal protective equipment (PPE) such as masks, gloves, gowns, and packaging materials, placing severe pressure on municipal waste systems. Studies reported widespread littering and leakage of discarded PPE into terrestrial and marine environments, where it contributes to plastic pollution and microplastic formation [1, 21]. The World Health Organization estimated that tens of thousands of tons of PPE were consumed globally each month at the height of the crisis [27]. Many municipalities lacked adequate segregation and disposal infrastructure for infectious waste, while hospitals faced mounting volumes of contaminated material that strained treatment capacity and increased occupational health risks. In parallel, some jurisdictions suspended bans on single-use plastics as part of infection-control measures, undermining earlier waste-reduction gains. Addressing these challenges requires strengthening waste-management systems, establishing safe protocols for handling infectious PPE, and investing in biodegradable alternatives to reduce long-term ecological impacts [22]. Data on PPE waste flows are still limited, and long-term ecological impacts of pandemic plastic pollution are uncertain.

1.8. Energy, Systems and Rebound Effects

Energy demand fell sharply during the strictest lockdowns, particularly in the transport and industrial sectors, leading to temporary reductions in CO_2 emissions [16]. However, these gains quickly disappeared as economic activity resumed, with 2021 seeing the largest year-on-year increase in global CO_2 emissions on record (IEA, 2021). Analysts emphasize that without structural changes such as investment in renewable energy, promotion of remote work where feasible, and alignment of fiscal recovery with climate targets emission reductions achieved during lockdowns will not be sustained (Forster *et al.*, 2020; IEA, 2021).

Evidence is limited on whether pandemic-induced behavioral changes, such as teleworking, will result in durable reductions in energy demand.

2. Materials and Methods

This paper is a narrative review of studies on the environmental impacts of COVID-19 lockdowns. The goal was to synthesize and critically assess emerging evidence rather than to exhaustively capture every publication.

We searched Web of Science, Scopus, PubMed, and Google Scholar using combinations of the terms *COVID-19*, *SARS-CoV-2*, *lockdown*, *confinement*, *air pollution*, CO_2, NO_2, *water quality*, *wastewater*, *detergents*, *plastic waste*, *PPE*, *wildlife*, *biodiversity*, *noise*, and *energy use*. Searches covered January 2020 to December 2021, and only English-language sources were included. Titles and abstracts were screened for relevance, and full texts were reviewed if they reported empirical data, quantitative indicators, or systematic observations of environmental change.

Peer-reviewed articles were prioritized, but authoritative grey literature (e.g., reports from the International Energy Agency [IEA]) was also considered. Studies were grouped into six themes: (i) air quality and greenhouse gases, (ii) water quality and wastewater, (iii) noise and seismic quieting, (iv) wildlife and biodiversity, (v) waste and PPE, and (vi) energy and rebound effects. Findings were synthesized qualitatively to identify patterns, contradictions, and gaps. Because of methodological and geographic heterogeneity, no meta-analysis was attempted.

3. Discussion

Considering how COVID-19 has changed how people lived around the world and has brought to light how the environment can be maintained and managed. According Zhou *et al.* [31] due to restriction of economic activities in China and around the world, industrial emission has dropped by at least 25%. Air pollution has drastically decreased during this period compared to last year this time for example there has been 50% decrease in air pollution in New York [30]. This has improved human heath reducing the number of people affected by air pollution-based illness. Effluents and toxic contaminants flushed into water bodies and marine habitats have also reduced thus improving the quality of these ecosystems [9]. Organisms in these ecosystems have thrived due to non-existent human socio-economic activities, wastes dumped into water bodies by tourists, demand for furniture wood, soil erosion, waste generation and clean beaches. According to Zambrano-Monserrate *et al.* [30], there is significant correlation between human activities and increased environmental degradation. This pandemic has caused lockdown and there is improvement in environmental quality, especially in areas of air quality, environmental noise reduction and water quality. However, the lockdown has reduced recycling of waste products which increases contamination of open spaces. This is due to rise in online purchase and decreased recycling of reusable products. Beaches are among those places that are kept clean during this pandemic lockdown. In some communities, tourism, recreation and sand play vital role in the survival of these communities, where this sector employs many people across the chain of work [18]. There are positive and negative environmental impacts of lockdown in the many places around the world, but some for example, in national parks and zoos were affected as people have lost their jobs in the conservation sector [25].

Table 1. *Environmental impacts of COVID-19 lockdowns, observed changes, timeframes, and representative sources.*

Environmental Aspect	Observed Change	Timeframe	Representative Sources
Air quality & greenhouse gases	Large short-term reductions in NO_2 (urban areas) and daily CO_2 (global peak ~17% decline) during strict lockdowns; emissions rebounded by late 2020–2021.	March–June 2020 (peak reductions); rebound by 2021.	[16, 15, 11]
Water quality	Improved clarity, reduced BOD, COD, and suspended matter in rivers and lakes near urban/industrial zones; short-lived, reverting after reopening.	March–May 2020 (strict lockdowns).	[21, 28, 20]
Household detergents / wastewater	Increased detergent and surfactant load from domestic wastewater, potentially raising BOD and ecotoxicological risk.	March–July 2020 (during confinement).	[17, 2]
Noise & seismic quieting	Reductions in anthropogenic noise and high-frequency seismic activity (up to 50% at some stations); quieter urban soundscapes.	March–August 2020.	[24, 18]
Wildlife & biodiversity ("anthropause")	Reduced human disturbance led to changes in animal movement and behavior; but conservation enforcement weakened in some regions.	April–August 2020 (global lockdown phases).	[22, 1]
Waste, PPE & plastics	Surge in PPE and single-use plastics (masks, gloves, packaging), leading to increased litter and pressure on waste systems.	April 2020 onwards (pandemic duration).	[15, 12]
Energy & rebound effects	Decline in global energy demand and CO_2 during early lockdowns; emissions rebounded strongly in 2021 with economic recovery.	March–June 2020 (reductions); rebound in 2021.	[6, 23]

Way Forward

The issue of climate change and environmental degradation have been some of the most challenging problems of the 21st century. IPCC [13, 14], reports have highlighted the importance of reducing some environmental degradation to combat climate change. Activities such as carbon emission, deforestation, conversion of wetlands to agricultural fields and over-grazing are some of the major problems leading to climate change. Governments and NGOs have been on the other hand advocating for the implementation of policies, treaties and laws to reduce such environmental problems caused by human activities. It evident that controlling human activities to management natural resources will improve environmental quality. This will assist vulnerable communities to deal with impacts climate change in the future as its impacts are expected to increase in decades to come. Committee of Parties are another important step taken by world leaders to mitigate the impacts of human activities on the environmental. Natural resources are become scarce and due to excessive utilization by humans thus increasing the ecological footprint [7]. Reduced pollution, industrial activities and waste generation have drastically improved water quality, air quality, clean recreation and tourism site. However, some studies showed that activities of poaching have increased due to insufficient funds to patrol parks [29]. Measures and special funds can be set aside for such unprecedented events to manage these important places and wildlife.

4. Conclusions

This review shows that the COVID-19 lockdowns provided an unprecedented global "experiment" in reducing human pressures on the environment. Air quality and greenhouse gas emissions improved markedly during strict restrictions, water bodies in many regions showed temporary recovery, noise levels and seismic activity dropped, and some wildlife benefited from reduced human disturbance. At the same time, the pandemic exacerbated other environmental risks, including increased detergent and surfactant pollution from domestic wastewater, surges in medical waste and PPE, disruption of conservation activities, and a strong rebound in energy demand and emissions once restrictions eased.

The overarching lesson is that short-term behavioral changes, while powerful, are insufficient to achieve lasting environmental improvements. To translate these insights into sustainable progress, policy must:

1) Strengthen environmental monitoring systems including urban wastewater and emerging pollutants like detergents and PPE.
2) Invest in resilient waste management and circular economy approaches, ensuring safe disposal of medical waste and reducing reliance on single-use plastics.
3) Align recovery packages with climate and biodiversity goals, prioritizing renewable energy, green infrastruc-

ture, and sustainable mobility.

4) Support conservation financing and enforcement, particularly in low- and middle-income countries where lockdowns disrupted protection efforts.
5) Encourage structural shifts such as teleworking, reduced travel, and sustainable consumption, building on behaviour trailed during lockdowns.

The COVID-19 pandemic highlighted both the fragility and resilience of natural systems. While the environmental gains were temporary, they underscore the scale of change achievable when human activity is curtailed. Embedding these lessons into long-term strategies is essential to mitigate climate change, protect biodiversity, and ensure sustainable use of natural resources in the decades ahead.

Abbreviations

BBC	British Broadcasting Corporation
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CNBC	Consumer News and Business Channel
CO_2	Carbon Dioxide
COVID-19	Coronavirus Disease 2019
DC	District of Columbia
FAO	Food and Agriculture Organization
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
NGO(s)	Non-Governmental Organization(s)
NO_2	Nitrogen Dioxide
ORCID	Open Researcher and Contributor ID
PPE	Personal Protective Equipment
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SDGs	Sustainable Development Goals
UK	United Kingdom
UN	United Nations
US	United States
VOC	Volatile Organic Compounds
WHO	World Health Organization

Author Contributions

Abdullahi Hassan Gana: Conceptualization, Methodology, Literature review, Data curation, Writing: Original Draft.

Abba Idris Sa'id: Validation, Writing: Review & Editing, Critical revision for intellectual content.

Conflicts of Interest

The authors declare no conflicts of interest.

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